TETRA TECH

# STATE-ONLY OPERATING PERMIT APPLICATION

## FOR
## MOUNT UNION STATION

***Performed for:***

**SUNOCO PIPELINE, L.P.**

***Prepared by:***

**Tetra Tech, Inc.**
**Foster Plaza 7**
**661 Andersen Drive**
**Pittsburgh, Pennsylvania 15220**

**May 20, 2014**

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# STATE-ONLY OPERATING PERMIT APPLICATION FOR MOUNT UNION STATION

**Submitted to:**

**Pennsylvania Department of Environmental Protection**
**South-central Regional Office**
**909 Elmerton Avenue**
**Harrisburg, Pennsylvania 17110**

**Submitted by:**

**Tetra Tech, Inc.**
**Foster Plaza 7**
**661 Andersen Drive**
**Pittsburgh, Pennsylvania 15220**

**On Behalf of:**

**Sunoco Pipeline, L.P.**

**MAY 2014**

**PREPARED UNDER THE DIRECTION OF:**

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**PITTSBURGH, PENNSYLVANIA**

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# SECTION 1

# REGULATORY ANALYSIS

# Regulatory Analysis

Following is a summary of state and federal rules and regulations that were reviewed to determine applicability to the sources (enclosed flare combusting natural gas and fugitive natural gas emissions from seal leaks) included this state-only operating permit application.

## State Regulatory Analysis

Pennsylvania Code Title 25 Environmental Protection Part I. Department of Environmental Protection Subpart C. Protection of Land Resources; Article II Air Resources

### Chapter 122. National Standards of Performance for New Stationary Sources

**Does not apply -** The Department determined that under Title 25 PA Code §127.14(a)(8) the source emissions are of minor significance (Appendix A).

### Chapter 123. Standards for contaminants

**25 § 123.1. Prohibition of certain fugitive emissions.**

**Does not apply -** The Department determined that under Title 25 PA Code §127.14(a)(8) the source emissions are of minor significance (Appendix A).

**25 § 123.2. Fugitive Particulate Matter.**

The flare is designed to produce no visible emissions and therefore visible emissions should not occur beyond the property boundary.

#### Particulate Matter Emissions

**25 § 123.11. Combustion Units.**

Particulate matter emissions from the flare are considered 0 micrograms per liter (µg/L) because the flare is smokeless (i.e., no visible emissions) and via AP-42 Table 13.5-1[1] the soot concentration of nonsmoking flares is 0 micrograms per liter (µg/L).

#### Sulfur Compound Emissions

**25 § 123.22. Combustion Units.**

**Does not apply –** Sulfur compound emissions will not occur because sulfur compounds will not be within the product stream that will be flared.

#### Odor Emissions

**25 § 123.31. Limitations.**

[1] United States Environmental Protection Agency (EPA), 1995. Compilation of Air Pollutant Emission Factors Volume 1: Stationary Point and Area Sources, Fifth Edition.

**Does not apply –** Control of malodors will not be necessary because malodorous air contaminants from the flare will not be detectable outside of the property where the flare is being operated. No malodorous compounds (e.g. mercaptan) will be contained in the product stream being flared.

### Visible Emissions

**25 § 123.41. Limitations.**

The flare is designed to produce no visible emissions and therefore the opacity of emissions will not exceed the limitations.

### Nitrogen Compound Emissions

**25 § 123.51. Monitoring requirements.**

**Does not apply –** The maximum heat input of the flare is 10 million BTUs per hour and this regulation only applies to combustion units with a rated heat input of 250 mill BTUs per hour or greater with annual average capacity factor of greater than 30%.

## Chapter 124. National Emission Standards for Hazardous Air Pollutants

**Does not apply –** Emissions from sources included in this application do not include hazardous air pollutants.

## Chapter 127. Construction, Modification, Reactivation, and Operation of Sources

**25 § 127.11 → 25 § 127.52**

**Does not apply –** The Department determined that the sources in this application are exempt from plan approval (Appendix A).

**25 § 127.81 → 25 § 127.83**

**Does not apply -** The Department determined for that under Title 25 PA Code §127.14(a)(8) the source emissions are of minor significance (Appendix A) and therefore would not trigger the requirements of the Prevention of Significant Deterioration promulgated by the United States Environmental Protection Agency under the Clean Air Act.

### Subchapter E. NEW SOURCE REVIEW

**25 § 127.201 → 25 § 127.18**

The Department determined that this project will not trigger the requirements of 25 PA Code Subchapter E or 40 CFR Part 52 (Appendix A).

An Applicability determination was conducted per 25 § 127.2013a and was included in the request for determination of minor significance and exemption from Plan Approval/Operating Permit under code 25 § 127.14 or 25 § 127.449. The conclusion of the applicability determination is that no New Source Review (NSR) pollutants emitted by the proposed source will cause a significant emissions increase or a significant net emissions increase (Appendix B).

## Subchapter F. OPERATING PERMIT REQUIRMENTS

**25 § 127.401**

Based upon review of a request for determination of minor significance and exemption from Plan Approval/Operating Permit under code 25 § 127.14 or 25 § 127.449 the Department determined that this project is not exempt from the operating permit requirements (Appendix A).

**25 § 127.411**

All required contents of the application are included except for those specified in a(6), a(7), a(8), and a(10) because those requirements were not requested by the Department (Appendix A).

**25 § 127.412**

Compliance review forms signed by a corporate officer are included in this State Only Operating Permit application.

**25 § 127.413**

A municipal notification was mailed that clearly describes the source and states there is a 30-day comment period which begins upon receipt of the notice (Appendix C). Proof of receipt will be forwarded to the Department.

**25 § 127.414**

If necessary, supplemental information will be submitted to the Department in accordance with 25 §127.414.

## Subchapter G. TITLE V OPERATING PERMITS

**25 § 127.501 → 25 § 127.543**

**Does not apply -** The Department determined that under Title 25 PA Code §127.14(a)(8) the source emissions are of minor significance (Appendix A).

## Subchapter H. GENERAL PLAN APPROVALS AND OPERATING PERMITS

**25 § 127.601 → 25 § 127.642**

**Does not apply –** This is project is not applicable for a general operating permit.

## Subchapter I. PLAN APPROVAL AND OPERATING PERMIT FEES

**25 § 127.703**

All operating permits fees were submitted to the Department prior to submittal of this application.

## Chapter 128. Alternative Emission Reduction Limitations

**Does not apply –** No proposal for an alternative emission reduction plan is included in this application.

## Chapter 129. Standards for Sources

**Does not apply –** The source in this application is not listed in this chapter. For example, this project is not for a petroleum refinery, bulk gasoline terminal, bulk gasoline plant, or an ethylene production plant.

## Chapter 135. Reporting of Sources

**25 § 135.2(6)**

**Does not apply -** The Department determined that under Title 25 PA Code §127.14(a)(8) the source emissions are of minor significance (Appendix A).

## Chapter 139. Sampling and Testing

**25 § 139.1 → 25 § 139.33**

Annual emissions performance testing will occur per the flare manufacturers recommended maintenance (Appendix B). Additionally, performance testing results were previously provided to the Department and are included in this application (Appendix B).

# Federal Regulatory Analysis

## 40 CFR Part 60 – Standards of Performance for New Stationary Sources

**Subpart Kb - Standards of Performance for Volatile Organic Liquid Storage Vessels (Including Petroleum Liquid Storage Vessels) for Which Construction, Reconstruction, or Modification Commenced after July 23, 1984**

**Does not apply –** Volatile organic compounds (VOCs) will not be stored in vessels on-site.

**Subpart XX - Standards of Performance for Bulk Gasoline Terminals**

**Does not apply –** The property on which the source is located is not a bulk gasoline terminal.

**Subpart IIII - Standards of Performance for Stationary Compression Ignition Internal Combustion Engine**

**Does not apply –** All pumping devices used to transport material will utilize electricity supplied by a public utility.

**Subpart JJJJ - Standards of Performance for Stationary Compression Ignition Internal Combustion Engine**

**Does not apply –** All pumping devices used to transport material will utilize electricity supplied by a public utility.

**Subpart OOOO - Standards of Performance for Crude Oil and Natural Gas Production, Transmission and Distribution**

**Does not apply –** The source is located at a pump station and pumping stations are not listed as a source affected by this subpart 40 CFR 60 § 60.5365.

# SECTION 2

# STATE-ONLY APPLICATION FORM

2700-PM-AQ0013 Rev. 8/2009

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY

# STATE-ONLY PERMIT APPLICATION

| FOR OFFICIAL USE ONLY |
|---|
| State-Only OP Number: _____ |
| Reviewed by: _____ |
| Date: _____ |
| Comments: _____ |

## Section 1 - General Information

### 1.1 Application Type

Type of permit for which application is made: (Check one)

- ☒ Initial
- ☐ Renewal Operating Permit No. _____
- ☐ Application Revision

### 1.2 Plant Information

Federal Tax ID: 23-3102656 Firm Name: Sunoco Pipeline L.P.

Plant Code: _____ Plant Name: Mount Union Station

NAICS Code: 486990 SIC Code: 4619

Description of NAICS Code: All Other Pipeline Transportation

Description of SIC Code: Pipelines, Not Elsewhere Classified

County: Huntingdon Municipality Shirley Township

Latitude: 40.345051 Longitude: -77.865313

Horizontal Reference Datum: NAD 1983 Horizontal Collection Method: NTDEP Reference Point: CNTAR

### 1.3 Contact Information

Name: Matt Gordon Title: Project Manager

Address: 525 Fritztown Road
Sinking Spring, PA 19608

Telephone Number: (610) 670-3284

Email Address: mlgordon@sunocologistics.com

### 1.4 Certification of Truth, Accuracy and Completeness

Note: This certification must be signed by a responsible official. Applications without a signed certification will be returned as incomplete.

I certify under penalty of law that, based on information and belief formed after reasonable inquiry, the statements and information contained in this application are true, accurate, and complete.

(Signed) [signature] Date: 5/16/2014

Name (Typed): Matt Gordon Title: Principal Engineer

**Please read instructions carefully before completing this application.**

## Section 2 - Site Information

### 2.1 Potential Emission Estimates for the Site

**Provide the estimated potential emission for the site BEFORE and AFTER utilizing the proposed restriction(s) and/or limitation(s).**

| Pollutant or CAS No. | Potential Emission BEFORE taking Limitations (TPY) | Potential Emission AFTER taking Limitations (TPY) |
|---|---|---|
| CO2e | 0.00E+00 | 6.72E-02 |
| CO2 | 0.00E+00 | 6.69E-02 |
| N2O | 0.00E+00 | 6.16E-07 |
| CH4 | 0.00E+00 | 3.08E-06 |
| CO | 0.00E+00 | 1.72E-04 |
| Total VOCs | 2.42E+01 | 2.48E-01 |
| Butane | 2.42E+01 | 2.48E-01 |
| Total HAPs | 0.00E+00 | 0.00E+00 |
| | | |
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*** Provide all supporting calculation methods as an attachment at the end of this application.**

### 2.2 Facility Type

Is this facility a Synthetic Minor Facility? Yes ☐ No ☒

**If yes, go to Section 2.3, "Synthetic Minor Facility".**

**If no, go to Section 3, "Site Inventory".**

**IMPORTANT**: Note that all Synthetic Minor Facilities must be able to meet the proposed restriction(s) and/or limitation(s) immediately upon the submission of this application. By signing the Certification of Compliance in Section 13 of this application, the facility for which a Synthetic Minor Status is proposed will be deemed a Synthetic Minor Facility according to the restriction(s) and/or limitation(s) proposed upon receipt of the application by the Department, unless the Department determines that the facility is unable to meet the Synthetic Minor requirements at a later date.

**Please read instructions carefully before completing this application.**

**2.3 Synthetic Minor Facility Information (to be completed by all facilities seeking Synthetic Minor Status)**

Synthetic Minor Status for this facility can be taken at the: Source Level ☐ AND/OR Site Level ☐

**If limitation(s) and/or restriction(s) can be taken at the site level (for all sources within this facility), complete the following questions, otherwise please go on to Section 3, "Site Inventory".**

Synthetic Minor Status for the Entire Site is achievable through the following restrictions: (Please check all that apply and describe in detail what is/are proposed):

| | | |
|---|---|---|
| ☐ | Hours of Operation | |
| ☐ | Production/Throughput Rate | |
| ☐ | Type of Fuel | |
| ☐ | Fuel Usage | |
| ☐ | Control Devices | |
| ☐ | Emissions Limitiations | |
| ☐ | Other | |

Describe how the elected restriction(s) will allow the facility to become a Synthetic Minor

**Note: If Section 2.3 is completed and there are no additional restrictions proposed at the source level, the applicant can omit Subsections 5, 6, and 7 in Sections 5, 6, and 7 for all sources in this permit application.**

**2.4 Compliance Method for the Site (for Synthetic Minor Facilities only)**

**Complete this section only if limitation(s) and/or restriction(s) were proposed in Section 2.3.**

a. Explain how you would demonstrate compliance with the restriction(s) and/or limitation(s) listed in Section 2.3:

b. Describe what is to be reported in the compliance report:

c. Reporting start date:

d. Indicate the frequency for submitting compliance report as explained above:

**Please read instructions carefully before completing this application.**

## Section 3 - Site Inventory

List all air pollution sources, control equipment, emission points and fuel material locations at this site. Duplicate this page as necessary. For renewals, only list sources not included in current permit.

| Unit ID No. | Company Designation | Unit Type |
|---|---|---|
| *101* | *John Zink Enclosed Flare* | *4' by 30' Enclosed ZTOF Production Flare* |
| *102* | *Fugitive Emissions from seal leaks* | *pump seals* |
| *103* | *Maintenance (Pigging) Operations* | *pipe line* |
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## Section 4 - Source Group (Optional)

### 4.1 Source Group Definition

This section applies to new State-Only Operating Permit applications only.

Define groups of source(s) that are subject to one or more applicable requirements that apply to all source(s) in the group.

| Group No. | Source ID (for source(s) in this group) |
|---|---|
| | |
| | |
| | |
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### 4.2 Applicable Requirements for Source Groups

For renewals, only list group level requirements not included in the current State-Only Operating Permit. If there are no changes, check the box to the right.

☐ No changes from current State-Only Operating Permit.

Describe and cite all applicable requirements pertaining to all source groups.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

| Group Number | Citation Number | Citation Limitation | Limitation Used |
|---|---|---|---|
| | | | |
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**Please read instructions carefully before completing this application.**

## Section 5 - Combustion Operational Inventory

(Complete this section for each combustion source in this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new combustion unit listed in Section 3 of this application.

### 5.1 General Source Information

a. Unit ID No.: _____ b. Company Designation: _____

c. Plan Approval or Operating Permit Number: _____

d. Manufacturer: _____ e. Model Number: _____

f. Source Description: _____

g. Rated Heat Input/Thruput: _____ h. Installation Date: _____

i. Exhaust Temperature: _____ Units: _____ j. Exhaust % Moisture: _____ k. Exhaust Flow Volume: _____ SCFM

### 5.2 Exhaust System Components

Explain how the exhaust components are configured:

| From Unit | Unit Description | To Unit | Unit Description | Percent Flow |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
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| | | | | |
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### 5.3 Source Classification Code (SCC) Listing for Standard Operation

| Fuel/Material | Associated SCC | Max Throughput Rate | Firing Sequence |
|---|---|---|---|
| | | | |
| | | | |
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| | | | |
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**5.4 Maximum Fuel Physical Characteristics**

If taking limitations on Fuel Physical Characteristics, see instructions.

| SCC/Fuel Burned | FML* | % Sulfer | % Ash | BTU Content (Units) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

*FML = Fuel Material Loction

**5.5 Limitations on Source Operation (optional)**

Maximum amount of hours of source operation per year: _____

| | | |
|---|---|---|
| ☐ | Hours of Operation | |
| ☐ | Production Throughput Rate | |
| ☐ | Type of Fuel | |
| ☐ | Fuel Usage | |
| ☐ | Control Devices | |
| ☐ | Emissions Limitations | |
| ☐ | Other | |

Describe how the elected restriction(s) will allow the facility to become a Synthetic Minor?

**5.6 Compliance Method for this source (for Synthetic Minor Sources only)**

Complete this section only if limitation(s) and/or restriction(s) were proposed in Section 5.5.

a. Explain how you would demonstrate compliance with the restriction(s) and/or limitation(s):

_____

_____

b. Describe what is to be reported in the compliance report:

_____

_____

c. Reporting start date: _____

d. Indicate the frequency for submitting compliance report as explained above: _____

**5.7 Source Potential to Emit (for Synthetic Minor Sources only)**

Give Potential Emission estimate for all air pollutants emitted at this source. Calculations for the Potential Emissions Estimate here should have included the restriction(s) and/or proposed in Section 5.5, if applicable.

| Pollutant or CAS Number | Fuel/SCC | Emissions/Activity Allowable per Unit | Calc. Method | Max. Capacity | Total Hours | Emission in TPY |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
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| | | | | | | |

**5.8 Source Applicable Requirements**

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list group level requirements not included in the current State Only Operating Permit. If there are no changes, check the box to the right.

☐ No changes from current State Only Operating Permit.

| Fuel/SCC | Citation Number | Citation Limitation | Limitation Used |
|---|---|---|---|
| | | | |
| | | | |
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**Please read instructions carefully before completing this application.**

## Section 6 - Incinerator Operational Inventory

(Complete this section for each incinerator at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new incinerator listed in Section 3 of this application.

### 6.1 General Source Information

a. Unit ID: _____ b. Company Designation: _____

c. Plan Approval or Operating Permit Number: _____

d. Manufacturer: _____ e. Model Number: _____

f. Source Description: _____

g. Rated Heat Input/Thruput: _____ h. Installation Date: _____

i. Exhaust Temperature: _____ Units: _____ j. Exhaust % Moisture: _____ k. Exhaust Flow Volume: _____ SCFM

l. Inc. Capacity: _____ Lbs/Hr m. Primary Burner Heat Input: Units:

n. Exhaust % $CO_2$: _____ o. Secondary Burner Heat Input: _____ Units: _____

p. Incinerator Class: _____

q. Waste Type: _____ r. Waste BTU/lb: _____

### 6.2 Exhaust System Components

Explain how the exhaust components are configured:

| From Unit | Unit Description | To Unit | Unit Description | Percent Flow |
|---|---|---|---|---|
| | | | | |
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| | | | | |

**Please read instructions carefully before completing this application.**

| 6.3 Source Classification Code (SCC) Listing for Standard Operation | | | |
|---|---|---|---|
| **Fuel/Material** | **Associated SCC** | **Max. Throughput Rate** | **Firing Sequence** |
| | | | |
| | | | |
| | | | |
| | | | |

**6.4 Maximum Fuel Physical Characteristics**

If taking limitations on Fuel Physical Characteristics, see instructions.

| SCC/Fuel Burned | FML* | % Sulfur | % Ash | BTU Content (Units) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |

*FML = Fuel Material Location

| 6.5 Limitations on Source Operation (optional) (for Synthetic Minor Sources only) | | |
|---|---|---|
| Maximum amount of hours of source operation per year: _____ | | |
| ☐ | Hours of Operation | |
| ☐ | Production Throughput Rate | |
| ☐ | Type of Fuel | |
| ☐ | Fuel Usage | |
| ☐ | Control Devices | |
| ☐ | Emissions Limitations | |
| ☐ | Other | |

Describe how the elected restriction(s) will allow the facility to become a Synthetic Minor?

**Please read instructions carefully before completing this application.**

**6.6 Compliance Method for this source (for Synthetic Minor Sources only)**

**Complete this section only if limitation(s) and/or restriction(s) were proposed in Section 6.5.**

a. Explain how you would demonstrate compliance with the restriction(s) and/or limitation(s):

_____

_____

_____

b. Describe what is to be reported in the compliance report:

_____

_____

_____

c. Reporting start date: _____

d. Indicate the frequency for submitting compliance report as explained above: _____

**6.7 Source Potential to Emit (for Synthetic Minor Sources only)**

Give Potential Emission estimate for all air pollutants emitted at this source. Calculations for the Potential Emissions Estimate here should have included the restriction(s) and/or limitation(s) proposed in Section 6.5, if applicable.

| Pollutant or CAS Number | Fuel/SCC | Emissions/Activity Allowable per Unit | Calc. Method | Max. Capacity | Total Hours | Emission in TPY |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
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**6.8 Source Applicable Requirements**

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list group level requirements not included in the current State Only Operating Permit. If there are no changes, check the box to the right.

☐ No changes from current State Only Operating Permit.

| Fuel/SCC | Citation Number | Citation Limitation | Limitation Used |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

## Section 7 – Process Operational Inventory

(Complete this section for each process at this site. Duplicate this section as needed).

For renewals, review and correct any pre-printed information and add additional sections for any new incinerator listed in Section 3 of this application.

### 7.1 General Source Information

a. Unit ID: 101 b. Company Designation: John Zink - Enclosed Flare

c. Plan Approval or Operating Permit Number: TBD

d. Manufacturer: John Zink e. Model Number: ZTOF04X30PF

f. Source Description: Enclosed Flare

g. Rated Heat Input/Thruput: 10,000,000 BTU/Hour - Max h. Installation Date: TBD - Tenative August 2014

i. Exhaust Temperature: 1660 Units: F j. Exhaust % Moisture: 6.1 k. Exhaust Flow Volume: 4,848 SCFM

### 7.2 Exhaust System Components

Explain how the exhaust components are configured:

| From Unit | Unit Description | To Unit | Unit Description | Percent Flow |
|---|---|---|---|---|
| 101 | pump station seal leaks | CD101 | John Zink - Enclosed Flare | |
| 102 | fugitive emissions from pump seal leaks | atmosphere | | |
| 103 | maintenance (pigging) operations | CD101 | John Zink - Enclosed Flare | |
| | | | | |
| | | | | |
| | | | | |

### 7.3 Source Classification Code (SCC) Listing for Standard Operation

| Fuel/Material | Associated SCC | Max. Throughput Rate | Firing Sequence |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

**7.4 Maximum Fuel Physical Characteristics**

If taking limitations on Fuel Physical Characteristics, see instructions.

| SCC/Fuel Burned | FML* | % Sulfur | % Ash | BTU Content (Units) |
|---|---|---|---|---|
| Butane | | 0 | 0 | 2,980 (BTU/scf) |
| Propane | | 0 | 0 | 2,370 (BTU/scf) |
| Ethane | | 0 | 0 | 1,630 (BTU/scf) |
| | | | | |

*FML = Fuel Material Location

**7.5 Limitations on Source Operation (optional) (for Synthetic Minor Sources only)**

Maximum amount of hours of source operation per year: _____

| | | |
|---|---|---|
| ☐ | Hours of Operation | |
| ☐ | Production Throughput Rate | |
| ☐ | Type of Fuel | |
| ☐ | Fuel Usage | |
| ☐ | Control Devices | |
| ☐ | Emissions Limitations | |
| ☐ | Other | |

Describe how the elected restriction(s) will allow the facility to become a Synthetic Minor?

**7.6 Compliance Method for this source (for Synthetic Minor Sources only)**

**Complete this section only if limitation(s) and/or restriction(s) were proposed in Section 7.6.**

a. Explain how you would demonstrate compliance with the restriction(s) and/or limitation(s):

_____

_____

b. Describe what is to be reported in the compliance report:

_____

_____

c. Reporting start date: _____

d. Indicate the frequency for submitting compliance report as explained above: _____

**7.7 Source Potential to Emit (for Synthetic Minor Sources only)**

Give Potential Emission estimate for all air pollutants emitted at this source. Calculations for the Potential Emissions Estimate here should have included the restriction(s) and/or limitation(s) proposed in Section 7.5, if applicable.

| Pollutant or CAS Number | Fuel/SCC | Emissions/Activity Allowable per Unit | Calc. Method | Max. Capacity | Total Hours | Emission in TPY |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
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**7.8 Source Applicable Requirements**

Describe and cite all applicable requirements pertaining to this source.

Note: A Method of Compliance Worksheet (Addendum 1) must be completed for each requirement listed.

For renewals, only list group level requirements not included in the current State Only Operating Permit. If there are no changes, check the box to the right.

☐ No changes from current State Only Operating Permit.

| Fuel/SCC | Citation Number | Citation Limitation | Limitation Used |
|---|---|---|---|
| | | | |
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## Section 8 – Control Device Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new control device listed in Section 3 of this application.

### 8.1 General Control Device Information

a. Unit ID: CD101 b. Company Designation: John Zink - Enclosed Flare

c. Used by Sources: Mariner East Pipeline

d. Type: Enclosed Flare

e. Pressure Drop in $H_2O$: ~ 10 psig at max flow rate f. Capture Efficiency: 99.9

g. Scrubber Flow Rate (GPM): Not Applicable

h. Manufacturer: John Zink Company LLC i. Model Number: ZTOF04X30PF

j. Installation Date: TBD - Tenative August 2014

### 8.2 Control Device Efficiencies for this Control Device:

| Pollutant Name | CAS Number | Estimated Control Efficiency | Basis for Efficiency Estimate |
|---|---|---|---|
| Butane (VOC) | 106-97-8 | 99.9 | EPA 40 CFR Part 60 Subpart OOOO Stack Emission Study. Performance criteria of the Emission Control Device was assessed as per 40 CFR Part 60, specifically paragraph §60.5413(d)(11) from the September 23rd, 2013 publication of the new NSPS for the Oil and Natural Gas Sector. |
| Propane (VOC) | 74-98-6 | 99.9 | see above |
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**Please read instructions carefully before completing this application.**

## Section 9 – Stack/Flue Information (duplicate this section as needed)

For renewals, review and correct any pre-printed information and add additional sections for any new stack/flue listed in Section 3 of this application.

### 9.1 General Stack/Vent Information

a. Unit ID: S101 b. Company Designation: John Zink - Enclosed Flare

c. Discharge Type: Enclosed Flare

d. Diameter (ft): 4 Height (ft): 30 Base Elevation (ft): 4

e. Exhaust Temperature: 1,660 F Exhaust % Moisture: 6.1 Exhaust Velocity: 27.3 ft/sec

f. Exhaust Volume: 20,583 ACFM Exhaust Volume: 4,848 SCFM

g. Distance to Nearest Property Line (ft): ~ 115 feet

h. Weather Cap?: ☒ Yes ☐ No

i. Used by Sources:

j. Latitude: 40.345051 Longitude: -77.865313

Horizontal Reference Datum: NAD 1983 Horizontal Collection Method: NTDEP Reference Point: CNTAR

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a. Unit ID: b. Company Designation:

c. Discharge Type:

d. Diameter (ft): Height (ft): Base Elevation (ft):

e. Exhaust Temperature: Exhaust % Moisture: Exhaust Velocity:

f. Exhaust Volume: ACFM Exhaust Volume: SCFM

g. Distance to Nearest Property Line (ft):

h. Weather Cap?: ☐ Yes ☐ No

i. Used by Sources:

j. Latitude: Longitude:

Horizontal Reference Datum: Horizontal Collection Method: Reference Point:

## Section 10 – Fuel Material Location (FML) Information (Optional)

For renewals, review and correct any pre-printed information and add additional sections for any new FML listed in Section 3 of this application.

### 10.1 Fuel Material Location Information

a. FML ID Number: _____ b. Name: _____

c. Capacity: _____ Units: _____ d. Fuel: _____

e. Maximum Fuel Characteristics: If fuel is coal, what is the moisture content? _____

% Ash: % Sulfur: BTU Content: Units:

f. Used by Source:

_____

a. FML ID Number: _____ b. Name: _____

c. Capacity: _____ Units: _____ d. Fuel: _____

e. Maximum Fuel Characteristics: If fuel is coal, what is the moisture content? _____

% Ash: _____ % Sulfur: _____ BTU Content: _____ Units: _____

f. Used by Source:

_____

a. FML ID Number: _____ b. Name: _____

c. Capacity: _____ Units: _____ d. Fuel: _____

e. Maximum Fuel Characteristics: If fuel is coal, what is the moisture content? _____

% Ash: _____ % Sulfur: _____ BTU Content: _____ Units: _____

f. Used by Source:

_____

**Please read instructions carefully before completing this application.**

## Section 11 – Alternative Operating Scenario (optional)

**(Duplicate this section for each source participated in this alternative scenarios)**

### 11.1 General Information

a. Alternative Operating Scenario Name or ID No.: _____

b. Source ID No.: _____ c. Source Name: _____

d. Source Type (check one): ☐ Combustion ☐ Incinerator ☐ Process

e. Give a brief description of this alternative scenario stating how it is different from the standard operation:

### 11.2 Operational Flexibility Request

Check all that apply.

☐ Alternative exhaust system component configuration.
If this box is checked, complete Sections 11.3 and 11.7

☐ Alternative type of fuel replacing or in addition to an existing fuel in standard operation.
If this box is checked, complete Sections 11.4 and/or 11.5 and 11.7

☐ Alternative process method replacing or in addition to a process SCC existing in standard operation.
If this box is checked, complete Sections 11.6 and 11.7

☐ Alternative lower limitations.

### 11.3 Exhaust System Components

Specify the complete exhaust system component configuration for this alternative operating scenario.

| From Component Type | From Component Number | To Component Type | To Component Number | Percent Flow | Begin Date | End Date |
|---|---|---|---|---|---|---|
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**11.4 Source Classification Code (SCC) Listing for Alternative Operation**

Give a complete listing of all fuels burned, products produced by a process or waste incinerated for this alternative operating scenario.

| Fuel | Associated SCC | Max. Throughput Rate | Firing Sequence |
|---|---|---|---|
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**11.5 Alternative Fuel Physical Characteristics**

Give a complete listing of all fuels physical characteristics for this alternative operating scenario.

| SCC/Fuel Burned | FML | % Sulfur | % Ash | BTU Content (Units) |
|---|---|---|---|---|
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**11.6 Alternative Process/Product Description**

a. Briefly describe the change(s) in raw materials and/or process methods used in this operating scenario, if applicable:

b. Provide and briefly describe the process SCC associated with this alternative operating scenario:

| Process SCC: | | SCC Description: | |
|---|---|---|---|

c. Alternative Product(s):

**Please read instructions carefully before completing this application.**

| **11.7 Source Potential to Emit** | | | | | | |
|---|---|---|---|---|---|---|
| Give Potential Emission estimate for all air pollutants emitted at this source for this operating scenario. | | | | | | |
| **Pollutant or CAS Number** | **Fuel** | **Emissions/Activity Allowable per Unit** | **Calc. Method** | **Max. Capacity** | **Total Hours** | **Emission in TPY** |
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## Section 12 – Compliance Plan for the Facility

| | | Yes | No |
|---|---|---|---|
| 12.1 | Will your facility be in compliance with all applicable requirements at the time of permit issuance and continue to comply with these requirements during the permit duration? | ☒ | ☐ |
| 12.2 | Will your facility be in compliance with all applicable requirements presently scheduled to take effect during the term of the permit? | ☒ | ☐ |
| 12.3 | Will these requirements be met by the regulatory required dates? | ☒ | ☐ |

If you checked "NO" in part 12.1, 12.2 or 12.3, answer the following questions:

12.4 Identify applicable requirement(s) for which compliance is not or will not be achieved:

| Source ID Number | Citation Number |
|---|---|
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12.4.1 Briefly describe how compliance with this/these applicable requirement(s) will be achieved:

12.4.2. Provide a detailed schedule of compliance for the non-complying sources or activities identified in this section of the application. Include an enforceable sequence of corrective actions with milestone and projected compliance dates.

| Date | Action/Milestone |
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12.4.3. Indicate the submittal frequency for the progress report(s): _____

12.4.4. Starting date for the submittal of the progress report(s): _____

**Please read instructions carefully before completing this application.**

## Section 13 – Certification of Compliance for Synthetic Minor Source

In order for this Synthetic Minor facility to avoid the State-Only Operating Permit requirements, the applicant must agree to be bound by the emissions limitation(s) and/or restriction(s) contained in this application. In addition, the applicant must agree that these emission limitation(s) are enforceable by the Department, the Environmental Protection Agency and the citizens.

**13.1 Schedule for Compliance Certification Submission**

a. Frequency of submittal: _____

b. Beginning date: _____

**13.2 Certification of Compliance (for Synthetic Minor Facility only)**

I certify under the penalty of 18 Pa. CS 4904 (b) (2) that the sources covered by this application will comply with the emission limitations and other requirements contained in this application and all previously issued plan approvals and operating permits. I further certify that, based on information and belief formed after reasonable inquiry, the statements and information in this application are true, accurate, and complete.

(Signed) _____ Date _____

Name (Typed) _____

Title: _____

# SECTION 3

# COMPLIANCE REVIEW FORM

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY

# AIR POLLUTION CONTROL ACT COMPLIANCE REVIEW FORM

Fully and accurately provide the following information, as specified. Attach additional sheets as necessary.

**Type of Compliance Review Form Submittal (check all that apply)**

☒ Original Filing
☐ Amended Filing

Date of Last Compliance Review Form Filing:
_____/_____/_____

**Type of Submittal**

☐ New Plan Approval
☐ Extension of Plan Approval
☐ Other: _____
☒ New Operating Permit
☐ Change of Ownership
☐ Renewal of Operating Permit
☐ Periodic Submission (@ 6 mos)

## SECTION A. GENERAL APPLICATION INFORMATION

**Name of Applicant/Permittee/("applicant")**
**(non-corporations-attach documentation of legal name)**
Sunoco Pipeline, L.P.

**Address** 525 Fritztown Road
Sinking Spring, PA 19608

**Telephone** 610-670-3284 **Taxpayer ID#** 23-310-2656

**Permit, Plan Approval or Application ID#**

**Identify the form of management under which the applicant conducts its business (check appropriate box)**

☐ Individual
☐ Municipality
☐ Proprietorship
☐ Public Corporation
☐ Private Corporation
☐ Syndicate
☐ Municipal Authority
☐ Fictitious Name
☐ Partnership
☒ Limited Partnership
☐ Government Agency
☐ Joint Venture
☐ Association
☐ Other Type of Business, specify below:

**Describe below the type(s) of business activities performed.**
SIC Code: 4619 - Pipelines, Not Elsewhere Classified

## SECTION B. GENERAL INFORMATION REGARDING "APPLICANT"

**If applicant is a corporation or a division or other unit of a corporation, provide the names, principal places of business, state of incorporation, and taxpayer ID numbers of all domestic and foreign parent corporations (including the ultimate parent corporation), and all domestic and foreign subsidiary corporations of the ultimate parent corporation with operations in Pennsylvania. Please include all corporate divisions or units, (whether incorporated or unincorporated) and privately held corporations. (A diagram of corporate relationships may be provided to illustrate corporate relationships.) Attach additional sheets as necessary.**

| Unit Name | Principal Places of Business | State of Incorporation | Taxpayer ID | Relationship to Applicant |
|---|---|---|---|---|
| N/A | | | | |
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## SECTION C. SPECIFIC INFORMATION REGARDING APPLICANT AND ITS "RELATED PARTIES"

**Pennsylvania Facilities. List the name and location (mailing address, municipality, county), telephone number, and relationship to applicant (parent, subsidiary or general partner) of applicant and all Related Parties' places of business, and facilities in Pennsylvania. Attach additional sheets as necessary.**

| Unit Name | Street Address | County and Municipality | Telephone No. | Relationship to Applicant |
|---|---|---|---|---|
| see attachment #1 | | | | |
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**Provide the names and business addresses of all general partners of the applicant and parent and subsidiary corporations, if any.**

| Name | Business Address |
|---|---|
| Sunoco Logistics Partners Operations GP, LLC | 1818 Market Street, Philadelphia, PA 19103-3615 |
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**List the names and business address of persons with overall management responsibility for the process being permitted (i.e. plant manager).**

| Name | Business Address |
|---|---|
| see attachment #1 | |
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**Plan Approvals or Operating Permits. List all plan approvals or operating permits issued by the Department or an approved local air pollution control agency under the APCA to the applicant or related parties that are currently in effect or have been in effect at any time 5 years prior to the date on which this form is notarized. This list shall include the plan approval and operating permit numbers, locations, issuance and expiration dates. Attach additional sheets as necessary.**

| Air Contamination Source | Plan Approval/ Operating Permit# | Location | Issuance Date | Expiration Date |
|---|---|---|---|---|
| see attachment #2 | | | | |
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**Compliance Background. (Note: Copies of specific documents, if applicable, must be made available to the Department upon its request.) List all documented conduct of violations or enforcement actions identified by the Department pursuant to the APCA, regulations, terms and conditions of an operating permit or plan approval or order by applicant or any related party, using the following format grouped by source and location in reverse chronological order. Attach additional sheets as necessary. See the definition of "documented conduct" for further clarification. Unless specifically directed by the Department, deviations which have been previously reported to the Department in writing, relating to monitoring and reporting, need not be reported.**

| Date | Location | Plan Approval/ Operating Permit# | Nature of Documented Conduct | Type of Department Action | Status: Litigation Existing/Continuing or Corrected/Date | Dollar Amount Penalty |
|---|---|---|---|---|---|---|
| 07/27/02 | No. 2 Tank Farm | 23-00044 | The VOC RACT fugitive emissions monitoring did not occur during the 2nd qtr. Of 2002. Failure to monitor | NOV | Monitoring was performed for 2nd qtr. 2002 and the Department was notified. | $ 0 |
| 05/20/04 | Ft. Mifflin Terminal | 23-00037 | Product discovered on roof of a tank, as well as open hatch | NOV | Corrected within 30 days. | $ 0 |
| 03/06/06 | Twin Oaks Terminal | 23-00045 | Failure to submit 05/01/05-10/31/05 semiannual monitoring report | NOV | Confusion with reporting dates in new permit issued on 10/05/05 resulted in semiannual report being submitted late. Report was issued to the Department on 02/21/06. | $ 0 |
| 03/06/06 | Twin Oaks Terminal | 23-00045 | Failure to complete stack test in a timely manner. | NOV | New permit required stack test to be completed by 2/15/06. Stack test completed on 03/01/06. | $ 0 |
| 06/12/07 | Darby Creek Tank Farm | 23-00011 | Product on tank roofs, in oil/water boxes, around roof drain outlets, on ground below crude mixers, open vacuum breakers, open roof drain cover, absence of required records, absence of required seal gap notifications, lack of records of annual PRV checks. | NOV/CACP | Response to PADEP submitted on 6/29/07, challenging all findings of NOV and requesting NOV to be rescinded. Awaiting response. CACP issued May 2008. A review of the findings is pending. | $37,730 |
| 03/01/07 | Fort Mifflin Terminal | 23-00037 | Failure to submit semi-annual compliance certification/deviation report in a timely manner. | NOV | Response to PADEP, submitted on 4/4/07, requesting NOV to be rescinded. NOV issued before the due date of report. Awaiting response. | $0 |
| 07/20/07 | Fort Mifflin Terminal | 23-00037 | Observed seal gaps, observed torn seals, vapor pressure exceedances. | NOV/CACP | Response to PADEP submitted on 7/24/07, challenging all findings of NOV and requesting NOV to be rescinded. CACP issued May 2008. Entered into agreement to settle in order to avoid time and expense of challenging the findings. | $2,700 |
| 07/20/07 | No. 2 Tank Farm | 23-00044 | Failure to submit semiannual deviation report in a timely manner, absence of required records, absence of required seal gap notifications. | NOV/CACP | Response to PADEP submitted on 7/31/07, challenging two of three findings of NOV. CACP issued May 2008. Entered into agreement to settle in order to avoid time and expense of challenging the findings. | $2,200 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10/02/07 | Willow Grove Terminal | 46-00091 | Failure to obtain required approval prior to installing a control device and operating a source without a permit. | NOV/CACP | Response to PADEP in July 2008 agreeing to violations and penalty | $5,000 |
| 10/28/09 | Montello Terminal | 06-05064B | Construction of a Vapor Recovery Unit prior to approval from the department | NOV | Response to PADEP submitted 11/03/09 explaining problems associated with obtaining plan approval. Plan approval issued 11/19/09. | $1,500 |
| 02/09/11 | Mechanicsburg Terminal | Plan Approval 21-05029B | Failure to submit an administrative amendment application to roll plan approval conditions into operating permit at least 15 days prior to the end of the initial 180-day shakedown period | NOV | Administrative amendment submitted to Department 12/10/2010. | $0 |
| 02/09/11 | Montello Terminal | Plan Approval 06-05064B | Failure to submit an administrative amendment application to roll plan approval conditions into operating permit at least 15 days prior to the end of the initial 180-day shakedown period | NOV | Administrative amendment submitted to Department 12/10/2010. | $0 |
| 12/28/11 | Willow Grove Terminal | 46-0091 | Failure to notify PADEP 30 days prior to conducting a stack test | NOV/CACP | Corrective Action submitted Jan 10,2012. CACP pending. | $0 |
| 8/12/13 | Delmont Terminal | 65-00354 | Exceedances of tank 701 and 702 annual VOC limitation | NOV | Correspondence with PADEP to revise permit. | $0 |

**List all incidents of deviations of the APCA, regulations, terms and conditions of an operating permit or plan approval or order by applicant or any related party, using the following format grouped by source and location in reverse chronological order. This list must include items both currently known and unknown to the Department. Attach additional sheets as necessary. See the definition of "deviations" for further clarification.**

| Date | Location | Plan Approval/ Operating Permit# | Nature of Deviation | Incident Status: Litigation Existing/Continuing Or Corrected/Date |
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**<u>CONTINUING OBLIGATION</u>. Applicant is under a continuing obligation to update this form using the Compliance Review Supplemental Form if any additional deviations occur between the date of submission and Department action on the application.**

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| VERIFICATION STATEMENT | |
|---|---|
| Subject to the penalties of Title 18 Pa.C.S. Section 4904 and 35 P.S. Section 4009(b)(2), I verify under penalty of law that I am authorized to make this verification on behalf of the Applicant/Permittee. I further verify that the information contained in this Compliance Review Form is true and complete to the best of my belief formed after reasonable inquiry. I further verify that reasonable procedures are in place to ensure that "documented conduct" and "deviations" as defined in 25 Pa Code Section 121.1 are identified and included in the information set forth in this Compliance Review Form. | |
| Signature | 5/13/14<br>Date |
| D.R. CHALSON<br>Name (Print or Type) | |
| V.P. OPERATIONS<br>Title | |

**Attachment #1:** Names, Locations and Facility Managers for all Sunoco Partners Marketing & Terminals L.P. Related Parties in PA.

| Facility Name | Owner/Operator | Federal Tax ID # | SIC Code | Facility Address | City | Zip Code | County | Facility Manager | Office Number |
|---|---|---|---|---|---|---|---|---|---|
| Beaver Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | State Road, Box 49 | Beaver | 15009 | Beaver | Mark Whalen | 724-774-9440 |
| Belmont Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 2700 West Passyunk Ave | Philadelphia | 19145 | Philadelphia | Robert Gray | 215-339-2550 |
| Blawnox Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | Freeport Road & Boyd | Pittsburgh | 15238 | Allegheny | Mark Whalen | 412-828-7500 |
| Darby Creek Tank Farm | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4612 | Calcon Hook Road | Sharon Hill | 19079 | Delaware | Fred Ammons | 610-586-6240 |
| Delmont Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | Route 66 | North Delmont | 15626 | Westmoreland | Mark Whalen | 724-468-4072 |
| Eldorado (Altoona) Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | Rt. 764 N. & Sugar Run Road | Altoona | 16601 | Blair | Mark Whalen | 814-944-8153 |
| Exton Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 601 E. Lincoln Highway | Exton | 19134 | Chester | Robert Gray | 610-859-5793 |
| Ft. Mifflin | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | Hog Island Road | Essington | 19029 | Delaware | Fred Ammons | 215-365-6688 |
| Fullerton Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 2480 Main Street | Fullerton | 18052 | Lehigh | Terry Wolfe | 610-264-0526 |
| Hog Island Warf | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 4 Atlantic Avenue | Essington | 19029 | Delaware | Fred Ammons | 215-492-9161 |
| Kingston Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | Rt. 11, Box 1479 | Kingston | 18704-3102 | Luzerne | Terry Wolfe | 570-288-2555 |
| Malvern Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 41 Malin Road | Malvern | 10355 | Chester | Robert Gray | 610-296-4517 |
| Marcus Hook Industrial Complex | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 100 Green Street | Marcus Hook | 19061 | Chester | Jonathan Hunt | 610-859-1043 |
| Mechanicsburg Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 5145 Simpson Ferry Road | Mechanicsburg | 17055 | Cumberland | Terry Wolfe | 717-766-2526 |
| Montello Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | PO Box 2089, Fritztown Road | Montello | 19608 | Berks | Terry Wolfe | 610-927-2090 |
| Northumberland Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | Rd#1, Box 285 E | Northumberland | 17857 | Northumberland | Terry Wolfe | 570-473-3575 |
| Pittsburgh Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 5733 Butler Street | Pittsburgh | 15210 | Allegheny | Mark Whalen | 412-784-3460 |
| Tamaqua Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | Tuscarara Street And Park | Tamaqua | 18252 | Schuylkill | Terry Wolfe | 570-668-0430 |
| Twin Oaks Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 4041 Market Street | Aston | 19014 | Delaware | Robert Gray | 610-859-5742 |
| #2 Tank Farm | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4613 | 7 Commerce Drive | Aston | 19014 | Delaware | Fred Ammons | 610-859-1421 |
| Willow Grove Term. | Sunoco Partners Marketing & Terminals L.P. | 23-3102655 | 4226 | 3290 Sunset Lane | Hatboro | 19040 | Montgomery | Robert Gray | 215-442-1694 |
| Twin Oaks Term. | Sunoco Partners Marketing & Terminals L.P | 23-3102655 | 4226 | 4041 Market Street | Aston | 19014-3197 | Delaware | D.R. Chalson | 610-859-5754 |

## Attachment #2: Plan Approvals & Operating Permits

| Facility | Owner / Operator | State | Permit Type | Permit # | Effective | Expiration |
|---|---|---|---|---|---|---|
| Beaver (Brighton/ Vanport) | Sunoco Partners Marketing & Terminals L.P. | PA | Operating Permit | 04-00489 | 03/26/2006 | 03/27/2011 |
| Belmont | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | V04-004 | 08/01/2010 | 08/01/2015 |
| Blawnox | Sunoco Partners Marketing & Terminals L.P. | PA | Synthetic Minor | 0011 | 06/28/2011 | 06/27/2016 |
| Darby Creek | Sunoco Partners Marketing & Terminals L.P. | PA | General Permit | GP2-23-0225 | 02/11/2010 | 02/11/2015 |
| Darby Creek | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 23-00011 | 10/06/2011 | 10/06/2016 |
| Delmont | Sunoco Partners Marketing & Terminals, L.P. | PA | Title V Permit | 65-00354 | 01/31/2012 | 01/31/2017 |
| Eldorado | Sunoco Partners Marketing & Terminals L.P. | PA | Synthetic Minor | 07-05025 | 10/01/2008 | 9/30/2013 (renewal submitted 2/26/13) |
| Exton | Sunoco Partners Marketing & Terminals L.P. | PA | Synthetic Minor | 15-00044 | 05/01/2010 | 04/30/2015 |
| Fort Mifflin | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 23-00037 | 11/01/2010 | 10/31/2015 |
| Fullerton | Sunoco Partners Marketing & Terminals L.P. | PA | Synthetic Minor | 39-00022 | 04/07/2009 | 04/07/2014 |
| Hog Island Wharf | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 23-00043 | 11/15/2011 | 11/14/2016 |
| Kingston | Sunoco Partners Marketing & Terminals L.P. | PA | Synthetic Minor | 40-00025 | 07/21/2009 | 07/21/2014 |
| Marcus Hook Industrial Complex | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 23-0001 | Facility purchased 4/1/2013 | Major permit modification in process |
| Marcus Hook Industrial Complex | Sunoco Partners Marketing & Terminals L.P. | PA | Plan Approval | 23-0119 | 02/05/2013 | 08/5/2014 |
| Malvern | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 15-00043 | 04/30/2009 | 04/30/3014 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Mechanicsburg | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 21-05029 | 04/01/2009 (revised 02/09/2011) | 04/31/2014 |
| Montello | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 06-05064 | 05/01/2009 (revised 2/8/2011) | 04/30/2014 |
| Northumberland | Sunoco Partners Marketing & Terminals L.P. | PA | Synthetic Minor | 49-00019 | 5/27/2009 | 5/26/2014 |
| #2 Tank Farm | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 23-00044 | 10/01/2010 | 09/30/2015 |
| Pittsburgh | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 0007 | 06/30/2011 | 06/29/2016 |
| Tamaqua | Sunoco Partners Marketing & Terminals L.P. | PA | Synthetic Minor | 54-00015 | 8/31/2009 | 8/31/2014 |
| Twin Oaks | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 23-00045 | 10/21/2010 | 10/21/2015 |
| Willow Grove | Sunoco Partners Marketing & Terminals L.P. | PA | Title V Permit | 46-00091 | 6/23/2011 | 6/23/2016 |

# SECTION 4

# GENERAL INFORMATION FORM

1300-PM-BIT0001 5/2012
Form

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION

# GENERAL INFORMATION FORM – AUTHORIZATION APPLICATION

**Before completing this General Information Form (GIF), read the step-by-step instructions provided in this application package. This version of the General Information Form (GIF) must be completed and returned with any program-specific application being submitted to the Department.**

| Related ID#s (If Known) | | DEP USE ONLY |
|---|---|---|
| **Client ID#** | **APS ID#** | Date Received & General Notes |
| **Site ID#** | **Auth ID#** | |
| **Facility ID#** | | |

## CLIENT INFORMATION

| **DEP Client ID#** | **Client Type / Code** |
|---|---|
| | PARTL |

| **Organization Name or Registered Fictitious Name** | **Employer ID#** (EIN) | **Dun & Bradstreet ID#** |
|---|---|---|
| Sunoco Pipline L.P. | 23-3102656 | |

| **Individual Last Name** | **First Name** | **MI** | **Suffix** | **SSN** |
|---|---|---|---|---|
| Gordon | Matt | L | | |

| **Additional Individual Last Name** | **First Name** | **MI** | **Suffix** | **SSN** |
|---|---|---|---|---|
| | | | | |

| **Mailing Address Line 1** | **Mailing Address Line 2** |
|---|---|
| 525 Fritztown Road | |

| **Address Last Line – City** | **State** | **ZIP+4** | **Country** |
|---|---|---|---|
| Sinking Spring | PA | 19608 | |

| **Client Contact Last Name** | **First Name** | **MI** | **Suffix** |
|---|---|---|---|
| Gordon | Matthew | L | |

| **Client Contact Title** | **Phone** | **Ext** |
|---|---|---|
| Project Manager | (610) 670-3284 | |

| **Email Address** | **FAX** |
|---|---|
| mlgordon@sunocologistics.com | |

## SITE INFORMATION

| **DEP Site ID#** | **Site Name** |
|---|---|
| | Mount Union Station |

| **EPA ID#** | **Estimated Number of Employees to be Present at Site** | 0 / wkly insp. |
|---|---|---|

**Description of Site**
Natural Gas liquid pumping station

| **County Name** | **Municipality** | **City** | **Boro** | **Twp** | **State** |
|---|---|---|---|---|---|
| Huntingdon | Shirley | ☐ | ☐ | ☒ | |
| **County Name** | **Municipality** | **City** | **Boro** | **Twp** | **State** |
| | | ☐ | ☐ | ☐ | |

| **Site Location Line 1** | **Site Location Line 2** |
|---|---|
| | |

| **Site Location Last Line – City** | **State** | **ZIP+4** |
|---|---|---|
| Mount Union | PA | 17066 |

**Detailed Written Directions to Site**
909 Elmerton Ave Harrisburg, PA 17110 1. Head southwest on Elmerton Ave 0.2 mi 2. Take the 1st right onto US-22 W (signs forI-81/US-322/Carlisle 22/Lewistowz 55/Hazleton 80) 55.9 mi 3. Take the exit on the left onto US-22W/US-522S toward Mt. Union 22.8 mi. 4. Turn left onto US-522S/Croghan Pike. The Mt. Union pump station will be on the right approximately 3.6 miles down the road.

| **Site Contact Last Name** | **First Name** | **MI** | **Suffix** |
|---|---|---|---|
| Gordon | Matthew | L | |

| **Site Contact Title** | **Site Contact Firm** |
|---|---|
| Project Manager | Sunoco Pipeline, L.P. |

| **Mailing Address Line 1** | **Mailing Address Line 2** |
|---|---|
| 525 Frtiztown Road | |

| Mailing Address Last Line – City | State | ZIP+4 |
|---|---|---|
| Sinking Springs | PA | |

| Phone | Ext | FAX | Email Address |
|---|---|---|---|
| (610) 670-3284 | | | mlgordon@sunocologistics.com |

**NAICS Codes** (Two- & Three-Digit Codes – List All That Apply) **6-Digit Code** (Optional)
486990

**Client to Site Relationship**
OWNOP

## FACILITY INFORMATION

| Modification of Existing Facility | Yes | No |
|---|---|---|
| 1. Will this project modify an existing facility, system, or activity? | ☐ | ☐ |
| 2. Will this project involve an addition to an existing facility, system, or activity? | ☐ | ☐ |

*If "Yes", check all relevant facility types and provide DEP facility identification numbers below.*

| | Facility Type | DEP Fac ID# | | Facility Type | DEP Fac ID# |
|---|---|---|---|---|---|
| ☐ | Air Emission Plant | | ☐ | Industrial Minerals Mining Operation | |
| ☐ | Beneficial Use (water) | | ☐ | Laboratory Location | |
| ☐ | Blasting Operation | | ☐ | Land Recycling Cleanup Location | |
| ☐ | Captive Hazardous Waste Operation | | ☐ | MineDrainageTrmt/LandRecyProjLocation | |
| ☐ | Coal Ash Beneficial Use Operation | | ☐ | Municipal Waste Operation | |
| ☐ | Coal Mining Operation | | ☐ | Oil & Gas Encroachment Location | |
| ☐ | Coal Pillar Location | | ☐ | Oil & Gas Location | |
| ☐ | Commercial Hazardous Waste Operation | | ☐ | Oil & Gas Water Poll Control Facility | |
| ☐ | Dam Location | | ☐ | Public Water Supply System | |
| ☐ | Deep Mine Safety Operation -Anthracite | | ☐ | Radiation Facility | |
| ☐ | Deep Mine Safety Operation -Bituminous | | ☐ | Residual Waste Operation | |
| ☐ | Deep Mine Safety Operation -Ind Minerals | | ☐ | Storage Tank Location | |
| ☐ | Encroachment Location (water, wetland) | | ☐ | Water Pollution Control Facility | |
| ☐ | Erosion & Sediment Control Facility | | ☐ | Water Resource | |
| ☐ | Explosive Storage Location | | ☐ | Other: | |

| Latitude/Longitude Point of Origin | Latitude | | | Longitude | | |
|---|---|---|---|---|---|---|
| | Degrees | Minutes | Seconds | Degrees | Minutes | Seconds |
| | 40 | 20 | **42.19** | -77 | 51 | 55.13 |

**Horizontal Accuracy Measure** Feet --or-- Meters

**Horizontal Reference Datum Code**
- ☐ North American Datum of 1927
- ☒ North American Datum of 1983
- ☐ World Geodetic System of 1984

**Horizontal Collection Method Code** NTDEP

**Reference Point Code** CNTAR

**Altitude** Feet 608 --or-- Meters

**Altitude Datum Name**
- ☐ The National Geodetic Vertical Datum of 1929
- ☒ The North American Vertical Datum of 1988 (NAVD88)

**Altitude (Vertical) Location Datum Collection Method Code** NTDEP

**Geometric Type Code** POINT

**Data Collection Date** 5/14/14

**Source Map Scale Number** 1 Inch(es) = 500 Feet
--or-- Centimeter(s) = Meters

## PROJECT INFORMATION

**Project Name**
Mount Union Pipline Station

**Project Description**
liquid natural gas pumping station

| Project Consultant Last Name | First Name | MI | Suffix |
|---|---|---|---|
| Kraus | Matthew | | |

| Project Consultant Title | Consulting Firm |
|---|---|
| Project Manager | Tetra Tech Inc |

| Mailing Address Line 1 | Mailing Address Line 2 |
|---|---|
| 661 Anderson Drive | Foster Plaza - 7 |

| Address Last Line – City | | | State | ZIP+4 |
|---|---|---|---|---|
| Pittsburgh | | | PA | 15220 |
| **Phone** | **Ext** | **FAX** | **Email Address** | |
| 412-921-8729 | | | matthew.kraus@tetratech.com | |

| Time Schedules | Project Milestone (Optional) |
|---|---|
| Tentative - Late Summer/Fall 2014 | |
| | |
| | |
| | |
| | |
| | |

**1. Have you informed the surrounding community and addressed any concerns prior to submitting the application to the Department?** ☐ Yes ☒ No

**2. Is your project funded by state or federal grants?** ☐ Yes ☒ No

**Note:** If "Yes", specify what aspect of the project is related to the grant and provide the grant source, contact person and grant expiration date.
Aspect of Project Related to Grant
Grant Source: _____
Grant Contact Person: _____
Grant Expiration Date: _____

**3. Is this application for an authorization on Appendix A of the Land Use Policy? (For referenced list, see Appendix A of the Land Use Policy attached to GIF instructions)** ☐ Yes ☒ No

**Note:** If "No" to Question 3, the application is not subject to the Land Use Policy.
If "Yes" to Question 3, the application is subject to this policy and the Applicant should answer the additional questions in the **Land Use Information** section.

## LAND USE INFORMATION

**Note:** Applicants are encouraged to submit copies of local land use approvals or other evidence of compliance with local comprehensive plans and zoning ordinances.

**1. Is there an adopted county or multi-county comprehensive plan?** ☐ Yes ☒ No

**2. Is there an adopted municipal or multi-municipal comprehensive plan?** ☐ Yes ☒ No

**3. Is there an adopted county-wide zoning ordinance, municipal zoning ordinance or joint municipal zoning ordinance?** ☐ Yes ☒ No

**Note:** If the Applicant answers "No" to either Questions 1, 2 or 3, the provisions of the PA MPC are not applicable and the Applicant does not need to respond to questions 4 and 5 below.
If the Applicant answers "Yes" to questions 1, 2 and 3, the Applicant should respond to questions 4 and 5 below.

**4. Does the proposed project meet the provisions of the zoning ordinance or does the proposed project have zoning approval?** If zoning approval has been received, attach documentation. ☐ Yes ☐ No

**5. Have you attached Municipal and County Land Use Letters for the project?** ☐ Yes ☐ No

## COORDINATION INFORMATION

**Note:** The PA Historical and Museum Commission must be notified of proposed projects in accordance with DEP Technical Guidance Document 012-0700-001 and the accompanying Cultural Resource Notice Form.

**If the activity will be a mining project** (i.e., mining of coal or industrial minerals, coal refuse disposal and/or the operation of a coal or industrial minerals preparation/processing facility), respond to questions 1.0 through 2.5 below.

**If the activity will not be a mining project**, skip questions 1.0 through 2.5 and begin with question 3.0.

| | | | | | |
|---|---|---|---|---|---|
| **1.0** | **Is this a coal mining project?** If "Yes", respond to 1.1-1.6. If "No", skip to Question 2.0. | ☐ | Yes | ☒ | No |
| **1.1** | **Will this coal mining project involve coal preparation/ processing activities in which the total amount of coal prepared/processed will be equal to or greater than 200 tons/day?** | ☐ | Yes | ☐ | No |
| **1.2** | **Will this coal mining project involve coal preparation/ processing activities in which the total amount of coal prepared/processed will be greater than 50,000 tons/year?** | ☐ | Yes | ☐ | No |
| **1.3** | **Will this coal mining project involve coal preparation/ processing activities in which thermal coal dryers or pneumatic coal cleaners will be used?** | ☐ | Yes | ☐ | No |
| **1.4** | **For this coal mining project, will sewage treatment facilities be constructed and treated waste water discharged to surface waters?** | ☐ | Yes | ☐ | No |
| **1.5** | **Will this coal mining project involve the construction of a permanent impoundment meeting one or more of the following criteria: (1) a contributory drainage area exceeding 100 acres; (2) a depth of water measured by the upstream toe of the dam at maximum storage elevation exceeding 15 feet; (3) an impounding capacity at maximum storage elevation exceeding 50 acre-feet?** | ☐ | Yes | ☐ | No |
| **1.6** | **Will this coal mining project involve underground coal mining to be conducted within 500 feet of an oil or gas well?** | ☐ | Yes | ☐ | No |
| **2.0** | **Is this a non-coal (industrial minerals) mining project?** If "Yes", respond to 2.1-2.6. If "No", skip to Question 3.0. | ☐ | Yes | ☒ | No |
| **2.1** | **Will this non-coal (industrial minerals) mining project involve the crushing and screening of non-coal minerals other than sand and gravel?** | ☐ | Yes | ☐ | No |
| **2.2** | **Will this non-coal (industrial minerals) mining project involve the crushing and/or screening of sand and gravel with the exception of wet sand and gravel operations (screening only) and dry sand and gravel operations with a capacity of less than 150 tons/hour of unconsolidated materials?** | ☐ | Yes | ☐ | No |
| **2.3** | **Will this non-coal (industrial minerals) mining project involve the construction, operation and/or modification of a portable non-metallic (i.e., non-coal) minerals processing plant under the authority of the General Permit for Portable Non-metallic Mineral Processing Plants (i.e., BAQ-PGPA/GP-3)?** | ☐ | Yes | ☐ | No |
| **2.4** | **For this non-coal (industrial minerals) mining project, will sewage treatment facilities be constructed and treated waste water discharged to surface waters?** | ☐ | Yes | ☐ | No |
| **2.5** | **Will this non-coal (industrial minerals) mining project involve the construction of a permanent impoundment meeting one or more of the following criteria: (1) a contributory drainage area exceeding 100 acres; (2) a depth of water measured by the upstream toe of the dam at maximum storage elevation exceeding 15 feet; (3) an impounding capacity at maximum storage elevation exceeding 50 acre-feet?** | ☐ | Yes | ☐ | No |

| | | | | | |
|---|---|---|---|---|---|
| **3.0** | **Will your project, activity, or authorization have anything to do with a well related to oil or gas production, have construction within 200 feet of, affect an oil or gas well, involve the waste from such a well, or string power lines above an oil or gas well?** If "Yes", respond to 3.1-3.3. If "No", skip to Question 4.0. | ☐ | Yes | ☒ | No |
| **3.1** | **Does the oil- or gas-related project involve any of the following: placement of fill, excavation within or placement of a structure, located in, along, across or projecting into a watercourse, floodway or body of water (including wetlands)?** | ☐ | Yes | ☐ | No |
| **3.2** | **Will the oil- or gas-related project involve discharge of industrial wastewater or stormwater to a dry swale, surface water, ground water or an existing sanitary sewer system or storm water system?** If "Yes", discuss in *Project Description*. | ☐ | Yes | ☐ | No |
| **3.3** | **Will the oil- or gas-related project involve the construction and operation of industrial waste treatment facilities?** | ☐ | Yes | ☐ | No |
| **4.0** | **Will the project involve a construction activity that results in earth disturbance?** If "Yes", specify the total disturbed acreage.<br>**4.0.1 Total Disturbed Acreage** 3.95 | ☒ | Yes | ☐ | No |
| **5.0** | **Does the project involve any of the following?**<br>If "Yes", respond to 5.1-5.3. If "No", skip to Question 6.0. | ☐ | Yes | ☒ | No |
| **5.1** | **Water Obstruction and Encroachment Projects – Does the project involve any of the following: placement of fill, excavation within or placement of a structure, located in, along, across or projecting into a watercourse, floodway or body of water?** | ☐ | Yes | ☐ | No |
| **5.2** | **Wetland Impacts – Does the project involve any of the following: placement of fill, excavation within or placement of a structure, located in, along, across or projecting into a wetland?** | ☐ | Yes | ☐ | No |
| **5.3** | **Floodplain Projects by the commonwealth, a Political Subdivision of the commonwealth or a Public Utility – Does the project involve any of the following: placement of fill, excavation within or placement of a structure, located in, along, across or projecting into a floodplain?** | ☐ | Yes | ☐ | No |
| **6.0** | **Will the project involve discharge of stormwater or wastewater from an industrial activity to a dry swale, surface water, ground water or an existing sanitary sewer system or separate storm water system?** | ☐ | Yes | ☒ | No |
| **7.0** | **Will the project involve the construction and operation of industrial waste treatment facilities?** | ☐ | Yes | ☒ | No |
| **8.0** | **Will the project involve construction of sewage treatment facilities, sanitary sewers, or sewage pumping stations?** If "Yes", indicate estimated proposed flow (gal/day). Also, discuss the sanitary sewer pipe sizes and the number of pumping stations/treatment facilities/name of downstream sewage facilities in the *Project Description*, where applicable.<br>**8.0.1 Estimated Proposed Flow (gal/day)** | ☐ | Yes | ☒ | No |
| **9.0** | **Will the project involve the subdivision of land, or the generation of 800 gpd or more of sewage on an existing parcel of land or the generation of an additional 400 gpd of sewage on an already-developed parcel, or the generation of 800 gpd or more of industrial wastewater that would be discharged to an existing sanitary sewer system?** | ☐ | Yes | ☒ | No |
| | **9.0.1 Was Act 537 sewage facilities planning submitted and approved by DEP?** If "Yes" attach the approval letter. Approval required prior to 105/NPDES approval. | ☐ | Yes | ☐ | No |
| **10.0** | **Is this project for the beneficial use of biosolids for land application within Pennsylvania?** If "Yes" indicate how much (i.e. gallons or dry tons per year).<br>**10.0.1 Gallons Per Year (residential septage)** _____<br>**10.0.2 Dry Tons Per Year (biosolids)** | ☐ | Yes | ☒ | No |
| **11.0** | **Does the project involve construction, modification or removal of a dam?**<br>If "Yes", identify the dam.<br>**11.0.1 Dam Name** | ☐ | Yes | ☒ | No |

| | | | | | |
|---|---|---|---|---|---|
| **12.0** | **Will the project interfere with the flow from, or otherwise impact, a dam?** If "Yes", identify the dam.<br>**12.0.1 Dam Name** | ☐ | Yes | ☒ | No |
| **13.0** | **Will the project involve operations (excluding during the construction period) that produce air emissions (i.e., NOX, VOC, etc.)?** If "Yes", identify each type of emission followed by the amount of that emission.<br>**13.0.1 Enter all types & amounts of emissions; separate each set with semicolons.** CO2e 6.72E-02 TPY; CO2 6.69E-02 TPY; N2O 6.16E-07 TPY; CH4 3.08E-06 TPY; CO 1.72E-04 TPY; Total VOCs 2.48E-01 TPY; Butane 2.48E-01 TPY; Total HAPs 0.00E+00 TPY | ☒ | Yes | ☐ | No |
| **14.0** | **Does the project include the construction or modification of a drinking water supply to serve 15 or more connections or 25 or more people, at least 60 days out of the year?** If "Yes", check all proposed sub-facilities. | ☐ | Yes | ☒ | No |
| | **14.0.1 Number of Persons Served** _____ | | | | |
| | **14.0.2 Number of Employee/Guests** _____ | | | | |
| | **14.0.3 Number of Connections** _____ | | | | |
| | **14.0.4 Sub-Fac: Distribution System** | ☐ | Yes | ☐ | No |
| | **14.0.5 Sub-Fac: Water Treatment Plant** | ☐ | Yes | ☐ | No |
| | **14.0.6 Sub-Fac: Source** | ☐ | Yes | ☐ | No |
| | **14.0.7 Sub-Fac: Pump Station** | ☐ | Yes | ☐ | No |
| | **14.0.8 Sub Fac: Transmission Main** | ☐ | Yes | ☐ | No |
| | **14.0.9 Sub-Fac: Storage Facility** | ☐ | Yes | ☐ | No |
| **15.0** | **Will your project include infiltration of storm water or waste water to ground water within one-half mile of a public water supply well, spring or infiltration gallery?** | ☐ | Yes | ☒ | No |
| **16.0** | **Is your project to be served by an existing public water supply?** If "Yes", indicate name of supplier and attach letter from supplier stating that it will serve the project.<br>**16.0.1 Supplier's Name** _____ | ☐ | Yes | ☒ | No |
| | **16.0.2 Letter of Approval from Supplier is Attached** | ☐ | Yes | ☐ | No |
| **17.0** | **Will this project involve a new or increased drinking water withdrawal from a stream or other water body?** If "Yes", should reference both Water Supply and Watershed Management.<br>**17.0.1 Stream Name** | ☐ | Yes | ☒ | No |
| **18.0** | **Will the construction or operation of this project involve treatment, storage, reuse, or disposal of waste?** If "Yes", indicate what type (i.e., hazardous, municipal (including infectious & chemotherapeutic), residual) and the amount to be treated, stored, re-used or disposed.<br>**18.0.1 Type & Amount** | ☐ | Yes | ☒ | No |
| **19.0** | **Will your project involve the removal of coal, minerals, etc. as part of any earth disturbance activities?** | ☐ | Yes | ☒ | No |
| **20.0** | **Does your project involve installation of a field constructed underground storage tank?** If "Yes", list each Substance & its Capacity. **Note:** Applicant may need a Storage Tank Site Specific Installation Permit.<br>**20.0.1 Enter all substances & capacity of each; separate each set with semicolons.** | ☐ | Yes | ☒ | No |
| **21.0** | **Does your project involve installation of an aboveground storage tank greater than 21,000 gallons capacity at an existing facility?** If "Yes", list each Substance & its Capacity. **Note:** Applicant may need a Storage Tank Site Specific Installation Permit.<br>**21.0.1 Enter all substances & capacity of each; separate each set with semicolons.** | ☐ | Yes | ☒ | No |

| | | | | | |
|---|---|---|---|---|---|
| **22.0** | **Does your project involve installation of a tank greater than 1,100 gallons which will contain a highly hazardous substance as defined in DEP's Regulated Substances List, 2570-BK-DEP2724?** If "Yes", list each Substance & its Capacity. **Note:** Applicant may need a Storage Tank Site Specific Installation Permit.<br>**22.0.1 Enter all substances & capacity of each; separate each set with semicolons.** | ☐ | Yes | ☒ | No |
| **23.0** | **Does your project involve installation of a storage tank at a new facility with a total AST capacity greater than 21,000 gallons?** If "Yes", list each Substance & its Capacity. **Note:** Applicant may need a Storage Tank Site Specific Installation Permit.<br>**23.0.1 Enter all substances & capacity of each; separate each set with semicolons.** | ☐ | Yes | ☒ | No |
| **24.0** | **Will the intended activity involve the use of a radiation source?** | ☐ | Yes | ☒ | No |

## CERTIFICATION

**I certify that I have the authority to submit this application on behalf of the applicant named herein and that the information provided in this application is true and correct to the best of my knowledge and information.**

**Type or Print Name** MATTHEW GORDON

| | | |
|---|---|---|
| **Signature** | **Title** PRINCIPAL ENGINEER | **Date** 5/14/14 |

# APPENDIX A

# PADEP DETERMATION ON RFD

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY

# Request for Determination of Requirement For Plan Approval/Operating Permit (RFD)

## OFFICIAL USE ONLY

| | | | |
|---|---|---|---|
| **Facility Name:** | SUNOCO PIPELINE LP-23-3102656 | **RFD Facility ID:** | 1873 |
| **RFD Application ID:** | 3685 | **Date Received:** | 04/02/2014 |
| **Reviewed BY:** | Gary Alan Helsel | **Approved Date:** | 04/02/2014 |
| **Approved By:** | Gary Alan Helsel | | |

- [x] **A plan approval is not required for this source (See 25 Pa. Code Section 127.14(a)(1)-(9)**
- [ ] **An operating permit is not required for this source (See 25 Pa. Code Section 127.443(a))**
- [ ] **The source(s) do(es) not qualify for exemption. Applicant is required to submit a plan approval application.**
- [x] **The source(s) do(es) not qualify for exemption. Applicant is required to submit an operating permit application.**

## Remarks

After review, the Department of Environmental Protection has determined that the installation and operation of a John Zink 4'X30' Enclosed ZTOF Flare to control emissions at the above referenced facility is exempt from the Plan Approval requirements per 25 PA Code §127.14(d) listed as No. 44 in the Department's Plan Approval and Operating Permit Exemptions list under Title 25 PA Code §127.14(a)(8). It is the Department's understanding that potential to emit including emissions from equipment leaks from the project will not exceed 0.25 tpy VOC, 0.01 tpy NOx, and 0.2 tpy CO based on the worst case of flaring a maximum of 312,800 scf of pure butane per year; that all compression for the project will be electrically powered as supplied by a public utility; that the flare will be operated by the manufacturer's specification and maintained by the manufacturer's recommended maintenance schedule; that, while the facility is not subject to the Subpart, the applicant will utilize a flare model that meets the requirements of 40 CFR Part 60 Subpart OOOO Section 60.5413(d); that the Mount Union Station is not considered to be adjacent or contiguous with any facilities under common control; and that this project will not trigger the requirements of 25 PA Code Subchapter E or 40 CFR Part 52. The Department has also determined that this project is not exempt from the operating permit requirements. Please submit an application for a State Only Operating Permit application which includes the conditions of this authorization prior to commencement of operation of this facility. This exemption does not affect your obligation to meet all applicable Pennsylvania Air Quality Regulations for this source. All air contamination sources and air pollution control devices must be operated in a manner consistent with the manufacturer's specifications and good engineering practice. Please be advised that this exemption is only valid for the equipment, throughput, and emission levels proposed in this request for determination (RFD). A revised RFD or plan approval application may be required prior to any future expansions or changes which increase atmospheric emissions.

## Conditions

# APPENDIX B

# MOUNT UNION STATION RFD SUBMITTAL

This Request for Determination (RFD) of changes of minor significance and exemption from plan approval/operating permit under Pa Code § 127.14 or § 127.449 is for an enclosed flare that will be constructed by Sunoco Pipeline L.P in Shirley Township, Mount Union, Pennsylvania (referred to hereafter as Mount Union Station) on the Mariner East pipeline. Mariner East is a pipeline project that will deliver butane, propane, and ethane from the liquid-rich Marcellus Shale areas in Western Pennsylvania to Marcus Hook, Pennsylvania, where it will be processed, stored, and distributed, to various domestic and waterborne markets. The pipeline will run from southwestern Pennsylvania to southeastern Pennsylvania and will traverse through Pennsylvania Department of Environmental Protection (PADEP) Southwest, South-Central, and Southeast regions. Pumping stations along the pipeline will use electric driven split case multistage centrifugal pumps to transport product through the pipeline. All pumping devices used to transport material will utilize electricity supplied by a public utility. The pipeline will transport the natural gas liquids butane, ethane, and propane. From August 2014 to July 2015 the pipeline will transport batches of a minimum 95% butane or 95% propane product. From July 2015 on the line is slated for pure liquid ethane.

A portion of emissions from seal leaks will be disposed of safely through a permanently installed, enclosed flare and another portion of seal leaks will be vented directly to the atmosphere. The maximum volume of product (i.e., butane, ethane, or propane) that leaks through the seals and is captured and combusted will be 0.5 standard cubic feet (SCF) per minute totaling 262,800 SCF per year. Fugitive seals leaks that vent directly to the atmosphere are estimated to be 0.224 tons per year of volatile organic compounds (VOCs) when butane or propane is the product being transferred. Additionally, once per year, the pipeline will require maintenance operations known as pigging, which involves cleaning the pipeline. During this maintenance period, it will be necessary to dispose of an amount of the natural gas liquids safely through each enclosed flare. The estimated maximum volume of gas to be flared at each station is 25,000 SCF during maintenance operations. The estimated annual volume of gas that will be flared at each station is 287,800 SCF. Once every 5 years, Smart Tools pigging operations will send the same amount (25,000 SCF) of gas to the flare. As a result, the worst case annual volume of pipeline gas flared will be 312,800 SCF once every 5 years. No hazardous air pollutant (HAP) emissions are expected to result from the Mariner East Pipeline operations described in this RFD. Emissions calculations and all corresponding assumptions due to maintenance operations, seal leaks, and fugitive emissions are included in this RFD as Attachment 1.

An Aggregation Analysis was completed on the basis of the facility definition contained in 25 PA Code Section 121.1, Guidance for Performing Single Stationary Source Determinations for Oil and Gas Industries (PADEP 270-0810-006). The Aggregation Analysis is included as Attachment 2 to this RFD. Additionally, in accordance with, 25 PA Code § 127.203a, Applicability Determination, this RFD provides the required applicability determination emissions increase calculations for regulated New Source Review (NSR) pollutants associated with the installation of an enclosed flare at Mount Union Station as part of the Sunoco Pipeline L.P. Mariner East pipeline construction project. The Applicability Determination is included as Attachment 3 to this RFD.

The enclosed flares that will be constructed at pumping stations along the Mariner East pipeline are John Zink Company LLC 4' by 30' Enclosed ZTOF Production Flares. A process and instrument diagram, specification sheets, detail diagram, manufacturer recommended maintenance forms, and a wiring diagram for the 4' by 30' Enclosed ZTOF Production Flare are included in Attachment 4. These flares were designed to comply with United States Environmental Protection Agency (EPA) 40 Code of Federal Regulations (CFR) Part 60 Subpart OOOO. In order to comply with that regulation a performance test must be conducted and a report must be submitted to and approved by the EPA to verify that the performance criteria listed per 40 CFR Part 60 Subpart OOOO, specifically paragraph §60.5413(d)(11) are met. Attachment 5 to this RFD is an EPA 40 CFR Part 60 Subpart OOOO Stack Emission Study for the ZTOP 025X15PF Unit. The flare studied in that report uses the same burner as the flares that will be installed along the Mariner East Pipeline and similar results (e.g. VOC destruction efficiencies) are expected for the 4' by 30' Enclosed ZTOP Production Flares, which are scheduled for a stack test study in March 2014.

Each flare constructed will be monitored 24 hours a day seven days a week via a supervisory control and data acquisition (SCADA) system and a physical inspection will occur at a minimum of once per week. Each observation will evaluate and document visible emissions, fugitive emissions, and malodors using the appropriate monitoring equipment. Sunoco Pipeline L.P. personnel will receive training and certification from the (PADEP) "Smoke School" subcontractor to determine the plume opacity. All daily and periodic observations will be documented. The proposed flare system is designed to be fully smokeless through the full range of flows. The flare will operate 24 hours a day seven days a week.

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY

# Request for Determination of Changes of Minor Significance and Exemption from Plan Approval/Operating Permit Under Pa Code §127.14 or §127.449

## A. Request for:

**Exemption from Plan Approval**

- ☐ Physical changes to sources of minor significance, pursuant to 25 Pa. Code Section 127.14(a)(9)
- ☐ Additional physical changes of minor significance that do not add new equipment, pursuant to 25 Pa. Code Section 127.14(c)(1)
- ☑ Other sources and classes of sources of minor significance, pursuant to 25 Pa. Code Section 127.14(a)(8)
- ☐ Additional physical changes of minor significance that add new equipment, pursuant to 25 Pa. Code Section 127.14(c)(2)
- ☑ Minor Sources or classes of sources, pursuant to 25 Pa. Code Section 127.14(a)(1)-(7)

**Exemption from Operating Permit**

- ☑ Other sources and classes of sources of minor significance, pursuant to 25 Pa. Code Section 127.14(a)(8)
- ☐ Physical changes to sources of minor significance, pursuant to 25 Pa. Code Section 127.14(a)(9)
- ☑ Changes due to De Minimis increases in emissions, pursuant to 25 Pa. Code Section 127.449
- ☐ Additional physical changes of minor significance that add new equipment, pursuant to 25 Pa. Code Section 127.14(c)(2)
- ☐ Additional physical changes of minor significance that do not add new equipment, pursuant to 25 Pa. Code Section 127.14(c)(1)

## B. Company/Facility Information

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**Company/Facility Name:** Sunoco Pipeline L.P. **Plant Name:**

**Site Address:** Latitude: 40.443298; Longitude: -79.254204 Blairsville PA 15717

**Mailing Address:** 535 Fritztown Road Sinking Spring PA 19608

**Federal Employer Identification Number (EIN):** 23-3102656

**Current Operating Permit No:** **NAICS Code:** 493190

**Name of Person Completing Form:** Matthew Kraus **Title:** Tetra Tech

| **Address** | **Telephone:** (412) 921-8729 |
|---|---|
| 661 Andersen Drive | **Fax:** (412) 921-4040 |
| Pittsburgh PA 15220 | **EMail:** matthew.kraus@tetratech.com |

**Name of Company/Facility Contact Person:** Matt Gordon **Title:** Sunoco Pipeline

| **Address** | **Telephone:** (610) 670-6284 |
|---|---|
| 535 Fritztown Road | **Fax:** |
| Sinking Spring PA 19608 | **EMail:** mlgordon@sunocologistics.com |

## C. Project Description

**Project Type:** ☐ Other ☐ Remediation ☐ Modification ☑ New Construction

**Total number of sources in project:** 1

**Description of project:** The project description is included as an attachment to this RFD.

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**DEPARTMENT OF ENVIRONMENTAL PROTECTION**
**BUREAU OF AIR QUALITY**

## Request for Determination of Changes of Minor Significance and Exemption from Plan Approval/Operating Permit Under Pa Code §127.14 or §127.449

### D. Source Description

**Source Name:** EF-4' by 30' Enclosed ZTOP Production Flare

**Source Category:** INTERNAL COMBUSTION -- Natural Gas

**Source Location:** Latitude: 40.443298, Longitude: -79.254204

**Source Type:** ☑ Stationary ☐ Portable

**Is equipment existing or proposed?** ☐ Existing ☑ Proposed

Actual or Planned Date of Installation: 07/01/2014

**Municipality:** Black Lick **County:** Indiana

**Source Description:** The emission source will consist of an enclosed flare that will be used to combust gas during pipeline maintenance operations. The gas enters an inlet manifold at the base of the unit and is then diverted to flow controlled burner trains. The burners premix the gas, controlled naturally aspirated air, and make-up gas when required. The combustion efficiency has been assumed to be 99.9 percent based on the Stack Emission Study presented in Attachment 5 for a similar flare that uses the same burner. The enclosed flares that will be constructed at pumping stations along the Mariner East pipeline are John Zink Company LLC 4# by 30# Enclosed ZTOF Production Flares. A process and instrument diagram, specification sheets, detail diagram, manufacturer recommended maintenance forms, and a wiring diagram for the 4# by 30# Enclosed ZTOF Production Flare are included in Attachment 4. These flares were designed to comply with United States Environmental Protection Agency (EPA) 40 Code of Federal Regulations (CFR) Part 60 Subpart OOOO. In order to comply with that regulation a performance test must be conducted and a report must be submitted to and approved by the EPA to verify that the performance criteria listed per 40 CFR Part 60 Subpart OOOO specifically paragraph §60.5413(d)(11) are met. Attachment 5 to this RFD is an EPA 40 CFR Part 60 Subpart OOOO Stack Emission Study for the ZTOP 025X15PF Unit. The flare studied in that report uses the same burner as the flares that will be installed along the Mariner East Pipeline and similar results (e.g. VOC destruction efficiencies) are expected for the 4# by 30# Enclosed ZTOP Production Flares, which are scheduled for a stack test study in March 2014. Each flare constructed will be monitored 24 hours a day seven days a week via a supervisory control and data acquisition (SCADA) system and a physical inspection will occur at a minimum of once per week. Daily inspections will be conducted at all manned locations such as the Delmont Station. Each observation will evaluate and document visible emissions, fugitive emissions, and malodors using the appropriate monitoring equipment. Sunoco Pipeline L.P. personnel will receive training and certification from the (PADEP) #Smoke School# subcontractor to determine the plume opacity. All daily and periodic observations will be documented. The proposed flare system is designed to be fully smokeless through the full range of flows. The flare will operate 24 hours a day seven days a week.

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| Pollutant | Calculation Method | Emissions (lbs/hr) | Emissions (tons/year) |
|---|---|---|---|
| Particulate | SEE COMMENT | 0.0000 | 0.0000 |
| PM10 | SEE COMMENT | 0.0000 | 0.0000 |
| PM2.5 | SEE COMMENT | 0.0000 | 0.0000 |
| SOX | SEE COMMENT | 0.0000 | 0.0000 |
| CO | SEE COMMENT | 0.0000 | 0.0002 |
| NOX | SEE COMMENT | 0.0000 | 0.0000 |
| VOC | SEE COMMENT | 0.0567 | 0.2480 |
| Hazardous Air Pollutants | SEE COMMENT | 0.0000 | 0.0000 |

**Will the construction of this source increase emissions from other sources at this facility?**

☐ Yes ☑ No

**Is the construction or modification of the source subject to 25 Pa. Code, Subchapter E, New Source Review (NSR)**

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DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF AIR QUALITY

**Request for Determination of Changes of Minor Significance and Exemption from Plan Approval/Operating Permit Under Pa Code §127.14 or §127.449**

**requirements or prevention of Significant Deterioration (PSD) of Air Quality regulations at Subchapter D?**

☐ Yes ☑ No

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**Request for Determination of Changes of Minor Significance and Exemption from Plan Approval/Operating Permit Under Pa Code §127.14 or §127.449**

## E. Exemption History

| Source Name | Date of Installation | Reason for Exemption | | |
|---|---|---|---|---|
| | | RFD | Exemption List | De Minimis |
| | | | | |

## F. List of Attached Documents

| Description of Attachment | Confidential? |
|---|---|
| Attachment 5 - Stack Emission Study. Will be sent via Tetra Tech file transfer site. | N |
| Flare Design Specs, Inspection, and Maintenance Forms | Y |
| Emission calculations for the proposed enclosed flare. | N |
| Applicability Determination for enclosed flare at New Station #1 | N |
| Project Description for New Station #1. | N |
| Aggregation Analysis for New Station #1 | N |

## G. Signature of Responsible Official or Authorized Representative

I, ,certify under penalty of law as provided in 18 Pa. C.S.A. § 4904 and 35 P.S. § 4009(b)(2) that based on information and belief formed after reasonable inquiry, the statements and information contained in this form are true, accurate, and complete.

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| | | |
|---|---|---|
| **Name** | **Date** | **Telephone** |
| **Address** | | **Email Address** |

**COMMONWEALTH OF PENNSYLVANIA**
**DEPARTMENT OF ENVIRONMENTAL PROTECTION**
**BUREAU OF AIR QUALITY**

**Request for Determination of Changes of Minor Significance and Exemption from Plan Approval/Operating Permit Under Pa Code §127.14 or §127.449**

**NOTES**

**From:** MARK GOROG **Date:** 01/15/2014

**Subject:** The Application is rejected by reviewer.

**Message:**
Applicant will revise application as discussed.

**From:** Fer Padilla **Date:** 05/14/2013

**Subject:** Exemption Request

**Message:**
§ 127.14. Exemptions

(a) Plan approval is not required for the construction, modification, reactivation or installation of the following:

(3) Combustion units with a rated capacity of less than 10 million Btu per hour of heat input fueled by natural gas supplied by a public utility, liquified petroleum gas or by commercial fuel oils which are No. 2 or lighter#viscosity less than or equal to 5.82 C St#and which meet the sulfur content requirements of § 123.22 (relating to combustion units). Combustion units converting to fuel oils which are No. 3 or heavier#viscosity greater than 5.82 C St#or contain sulfur in excess of the requirements of § 123.22 require approval. For the purpose of this section, commercial fuel oil shall be virgin oil which has no reprocessed, recycled or waste material added.

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# ATTACHMENT 1 - EMISSIONS CALCULATIONS

# 1-1 FLOW SERVE EMISSIONS SEAL LEAKS SUPPORT INFORMATION

**Thomas Schullik**
District Manager

**OEM & Project Sales**
Seals and Support Systems

August 30, 2013

Mr. Trey Maxwell
Best PumpWorks
8885 Monroe Rd.
Houston, TX 77061

SUBJECT: Sunoco Mariner East Project.
Estimated Seal Performance Data.

Below are answers to a series of questions posed to Flowserve's Seal Engineering Team. Answers are based on the customer conditions of service at time of quoting.

- Best PumpWorks610 – PMW Model – 6x8x12H Size – BB3 style pump – Running at 1800-3600 RPM
- Light Hydrocarbon – NGL Mix of Ethane and Propane @ 100F (Max)
- Specific Gravity of 0.26/0.52 – Viscosity of 0.13cP
- Suction Pressure = 579 PSIG, Discharge = 1435 PSIG, Product Vapor Pressure of 531 PSIA
- Seals Designed for Max Potential Box Pressure of 1480 PSIG.
- Seal Model – UHTW/GSL

a. The expected leakage of Primary Liquid Wavy Face seal that would be directed to Flare?
   i. For 100% Ethane and 100% Propane conditions:
   Flowserve would estimate the leakage range in testing is .15-.5 scfm on 100% ethane and is predicted very similar by FEA for 100% propane. This is not a guaranteed rate, just an estimate based on similar testing.
   ii. Normal Operation seal chamber pressures:
   Same answer as above. Flowserve would estimate the leakage range in testing is .15-.5 scfm on 100% ethane and is predicted very similar by FEA for 100% propane. This is not a guaranteed rate, just an estimate based on similar testing.
   iii. Max pump discharge pressure:
   Test data for ethane only goes up to 1100 psig and is in the .15-.5 scfm range as well. Again, this not a guaranteed rate.

b. The expected leakage to atmospheric side of the GSLW for 100% Propane and 100% Ethane operation?
   i. Under normal seal chamber pressure operation conditions:
   The GSL will operate at the cracking pressure of the check valve we require in the flare line. All the testing has been done with a 10 psi cracking valve. Testing done recently has not captured GSL leakage to the atmosphere. Original testing on the GSL measured leakage on a 2,375 seal at ~175 ppm at 10 psi (GSL Seal Profile, Page 7, and Section 1111-0200-05-G). Visually, there has been no noticeable leakage from the GSL under normal operating conditions.

Flowserve Corporation
www.flowserve.com

14219 Westfair West Road
Houston, TX 77041

Phone: 281-671-9233
Fax: 281-671-9267
Cell Phone: 610-662-5482

**Thomas Schullik**
District Manager

**OEM & Project Sales**
Seals and Support Systems

Based on historical leakage rate lab testing on Propane for low emission seals we estimate leakage to be close to zero. Leakage would be approximately 0.01 SCFH. GSL seals measured seal emissions to be less than 200 ppm.

ii. Under normal operation conditions seal chamber pressure operation (as if the primary seal vanished):
The same comment as above about capturing GSL leakage. Using the same GSL Seal Profile, the seal was run at 300 psi nitrogen pressure and produced ~550 ml/min of external leakage. We have also run the GSL on CO2 at 2200 psig and ethylene at 1150 psig and the seals hold the pressure with minimal leakage. The seal will prevent a major release to atmosphere.

iii. Under Max Pump discharge pressure (as if the primary seal vanished):
The Same comment as above about capturing GSL leakage. Using the same GSL Seal Profile, the seal was run at 300 psi nitrogen pressure and produced ~550 ml/min of external leakage. We have also run the GSL on CO2 at 2200 psig and ethylene at 1150 psig and the seals hold the pressure with minimal leakage. The seal will prevent a major release to atmosphere.

c. The expected flow to the Flare through Plan 76 in the case of catastrophic inboard seal failure (as if the primary seal vanished)?

The flow rate to the flare when the inner seal vanishes is a function of the GSL leakage and the restrictions in the flare connection. The flare connection to the seal would become a direct tap into the seal chamber of the pump with whatever restrictions there are in the line acting as orifices. Estimating this rate is an orifice calculation based on the components in the P76 system. Since we don't want a lot of restriction in the flare line under normal conditions, the flow rate when the inner seal disappears is going to be very high. The answers to the specific cases depend on the design of the P76 system. Designing for 10x normal leak rate is a good starting point.

If you have additional questions or any concern please let us know and we will be happy to address the issue. We are confident that our proposed seal design will meet the needs of these application conditions. Of course we will conduct an FEA of the seal design for optimization of design and construction should we be given the opportunity to provide our seals for this project.

Thank you again for this opportunity to provide additional detail.

Kind Regards,

Tom Schullik
District Manager – Gulf Coast
Flowserve Corporation
14219 Westfair West Road
Houston, TX 77041

# 1-2 MAXIMUM FLOW RATE CALCULATION SUPPORT INFORMATION

**Mariner East Project**
Rooney Engineering, Inc.
2/3/2014

**Calculations for Pump Station Flare Design Basis**

Flowserve will be providing the pump seals on the pumps being ordered from BestPump Works. Due to the nature of the seal design and the selected seal flush plan, there will be a constant (small) flow of product from the pump seals through the API 12/75 flush plan. The estimated flowrate from the vendor is as follows:

***Constant Flow During Normal Operation = 0.5 SCFM (720 SCFD) (Estimated)***

Additionally, the flares at the pump stations may be used to blow down portions of the pump station piping for maintenance purposes. This would occur only during operational upsets or for DOT direct assessment of piping, or during maintenance pigging operations. The sizing basis for this scenario will be based on the total volume of product to be exhausted through the flare and the desired duration of the flare event.

| | |
|---|---|
| 94.5 | actual ft3 (volume of 120 feet of 12" Station Pipe, Pump Discharge to Pig Launcher) |
| 7.0 | hours for blowdown |
| 10,000,000 | BTU/hr (Max for flare design) |

**Ethane**

| | |
|---|---|
| 25.6 | lbm/ft3 (density at 1480 psig & 60°F) |
| 2,419 | lbm (total mass to be flared) |
| 1.04 | SG @ STP (Air = 1.0) |
| 0.08 | lbm/ft3 (density at STP) |
| 28,825 | ft3 (total volume to be flared @STP) |
| 98,828 | scfd |
| 1,641 | BTU/ft3 (Heat of Combustion - Lower) |
| 6,757,335 | BTU/hr |
| **OK** | Design Check |

**Propane**

| | |
|---|---|
| 33.1 | lbm/ft3 (density at 1480 psig & 60°F) |
| 3,128 | lbm (total mass to be flared) |
| 1.6 | SG @ STP (Air = 1.0) |
| 0.13 | lbm/ft3 (density at STP) |
| 24,225 | ft3 (total volume to be flared @STP) |
| 83,058 | scfd |
| 2,385 | BTU/ft3 (Heat of Combustion - Lower) |
| 8,253,851 | BTU/hr |
| **OK** | Design Check |

**Butane**

| | |
|---|---|
| 37.3 | lbm/ft3 (density at 1480 psig & 60°F) |
| 3,525 | lbm (total mass to be flared) |
| 2.0 | SG @ STP (Air = 1.0) |
| 0.16 | lbm/ft3 (density at STP) |
| 21,763 | ft3 (total volume to be flared @STP) |
| 74,616 | scfd |
| 3,113 | BTU/ft3 (Heat of Combustion - Lower) |
| 9,678,339 | BTU/hr |
| **OK** | Design Check |

## 1-3 POTENTIAL EMISSIONS RATE CALCULATIONS

### 1-3.1 Potential Emissions Rate Summary

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Annual Potential Emissions Rate Summary - Butane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Pigging Operations Emissions Directed to the Flare | | | | | | Seal Leak Emissions Directed to the Flare | | | Seal Leak Emissions To the Atmosphere | | | Total Emissions - Butane Scenario 1(4) | | | Total Emissions - Butane Scenario 2(5) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Butane - Scenario 1(1) | | | Butane - Scenario 2(2) | | | 100% Butane | | | Fugitive Emissions(3) | | | | | | | | |
| | Emissions | | | Emissions | | | Emissions | | | | | | Emissions | | | Emissions | | |
| Pollutants | lbs./hour | lbs./year | tons/year | lbs./hour | lbs./year | tons/year | lbs./hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year |
| $CO_2e$ | 1.23E+00 | 1.07E+04 | 5.37E+00 | 2.45E+00 | 2.15E+04 | 1.07E+01 | 1.29E+01 | 1.13E+05 | 5.64E+01 | -- | -- | -- | 1.41E+01 | 1.24E+05 | 6.18E+01 | 1.53E+01 | 1.34E+05 | 6.72E+01 |
| $CO_2$ | 1.22E+00 | 1.07E+04 | 5.35E+00 | 2.44E+00 | 2.14E+04 | 1.07E+01 | 1.28E+01 | 1.12E+05 | 5.62E+01 | -- | -- | -- | 1.41E+01 | 1.23E+05 | 6.16E+01 | 1.53E+01 | 1.34E+05 | 6.69E+01 |
| $N_2O$ | 1.12E-05 | 9.85E-02 | 4.93E-05 | 2.25E-05 | 1.97E-01 | 9.85E-05 | 1.18E-04 | 1.04E+00 | 5.18E-04 | -- | -- | -- | 1.29E-04 | 1.13E+00 | 5.67E-04 | 1.41E-04 | 1.23E+00 | 6.16E-04 |
| $CH_4$ | 5.62E-05 | 4.93E-01 | 2.46E-04 | 1.12E-04 | 9.85E-01 | 4.93E-04 | 5.91E-04 | 5.18E+00 | 2.59E-03 | -- | -- | -- | 6.47E-04 | 5.67E+00 | 2.84E-03 | 7.04E-04 | 6.16E+00 | 3.08E-03 |
| CO | 3.15E-03 | 2.76E+01 | 1.38E-02 | 6.29E-03 | 5.51E+01 | 2.76E-02 | 3.31E-02 | 2.90E+02 | 1.45E-01 | -- | -- | -- | 3.62E-02 | 3.17E+02 | 1.59E-01 | 3.94E-02 | 3.45E+02 | 1.72E-01 |
| Total VOCs | 4.38E-01 | 3.83E+03 | 1.92E+00 | 8.75E-01 | 7.67E+03 | 3.83E+00 | 4.60E+00 | 4.03E+04 | 2.02E+01 | 5.12E-02 | 4.48E+02 | 2.24E-01 | 5.09E+00 | 4.46E+04 | 2.23E+01 | 5.53E+00 | 4.84E+04 | 2.42E+01 |
| Propane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ethane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Butane | 4.38E-01 | 3.83E+03 | 1.92E+00 | 8.75E-01 | 7.67E+03 | 3.83E+00 | 4.60E+00 | 4.03E+04 | 2.02E+01 | -- | -- | -- | 5.09E+00 | 4.46E+04 | 2.23E+01 | 5.53E+00 | 4.84E+04 | 2.42E+01 |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

(1) - Scenario 1 assumes that the volume of gas flared during pigging operations is 25,000 scf/year.
(2) - Scenario 2 assumes that the volume of gas flared during pigging operations is 50,000 scf/year.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential emissions rate calculations.
(4) - Totals presented are the sum of the pigging operations emissions (Scenario 1), seal leak emissions directed to the flare, and seal leak emissions to the atmosphere (for total VOCs only).
(5) - Totals presented are the sum of the pigging operations emissions (Scenario 2), seal leak emissions directed to the flare, and seal leak emissions to the atmosphere (for total VOCs only).

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Annual Potential Emissions Rate Summary - Propane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Pigging Operations Emissions Directed to the Flare | | | | | | Seal Leak Emissions Directed to the Flare | | | Seal Leak Emissions To the Atmosphere | | | Total Emissions - Propane Scenario 1(4) | | | Total Emissions - Propane Scenario 2(5) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Propane - Scenario 1(1) | | | Propane - Scenario 2(2) | | | 100% Propane | | | Fugitive Emissions(3) | | | | | | | | |
| | Emissions | | | Emissions | | | Emissions | | | | | | Emissions | | | Emissions | | |
| Pollutants | lbs./hour | lbs./year | tons/year | lbs./hour | lbs./year | tons/year | lbs./hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year |
| $CO_2e$ | 9.20E-01 | 8.06E+03 | 4.03E+00 | 1.84E+00 | 1.61E+04 | 8.06E+00 | 9.67E+00 | 8.47E+04 | 4.24E+01 | -- | -- | -- | 1.06E+01 | 9.28E+04 | 4.64E+01 | 1.15E+01 | 1.01E+05 | 5.04E+01 |
| $CO_2$ | 9.16E-01 | 8.03E+03 | 4.01E+00 | 1.83E+00 | 1.61E+04 | 8.03E+00 | 9.63E+00 | 8.44E+04 | 4.22E+01 | -- | -- | -- | 1.05E+01 | 9.24E+04 | 4.62E+01 | 1.15E+01 | 1.00E+05 | 5.02E+01 |
| $N_2O$ | 8.94E-06 | 7.84E-02 | 3.92E-05 | 1.79E-05 | 1.57E-01 | 7.84E-05 | 9.40E-05 | 8.24E-01 | 4.12E-04 | -- | -- | -- | 1.03E-04 | 9.02E-01 | 4.51E-04 | 1.12E-04 | 9.80E-01 | 4.90E-04 |
| $CH_4$ | 4.47E-05 | 3.92E-01 | 1.96E-04 | 8.94E-05 | 7.84E-01 | 3.92E-04 | 4.70E-04 | 4.12E+00 | 2.06E-03 | -- | -- | -- | 5.15E-04 | 4.51E+00 | 2.25E-03 | 5.60E-04 | 4.90E+00 | 2.45E-03 |
| CO | 2.50E-03 | 2.19E+01 | 1.10E-02 | 5.01E-03 | 4.38E+01 | 2.19E-02 | 2.63E-02 | 2.30E+02 | 1.15E-01 | -- | -- | -- | 2.88E-02 | 2.52E+02 | 1.26E-01 | 3.13E-02 | 2.74E+02 | 1.37E-01 |
| Total VOCs | 3.31E-01 | 2.90E+03 | 1.45E+00 | 6.63E-01 | 5.80E+03 | 2.90E+00 | 3.49E+00 | 3.06E+04 | 1.53E+01 | 5.12E-02 | 4.48E+02 | 2.24E-01 | 3.87E+00 | 3.39E+04 | 1.70E+01 | 4.20E+00 | 3.68E+04 | 1.84E+01 |
| Propane | 3.31E-01 | 2.90E+03 | 1.45E+00 | 6.63E-01 | 5.80E+03 | 2.90E+00 | 3.49E+00 | 3.06E+04 | 1.53E+01 | -- | -- | -- | 3.87E+00 | 3.39E+04 | 1.70E+01 | 4.20E+00 | 3.68E+04 | 1.84E+01 |
| Ethane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Butane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

(1) - Scenario 1 assumes that the volume of gas flared during pigging operations is 25,000 scf/year.
(2) - Scenario 2 assumes that the volume of gas flared during pigging operations is 50,000 scf/year.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential emissions rate calculations.
(4) - Totals presented are the sum of the pigging operations emissions (Scenario 1), seal leak emissions directed to the flare, and seal leak emissions to the atmosphere (for VOCs only).
(5) - Totals presented are the sum of the pigging operations emissions (Scenario 2), seal leak emissions directed to the flare, and seal leak emissions to the atmosphere (for VOCs only).

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Annual Potential Emissions Rate Summary - Ethane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Pigging Operations Emissions Directed to the Flare | | | | | | Seal Leak Emissions Directed to the Flare | | | Seal Leak Emissions To the Atmosphere | | | Total Emissions - Ethane Scenario 1(4) | | | Total Emissions - Ethane Scenario 2(5) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ethane - Scenario 1(1) | | | Ethane - Scenario 2(2) | | | 100% Ethane | | | Fugitive Emissions(3) | | | | | | | | |
| | Emissions | | | Emissions | | | Emissions | | | | | | Emissions | | | Emissions | | |
| Pollutants | lbs./hour | lbs./year | tons/year | lbs./hour | lbs./year | tons/year | lbs./hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year |
| $CO_2e$ | 6.45E-01 | 5.65E+03 | 2.82E+00 | 1.29E+00 | 1.13E+04 | 5.65E+00 | 6.78E+00 | 5.94E+04 | 2.97E+01 | -- | -- | -- | 7.42E+00 | 6.50E+04 | 3.25E+01 | 8.07E+00 | 7.07E+04 | 3.53E+01 |
| $CO_2$ | 6.42E-01 | 5.63E+03 | 2.81E+00 | 1.28E+00 | 1.13E+04 | 5.63E+00 | 6.75E+00 | 5.91E+04 | 2.96E+01 | -- | -- | -- | 7.39E+00 | 6.48E+04 | 3.24E+01 | 8.04E+00 | 7.04E+04 | 3.52E+01 |
| $N_2O$ | 6.15E-06 | 5.39E-02 | 2.69E-05 | 1.23E-05 | 1.08E-01 | 5.39E-05 | 6.47E-05 | 5.66E-01 | 2.83E-04 | -- | -- | -- | 7.08E-05 | 6.20E-01 | 3.10E-04 | 7.70E-05 | 6.74E-01 | 3.37E-04 |
| $CH_4$ | 3.08E-05 | 2.69E-01 | 1.35E-04 | 6.15E-05 | 5.39E-01 | 2.69E-04 | 3.23E-04 | 3.23E-04 | 3.23E-04 | -- | -- | -- | 3.54E-04 | 2.70E-01 | 4.58E-04 | 3.85E-04 | 5.39E-01 | 5.93E-04 |
| CO | 1.72E-03 | 1.51E+01 | 7.54E-03 | 3.44E-03 | 3.02E+01 | 1.51E-02 | 2.63E-02 | 2.30E+02 | 7.92E-02 | -- | -- | -- | 2.80E-02 | 2.46E+02 | 8.68E-02 | 2.97E-02 | 2.61E+02 | 9.43E-02 |
| Total VOCs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.12E-02 | 4.48E+02 | 2.24E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Propane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ethane | 2.26E-01 | 1.98E+03 | 9.92E-01 | 4.53E-01 | 3.97E+03 | 1.98E+00 | 2.38E+00 | 2.09E+04 | 1.04E+01 | -- | -- | -- | 2.61E+00 | 2.28E+04 | 1.14E+01 | 2.83E+00 | 2.48E+04 | 1.24E+01 |
| Butane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

(1) - Scenario 1 assumes that the volume of gas flared during pigging operations is 25,000 scf/year.
(2) - Scenario 2 assumes that the volume of gas flared during pigging operations is 50,000 scf/year.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential emissions rate calculations.
(4) - Totals presented are the sum of the pigging operations emissions (Scenario 1) and seal leak emissions directed to the flare. Seal leak emissions to the atmosphere (for VOCs only) are not included because ethane is not considered a VOC.
(5) - Totals presented are the sum of the pigging operations emissions (Scenario 2) and seal leak emissions directed to the flare Seal leak emissions to the atmosphere (for VOCs only) are not included because ethane is not considered a VOC.

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Maximum Hourly Potential Emissions Rate Summary - Butane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Pigging Operations Emissions Directed to the Flare | | Seal Leak Emissions Directed to the Flare | | Seal Leak Emissions To the Atmosphere | | Total Emissions - Butane - Maximum Hourly Basis(4) | |
|---|---|---|---|---|---|---|---|---|
| | Butane - Maximum Hourly Basis(1) | | 100% Butane(2) | | Fugitive Emissions(2)(3) | | | |
| | Emissions | | Emissions | | | | Emissions | |
| **Pollutants** | **lbs./hour** | **tons/hour** | **lbs./hour** | **tons/hour** | **lbs/hour** | **tons/hour** | **lbs/hour** | **tons/hour** |
| $CO_2e$ | 1.34E+03 | 6.68E-01 | 1.29E+01 | 6.44E-03 | -- | -- | 1.35E+03 | 6.74E-01 |
| $CO_2$ | 1.33E+03 | 6.65E-01 | 1.28E+01 | 6.42E-03 | -- | -- | 1.34E+03 | 6.72E-01 |
| $N_2O$ | 1.23E-02 | 6.13E-06 | 1.18E-04 | 5.91E-08 | -- | -- | 1.24E-02 | 6.19E-06 |
| $CH_4$ | 6.13E-02 | 3.06E-05 | 5.91E-04 | 2.96E-07 | -- | -- | 6.19E-02 | 3.09E-05 |
| CO | 3.43E+00 | 1.71E-03 | 3.31E-02 | 1.65E-05 | -- | -- | 3.46E+00 | 1.73E-03 |
| Total VOCs | 4.77E+02 | 2.38E-01 | 4.60E+00 | 2.30E-03 | 5.12E-02 | 2.56E-05 | 4.81E+02 | 2.41E-01 |
| Propane | -- | -- | -- | -- | -- | -- | -- | -- |
| Ethane | -- | -- | -- | -- | -- | -- | -- | -- |
| Butane | 4.77E+02 | 2.38E-01 | 4.60E+00 | 2.30E-03 | -- | -- | 4.81E+02 | 2.41E-01 |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | 0.00E+00 | 0.00E+00 |

(1) - The maximum hourly basis calculation assumes that the volume of gas flared during pigging operations is 3,109 scf/hour.
(2) - Seal leaks directed to the flare and fugitive emissions are assumed to be the same as those calculated for an annual basis.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential to emit calculations.
(4) - Totals presented are the sum of the pigging operations emissions (hourly basis), seal leak emissions directed to the flare (same as for an annual basis), and seal leak emissions to the atmosphere (for VOCs only).

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Maximum Hourly Potential Emissions Rate Summary - **Propane** | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | **Pigging Operations Emissions Directed to the Flare** | | **Seal Leak Emissions Directed to the Flare** | | **Seal Leak Emissions To the Atmosphere** | | **Total Emissions - Propane - Maximum Hourly Basis(4)** | |
|---|---|---|---|---|---|---|---|---|
| | **Propane - Maximum Hourly Basis(1)** | | **100% Propane(2)** | | **Fugitive Emissions(2)(3)** | | | |
| | **Emissions** | | **Emissions** | | | | **Emissions** | |
| **Pollutants** | **lbs./hour** | **tons/hour** | **lbs./hour** | **tons/hour** | **lbs/hour** | **tons/hour** | **lbs/hour** | **tons/hour** |
| $CO_2e$ | 1.12E+03 | 5.58E-01 | 9.67E+00 | 4.84E-03 | -- | -- | 1.13E+03 | 5.63E-01 |
| $CO_2$ | 1.11E+03 | 5.56E-01 | 9.63E+00 | 4.82E-03 | -- | -- | 1.12E+03 | 5.60E-01 |
| $N_2O$ | 1.08E-02 | 5.42E-06 | 9.40E-05 | 4.70E-08 | -- | -- | 1.09E-02 | 5.47E-06 |
| $CH_4$ | 5.42E-02 | 2.71E-05 | 4.70E-04 | 2.35E-07 | -- | -- | 5.47E-02 | 2.74E-05 |
| CO | 3.03E+00 | 1.52E-03 | 2.63E-02 | 1.32E-05 | -- | -- | 3.06E+00 | 1.53E-03 |
| Total VOCs | 4.02E+02 | 2.01E-01 | 3.49E+00 | 1.75E-03 | 5.12E-02 | 2.56E-05 | 4.05E+02 | 2.03E-01 |
| Propane | 4.02E+02 | 2.01E-01 | 3.49E+00 | 1.75E-03 | -- | -- | 4.05E+02 | 2.03E-01 |
| Ethane | -- | -- | -- | -- | -- | -- | -- | -- |
| Butane | -- | -- | -- | -- | -- | -- | -- | -- |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | 0.00E+00 | 0.00E+00 |

(1) - The maximum hourly basis calculation assumes that the volume of gas flared during pigging operations is 3,461 scf/hour.
(2) - Seal leaks directed to the flare and fugitive emissions are assumed to be the same as those calculated for an annual basis.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential to emit calculations.
(4) - Totals presented are the sum of the pigging operations emissions (hourly basis), seal leak emissions directed to the flare (same as for an annual basis), and seal leak emissions to the atmosphere (for VOCs only).

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Maximum Hourly Potential Emissions Rate Summary - **Ethane** | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Pigging Operations Emissions Directed to the Flare | | Seal Leak Emissions Directed to the Flare | | Seal Leak Emissions To the Atmosphere | | Total Emissions - Ethane - Maximum Hourly Basis(4) | |
|---|---|---|---|---|---|---|---|---|
| | Ethane - Maximum Hourly Basis 1(1) | | 100% Ethane(2) | | Fugitive Emissions(2)(3) | | | |
| | Emissions | | Emissions | | | | Emissions | |
| **Pollutants** | **lbs./hour** | **tons/hour** | **lbs./hour** | **tons/hour** | **lbs/hour** | **tons/hour** | **lbs/hour** | **tons/hour** |
| $CO_2e$ | 9.30E+02 | 4.65E-01 | 6.78E+00 | 3.39E-03 | -- | -- | 9.37E+02 | 4.69E-01 |
| $CO_2$ | 9.27E+02 | 4.63E-01 | 6.75E+00 | 3.38E-03 | -- | -- | 9.33E+02 | 4.67E-01 |
| $N_2O$ | 8.88E-03 | 4.44E-06 | 6.47E-05 | 3.23E-08 | -- | -- | 8.94E-03 | 4.47E-06 |
| $CH_4$ | 4.44E-02 | 2.22E-05 | 3.23E-04 | 1.62E-07 | -- | -- | 4.47E-02 | 2.24E-05 |
| CO | 2.48E+00 | 1.24E-03 | 2.63E-02 | 1.32E-05 | -- | -- | 2.51E+00 | 1.25E-03 |
| Total VOCs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.12E-02 | 2.56E-05 | 0.00E+00 | 0.00E+00 |
| Propane | -- | -- | -- | -- | -- | -- | -- | -- |
| Ethane | 3.27E+02 | 1.63E-01 | 2.38E+00 | 1.19E-03 | -- | -- | 3.29E+02 | 1.65E-01 |
| Butane | -- | -- | -- | -- | -- | -- | -- | -- |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | 0.00E+00 | 0.00E+00 |

(1) - The maximum hourly basis calculation assumes that the volume of gas flared during pigging operations is 4,118 scf/hour.
(2) - Seal leaks directed to the flare and fugitive emissions are assumed to be the same as those calculated for an annual basis.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential to emit calculations.
(4) - Totals presented are the sum of the pigging operations emissions (hourly basis), seal leak emissions directed to the flare (same as for an annual basis), and seal leak emissions to the atmosphere (for VOCs only).

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

### 1-3.2 Pigging Operations Directed to the Flare

### 1-3.2.1 Butane Emissions from Pigging Operations

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Annual Potential Emissions Rate Summary - **Butane** | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|
| | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour(1)** | **lbs./year** | **tons/year** | **lbs./hour(1)** | **lbs./year** | **tons/year** |
| $CO_2e$ | 1.23E+00 | 1.07E+04 | 5.37E+00 | 2.45E+00 | 2.15E+04 | 1.07E+01 |
| $CO_2$ | 1.22E+00 | 1.07E+04 | 5.35E+00 | 2.44E+00 | 2.14E+04 | 1.07E+01 |
| $N_2O$ | 1.12E-05 | 9.85E-02 | 4.93E-05 | 2.25E-05 | 1.97E-01 | 9.85E-05 |
| $CH_4$ | 5.62E-05 | 4.93E-01 | 2.46E-04 | 1.12E-04 | 9.85E-01 | 4.93E-04 |
| CO | 3.15E-03 | 2.76E+01 | 1.38E-02 | 6.29E-03 | 5.51E+01 | 2.76E-02 |
| Total VOCs | 4.38E-01 | 3.83E+03 | 1.92E+00 | 8.75E-01 | 7.67E+03 | 3.83E+00 |
| Butane | 4.38E-01 | 3.83E+03 | 1.92E+00 | 8.75E-01 | 7.67E+03 | 3.83E+00 |
| HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| | Maximum Hourly Rate | |
|---|---|---|
| | Emissions | |
| **Pollutants** | **lbs./hour(2)** | **tons/hour(2)** |
| $CO_2e$ | 1.34E+03 | 6.68E-01 |
| $CO_2$ | 1.33E+03 | 6.65E-01 |
| $N_2O$ | 1.23E-02 | 6.13E-06 |
| $CH_4$ | 6.13E-02 | 3.06E-05 |
| CO | 3.43E+00 | 1.71E-03 |
| Total VOCs | 4.77E+02 | 2.38E-01 |
| Butane | 4.77E+02 | 2.38E-01 |
| Total HAPs | 0.00E+00 | 0.00E+00 |

1 - Average rate based on annual emissions.
2 - Maximum hourly rate.

$CH_4$ = Methane

CO = Carbon Monoxide

$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#result

$CO_2$ = Carbon Dioxide

HAPs = Hazardous Air Pollutants

$N_2O$ = Nitrous Oxide

Total VOCs = Volatile Organic Compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Source Information and Assumptions for Potential Emissions Rate Calculations - Butane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | | | | |
|---|---|---|---|---|
| Scenario 1 | Volume of gas flared | 25,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. |
| Scenario 2 | Volume of gas flared | 50,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. Once every 5 years, Smart Tools pigging operations will also occur and send the same amount (25,000 scf) of gas to the flare. |
| Lower Heating Value (BTU/scf) | | 2,980 | | |
| Flare Control Efficiency (1) | | 0% | | |

| Gas Composition | |
|---|---|
| Gas | Percent |
| Butane | 0-100% |

Flare Manufacturer: John Zinc, Inc. LLC
Estimated Flare Height: 30 feet

**Expected Emissions**

Flare emissions will include products of combustion and uncombusted flared gas compound (butane). The flared gas will consist of butane and will not contain sulfur-bearing compounds or any HAPs. Fugitive emissions from seal leaks will be directed to the flare for combustion. There will be some leakage (fugitive emissions) to the atmospheric side of the seal. The potential emissions rate for atmospheric side seal leaks for VOCs (i.e., butane) are estimated to be 2.24E-01 tons/year.

**Products of Combustion**

The products of combustion from flaring of butane will include VOCs, NOx consisting of $N_2O$, and carbon dioxide, carbon monoxide, and methane.

**Compounds from Uncombusted Flared Gas**

The flare's estimated destruction efficiency determines what fraction of the flared gas remains uncombusted. The uncombusted flared gas compounds will include butane. These calculations are based on the potential emissions rate, which does not include a destruction efficiency (i.e, destruction efficiency = 0-percent).

1. PER calculations do not include a control efficiency.

BTU = British Thermal Units
HAP = hazardous air pollutants
NOx = nitrogen oxides
$N_20$= nitrous oxide
PER = potential emissions rate
scf = standard cubic feet
VOCs = volatile organic compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Butane - Scenario 1 | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 25,000 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 25,000 | scf/year |
| Flare Gas Molecular Weight = | 58.12000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Butane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 3.83E+03 | lb./year |
| | 1.92E+00 | ton/year |
| Butane Emissions = | 3.83E+03 | lb./year |
| | 1.92E+00 | ton/year |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Butane - Scenario 2 | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 50,000 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| Flare Gas Molecular Weight = | 58.12000 | lb/lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Butane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb-mole |
| Results | | |
| Total VOC Emissions = | 7.67E+03 | lb./year |
| | 3.83E+00 | ton/year |
| Butane Emissions = | 7.67E+03 | lb./year |
| | 3.83E+00 | ton/year |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Butane - Maximum Hourly Basis | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 3,109 scf/year(1)

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 3,109 | scf/hour(1) |
| Flare Gas Molecular Weight = | 58.12000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Butane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 4.77E+02 | lb./hour |
| | 2.38E-01 | ton/hour |
| Butane Emissions = | 4.77E+02 | lb./hour |
| | 2.38E-01 | ton/hour |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Butane - Scenario 1 | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume * Emission Factor(EF) *Lower Heating Value (LHV)

Where:

Gas Volume uncombusted (100%) = 25,000 scf/year

LHV = 2,980 Btu/scf

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 65.15 | 143.59 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.07E+04 | 5.35E+00 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 9.85E-02 | 4.93E-05 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 4.93E-01 | 2.46E-04 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Butane - Scenario 2 | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume * Emission Factor(EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| LHV = | 2,980 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 65.15 | 143.59 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 2.14E+04 | 1.07E+01 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.97E-01 | 9.85E-05 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 9.85E-01 | 4.93E-04 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Butane - Maximum Hourly Basis | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor(EF) *Lower Heating Value (LHV)

Where:

Gas Volume uncombusted (100%) = 3,109 scf/hour(1)

LHV = 2,980 Btu/scf

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 65.15 | 143.59 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 1.33E+03 | 6.65E-01 |

| $N_2O$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 1.23E-02 | 6.13E-06 |

| $CH_4$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 6.13E-02 | 3.06E-05 |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

1kg = 2.204 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Butane - Scenario 1 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 25,000 | scf/year |
| LHV = | 2,980 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs/year | Tons/year |
| Emissions | 2.76E+01 | 1.38E-02 |

1 ton = 2000 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Butane - Scenario 2 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| LHV = | 2,980 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | lbs/year | Tons/year |
|---|---|---|
| Emissions | 5.51E+01 | 2.76E-02 |

1 ton = 2000 lbs.

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Butane - Maximum Hourly Basis | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 3,109 | scf/hour(1) |
| LHV = | 2,980 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs/hour | Tons/hour |
| Emissions | 3.43E+00 | 1.71E-03 |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

1 ton = 2000 lbs.

### 1-3.2.2 Propane Emissions from Pigging Operations

| | | | |
|---|---|---|---|
| TETRA TECH | | | |
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Annual Potential Emissions Rate Summary - **Propane** | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|
| | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour(1)** | **lbs./year** | **tons/year** | **lbs./hour(1)** | **lbs./year** | **tons/year** |
| $CO_2e$ | 9.20E-01 | 8.06E+03 | 4.03E+00 | 1.84E+00 | 1.61E+04 | 8.06E+00 |
| $CO_2$ | 9.16E-01 | 8.03E+03 | 4.01E+00 | 1.83E+00 | 1.61E+04 | 8.03E+00 |
| $N_2O$ | 8.94E-06 | 7.84E-02 | 3.92E-05 | 1.79E-05 | 1.57E-01 | 7.84E-05 |
| $CH_4$ | 4.47E-05 | 3.92E-01 | 1.96E-04 | 8.94E-05 | 7.84E-01 | 3.92E-04 |
| CO | 2.50E-03 | 2.19E+01 | 1.10E-02 | 5.01E-03 | 4.38E+01 | 2.19E-02 |
| Total VOCs | 3.31E-01 | 2.90E+03 | 1.45E+00 | 6.63E-01 | 5.80E+03 | 2.90E+00 |
| Propane | 3.31E-01 | 2.90E+03 | 1.45E+00 | 6.63E-01 | 5.80E+03 | 2.90E+00 |
| HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| | Maximum Hourly Rate | |
|---|---|---|
| | Emissions | |
| **Pollutants** | **lbs./hour(2)** | **tons/hour(2)** |
| $CO_2e$ | 1.12E+03 | 5.58E-01 |
| $CO_2$ | 1.11E+03 | 5.56E-01 |
| $N_2O$ | 1.08E-02 | 5.42E-06 |
| $CH_4$ | 5.42E-02 | 2.71E-05 |
| CO | 3.03E+00 | 1.52E-03 |
| Total VOCs | 4.02E+02 | 2.01E-01 |
| Propane | 4.02E+02 | 2.01E-01 |
| Total HAPs | 0.00E+00 | 0.00E+00 |

1 - Average rate based on annual emissions.
2 - Maximum hourly rate.

$CH_4$ = Methane

CO = Carbon Monoxide

$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

$CO_2$ = Carbon Dioxide

HAPs = Hazardous Air Pollutants

$N_2O$ = Nitrous Oxide

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Source Information and Assumptions for Potential Emissions Rate Calculations - Propane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | | | | |
|---|---|---|---|---|
| Scenario 1 | Volume of gas flared | 25,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. |
| Scenario 2 | Volume of gas flared | 50,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. Once every 5 years, Smart Tools pigging operations will also occur and send the same amount (25,000 scf) of gas to the flare. |
| Lower Heating Value (BTU/scf) | | 2,370 | | |
| Flare Control Efficiency (1) | | 0% | | |

| Gas Composition | |
|---|---|
| Gas | Percent |
| Propane | 0-100% |

Flare Manufacturer: John Zinc Inc., LLC
Estimated Flare Height: 30 feet

**Expected Emissions**

Flare emissions will include products of combustion and uncombusted flared gas compound (propane). The flared gas will consist of propane and will not contain sulfur-bearing compounds or any HAPs. Fugitive emissions from seal leaks will be directed to the flare for combustion. There will be some leakage (fugitive emissions) to the atmospheric side of the seal. The potential emissions rate for atmospheric side seal leaks for VOCs (i.e., propane) are estimated to be 2.24E-01 tons/year.

**Products of Combustion**

The products of combustion from flaring of propane will include VOCs, NOx consisting of $N_2O$, and carbon dioxide, carbon monoxide, and methane.

**Compounds from Uncombusted Flared Gas**

The flare's estimated destruction efficiency determines what fraction of the flared gas remains uncombusted. The uncombusted flared gas compounds will include propane. These calculations are based on the potential emissions rate, which does not include a destruction efficiency (i.e, destruction efficiency = 0-percent).

1. PER calculations do not include a control efficiency.

BTU = British Thermal Units
HAP = hazardous air pollutants
NOx = nitrogen oxides
$N_20$= nitrous oxide
PER = potential emissions rate
scf = standard cubic feet
VOCs = volatile organic compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Propane - Scenario 1 | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 25,000 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 25,000 | scf/year |
| Flare Gas Molecular Weight = | 44.00000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction : Propane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 2.90E+03 | lb./year |
| | 1.45E+00 | ton/year |
| Propane Emissions = | 2.90E+03 | lb./year |
| | 1.45E+00 | ton/year |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Propane - Scenario 2 | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 50,000 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| Flare Gas Molecular Weight = | 44.00000 | lb/lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction : Propane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb-mole |
| Results | | |
| Total VOC Emissions = | 5.80E+03 | lb./year |
| | 2.90E+00 | ton/year |
| Propane Emissions = | 5.80E+03 | lb./year |
| | 2.90E+00 | ton/year |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Propane - Maximum Hourly Basis | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 3,461 scf/year(1)

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 3,461 | scf/hour(1) |
| Flare Gas Molecular Weight = | 44.00000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction : Propane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 4.02E+02 | lb./hour |
| | 2.01E-01 | ton/hour |
| Propane Emissions = | 4.02E+02 | lb./hour |
| | 2.01E-01 | ton/hour |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Propane - Scenario 1 | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume * Emission Factor(EF) * Lower Heating Value

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (100%) = | 25,000 | scf/year |
| LHV = | 2,370 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 61.46 | 135.46 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 8.03E+03 | 4.01E+00 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 7.84E-02 | 3.92E-05 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 3.92E-01 | 1.96E-04 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Propane - Scenario 2 | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor(EF) * Lower Heating Value

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| LHV = | 2,370 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 61.46 | 135.46 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 1.61E+04 | 8.03E+00 |

| $N_2O$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 1.57E-01 | 7.84E-05 |

| $CH_4$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 7.84E-01 | 3.92E-04 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Propane - Maximum Hourly Basis | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor(EF) * Lower Heating Value

Where:

Gas Volume uncombusted (100%) = 3,461 scf/hour(1)

LHV = 2,370 Btu/scf

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 61.46 | 135.46 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 1.11E+03 | 5.56E-01 |

| $N_2O$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 1.08E-02 | 5.42E-06 |

| $CH_4$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 5.42E-02 | 2.71E-05 |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

1kg = 2.204 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Propane - Scenario 1 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 25,000 | scf/year |
| LHV = | 2,370 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs/year | Tons/year |
| Emissions | 2.19E+01 | 1.10E-02 |

1 ton = 2000 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Propane - Scenario 2 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| LHV = | 2,370 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | lbs/year | Tons/year |
|---|---|---|
| Emissions | 4.38E+01 | 2.19E-02 |

1 ton = 2000 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Propane - Maximum Hourly Basis | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 3,461 | scf/hour(1) |
| LHV = | 2,370 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs/hour | Tons/hour |
| Emissions | 3.03E+00 | 1.52E-03 |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

1 ton = 2000 lbs.

### 1-3.2.3 Ethane Emissions from Pigging Operations

| | | | |
|---|---|---|---|
| TETRA TECH | | | |
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Annual Potential Emissions Rate Summary - **Ethane** | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|
| | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour(1)** | **lbs./year** | **tons/year** | **lbs./hour(1)** | **lbs./year** | **tons/year** |
| $CO_2e$ | 6.45E-01 | 5.65E+03 | 2.82E+00 | 1.29E+00 | 1.13E+04 | 5.65E+00 |
| $CO_2$ | 6.42E-01 | 5.63E+03 | 2.81E+00 | 1.28E+00 | 1.13E+04 | 5.63E+00 |
| $N_2O$ | 6.15E-06 | 5.39E-02 | 2.69E-05 | 1.23E-05 | 1.08E-01 | 5.39E-05 |
| $CH_4$ | 3.08E-05 | 2.69E-01 | 1.35E-04 | 6.15E-05 | 5.39E-01 | 2.69E-04 |
| CO | 1.72E-03 | 1.51E+01 | 7.54E-03 | 3.44E-03 | 3.02E+01 | 1.51E-02 |
| Total VOCs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ethane | 2.26E-01 | 1.98E+03 | 9.92E-01 | 4.53E-01 | 3.97E+03 | 1.98E+00 |
| HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| | Maximum Hourly Rate | |
|---|---|---|
| | Emissions | |
| **Pollutants** | **lbs./hour(2)** | **tons/hour(2)** |
| $CO_2e$ | 9.30E+02 | 4.65E-01 |
| $CO_2$ | 9.27E+02 | 4.63E-01 |
| $N_2O$ | 8.88E-03 | 4.44E-06 |
| $CH_4$ | 4.44E-02 | 2.22E-05 |
| CO | 2.48E+00 | 1.24E-03 |
| Total VOCs | 0.00E+00 | 0.00E+00 |
| Ethane | 3.27E+02 | 1.63E-01 |
| Total HAPs | 0.00E+00 | 0.00E+00 |

1 - Average rate based on annual emissions.
2 - Maximum hourly rate.

$CH_4$ = Methane

CO = Carbon Monoxide

$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

$CO_2$ = Carbon Dioxide

HAPs = Hazardous Air Pollutants

$N_2O$ = Nitrous Oxide

Total VOCs = Volatile Organic Compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Source Information and Assumptions for Potential Emissions Rate Calculations - Ethane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | | | | |
|---|---|---|---|---|
| Scenario 1 | Volume of gas flared | 25,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. |
| Scenario 2 | Volume of gas flared | 50,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. Once every 5 years, Smart Tools pigging operations will also occur and send the same amount (25,000 scf) of gas to the flare. |
| Lower Heating Value (BTU/scf) | | 1,630 | | |
| Flare Control Efficiency (1) | | 0% | | |

| Gas Composition | |
|---|---|
| Gas | Percent |
| Ethane | 0-100% |

Flare Manufacturer: John Zinc Inc., LLC
Estimated Flare Height: 30 feet

**Expected Emissions**

Flare emissions will include products of combustion and uncombusted flared gas compound (ethane). The flared gas will consist of ethane and will not contain sulfur-bearing compounds, VOCs or any HAPs. Fugitive emissions from seal leaks will be directed to the flare for combustion. There will be some leakage (fugitive emissions) to the atmospheric side of the seal. The potential emissions rate for atmospheric side seal leaks for ethane are estimated to be 2.24E-01 tons/year.

**Products of Combustion**

The products of combustion from flaring of ethane will include VOCs, NOx consisting of $N_2O$, and carbon dioxide, carbon monoxide, and methane.

**Compounds from Uncombusted Flared Gas**

The flare's estimated destruction efficiency determines what fraction of the flared gas remains uncombusted. The uncombusted flared gas compounds will include ethane. These calculations are based on the potential emissions rate, which does not include a destruction efficiency (i.e, destruction efficiency = 0-percent).

1. PER calculations do not include a control efficiency.

BTU = British Thermal Units
HAP = hazardous air pollutants
NOx = nitrogen oxides
$N_2O$= nitrous oxide
PER = potential emissions rate
scf = standard cubic feet
VOCs = volatile organic compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Ethane - Scenario 1 | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 25,000 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 25,000 | scf/year |
| Flare Gas Molecular Weight = | 30.07000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 0.00000 | |
| Weight Fraction : Ethane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 0.00E+00 | lb./year |
| | 0.00E+00 | ton/year |
| Ethane Emissions = | 1.98E+03 | lb./year |
| | 9.92E-01 | ton/year |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Ethane - Scenario 2 | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 50,000 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| Flare Gas Molecular Weight = | 30.07000 | lb/lb-mol |
| Weight Fraction: Total VOCs = | 0.00000 | |
| Weight Fraction : Ethane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb-mole |
| Results | | |
| Total VOC Emissions = | 0.00E+00 | lb./year |
| | 0.00E+00 | ton/year |
| Ethane Emissions = | 3.97E+03 | lb./year |
| | 1.98E+00 | ton/year |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | VOC emissions - Ethane - Maximum Hourly Rate | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 4,118 scf/year(1)

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (100%) = | 4,118 | scf/hour(1) |
| Flare Gas Molecular Weight = | 30.07000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 0.00000 | |
| Weight Fraction : Ethane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 0.00E+00 | lb./hour |
| | 0.00E+00 | ton/hour |
| Ethane Emissions = | 3.27E+02 | lb./hour |
| | 1.63E-01 | ton/hour |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Ethane - Scenario 1 | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume * Emission Factor(EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (100%) = | 25,000 | scf/year |
| LHV = | 1,630 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 62.64 | 138.06 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 5.63E+03 | 2.81E+00 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 5.39E-02 | 2.69E-05 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 2.69E-01 | 1.35E-04 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Ethane - Scenario 2 | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor(EF) *Lower Heating Value(LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| LHV = | 1,630 | Btu/scf |

| **Pollutant** | **EF (kg/mmBtu)** | **EF (lb./mmBtu)** |
|---|---|---|
| $CO_2$ | 62.64 | 138.06 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.13E+04 | 5.63E+00 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.08E-01 | 5.39E-05 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 5.39E-01 | 2.69E-04 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Ethane - Maximum Hourly Basis | | |
| BASED ON: | Potential emissions rate, client information and references for emission factors, including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor(EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (100%) = | 4,118 | scf/hour[1] |
| LHV = | 1,630 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 62.64 | 138.06 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 9.27E+02 | 4.63E-01 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 8.88E-03 | 4.44E-06 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 4.44E-02 | 2.22E-05 |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

1kg = 2.204 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Ethane - Scenario 1 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 25,000 | scf/year |
| LHV = | 1,630 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | lbs/year | Tons/year |
|---|---|---|
| Emissions | 1.51E+01 | 7.54E-03 |

1 ton = 2000 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Ethane - Scenario 2 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 50,000 | scf/year |
| LHV = | 1,630 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | lbs/year | Tons/year |
|---|---|---|
| Emissions | 3.02E+01 | 1.51E-02 |

1 ton = 2000 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/27/14 |
| SUBJECT: | Carbon monoxide emissions - Ethane - Maximum Hourly Basis | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversation factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (100%) = | 4,118 | scf/hour(1) |
| LHV = | 1,630 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs/hour | Tons/hour |
| Emissions | 2.48E+00 | 1.24E-03 |

(1) - Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

1 ton = 2000 lbs.

### 1-3.3 Seal Leak Emissions

### 1-3.3.1 Seal Leak Potential Emissions Rate Summary

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | CR | DATE: | 01/29/14 |
| SUBJECT: | Annual Potential Emissions Rate Calculation Summary Due to Seal Leaks | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Seal Leak Emissions Directed to the Flare | | | | | | | | | Seal Leak Emissions To the Atmosphere | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario 1 | | | Scenario 2 | | | Scenario 3 | | | Fugitive Emissions (1) | | |
| | Emissions | | | Emissions | | | Emissions | | | | | |
| Pollutants | lbs./hour | lbs./year | tons/year | lbs./hour | lbs./year | tons/year | lbs./hour | lbs./year | tons/year | lbs/hour | lbs./year | tons/year |
| $CO_2e$ | 6.78E+00 | 5.94E+04 | 2.97E+01 | 9.67E+00 | 8.47E+04 | 4.24E+01 | 1.29E+01 | 1.13E+05 | 5.64E+01 | -- | -- | -- |
| $CO_2$ | 6.75E+00 | 5.91E+04 | 2.96E+01 | 9.63E+00 | 8.44E+04 | 4.22E+01 | 1.28E+01 | 1.12E+05 | 5.62E+01 | -- | -- | -- |
| $N_2O$ | 6.47E-05 | 5.66E-01 | 2.83E-04 | 9.40E-05 | 8.24E-01 | 4.12E-04 | 1.18E-04 | 1.04E+00 | 5.18E-04 | -- | -- | -- |
| $CH_4$ | 3.23E-04 | 2.83E+00 | 1.42E-03 | 4.70E-04 | 4.12E+00 | 2.06E-03 | 5.91E-04 | 5.18E+00 | 2.59E-03 | -- | -- | -- |
| CO | 2.63E-02 | 2.30E+02 | 7.92E-02 | 2.63E-02 | 2.30E+02 | 1.15E-01 | 3.31E-02 | 2.90E+02 | 1.45E-01 | -- | -- | -- |
| Total VOCs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.49E+00 | 3.06E+04 | 1.53E+01 | 4.60E+00 | 4.03E+04 | 2.02E+01 | 5.12E-02 | 4.48E+02 | 2.24E-01 |
| Propane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.49E+00 | 3.06E+04 | 1.53E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- |
| Ethane | 2.38E+00 | 2.09E+04 | 1.04E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- |
| Butane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.60E+00 | 4.03E+04 | 2.02E+01 | -- | -- | -- |
| HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- |

(1) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to Scenarios 1, 2 and 3 for potential emissions rate calculations.

$CH_4$ = Methane

$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

$CO_2$ = Carbon Dioxide

HAPs = Hazardous Air Pollutants

$N_2O$ = Nitrous Oxide

Total VOCs = Volatile Organic Compounds

### 1-3.3.2 Seal Leaks Directed to the Flare

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | CR | DATE: | 01/29/14 |
| SUBJECT: | Source Information and Assumptions - Seal Leaks Directed to Flare | | |
| BASED ON: | Client Information, potential emissions rate, and other reference materials as noted in each calculation worksheet. | | |

| | | | | |
|---|---|---|---|---|
| Seal Leak Scenario 1 | Leaks directed to flare | 262,800 | scf/year | Potential emission rate calculations for seal leaks that are directed to the flare. Estimated leakage has a range from 0.15 to 0.5 scfm. A leakage of 0.5 scfm was assumed as the most conservative estimate. Seal Leak Scenario 1 is based off a gas composition of 100% ethane. |
| Seal Leak Scenario 2 | Leaks directed to flare | 262,800 | scf/year | Potential emission rate calculations for seal leaks that are directed to flare. Estimated leakage has a range from 0.15 to 0.5 scfm. A leakage of 0.5 scfm was assumed as the most conservative estimate. Seal Leak Scenario 2 is based off a gas composition of 100% propane. |
| Seal Leak Scenario 3 | Leaks directed to flare | 262,800 | scf/year | Potential emission rate calculations for seal leaks that are directed to flare. Estimated leakage has a range from 0.15 to 0.5 scfm. A leakage of 0.5 scfm was assumed as the most conservative estimate. Seal Leak Scenario 3 is based off a gas composition of 100% butane. |

| | |
|---|---|
| Ethane Lower Heating Value (BTU/scf) | 1,630 |
| Propane Lower Heating Value (BTU/scf) | 2,370 |
| Butane Lower Heating Value (BTU/scf) | 2,980 |
| Flare Control Efficiency | 0% |

**Gas Composition**

| Gas | Percent | | |
|---|---|---|---|
| | Seal Leak Scenario 1 | Seal Leak Scenario 2 | Seal Leak Scenario 3 |
| Ethane | 100% | 0% | 0% |
| Propane | 0% | 100% | 0% |
| Butane | 0% | 0% | 100% |

Flare Manufacturer: John Zinc Co. LLC
Estimated Flare Height: 30 feet

**Expected Emissions**

Flare emissions will include products of combustion and uncombusted flared gas compounds (propane, ethane or butane). The flared gas will consist of a mixture of propane, ethane or butane and will not contain sulfur-bearing compounds or any hazardous air pollutants (HAPs). Fugitive emissions from seal leaks will be directed to the flare for combustion. There will be some leakage (fugitive emissions) to the atmospheric side of the seal. The potential emissions rate (PER) for atmospheric side seal leaks for VOCs are estimated to be 2.24E-01 tons/year.

**Products of Combustion**

The products of combustion from flaring propane, ethane or butane will include volatile organic compounds (VOCs), nitrogen oxides (NOx) consisting of nitrous oxide ($N_2O$), carbon dioxide, carbon monoxide, and methane.

**Compounds from Uncombusted Flared Gas**

The flare's estimated destruction efficiency determines what fraction of the flared gas remains uncombusted. The uncombusted flared gas compounds will include propane, ethane or butane. These calculations are based on the PER, which does not include an destruction efficiency (i.e., flare control efficiency = 0-percent).

BTU = British Thermal Units
HAPs = hazardous air pollutants
$N_2O$= nitrous oxide
NOx = nitrogen oxides
PER= potential emissions rate
scf = standard cubic feet
VOCs = volatile organic compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: CR | | DATE: | 01/29/14 |
| SUBJECT: | VOC emissions - Ethane - Seal Leak Scenario 1 - Leaks directed to flare | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

**VOC Flare Emissions Calculations**

Emissions (lb/event) = Seal leak gas volume ∗ coversion factor (CF) * Molecular Weight * Weight Fraction

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per event
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 262,800 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume leaked (100%) = | 262,800 | scf/year |
| Flare Gas Molecular Weight = | 30.07 | lb./lb-mol |
| Weight Fraction: Total VOCs (1) = | 0.00000 | |
| Weight Fraction: Ethane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC(1) Emissions = | 0.00E+00 | lb./year |
| | 0.00E+00 | ton/year |
| Ethane Emissions = | 2.09E+04 | lb./year |
| | 1.04E+01 | ton/year |

1. Ethane is considered to have negligible photochemical activity per 40CFR51.100 and is not a VOC.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: CR | | DATE: | 01/29/14 |
| SUBJECT: | VOC emissions - Propane - Seal Leak Scenario 2 - Leaks directed to flare | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

**VOC Flare Emissions Calculations**

Emissions (lb/event) = Seal leak gas volume ∗ coversion factor (CF) * Molecular Weight * Weight Fraction

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per event
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 262,800 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume leaked (100%) = | 262,800 | scf/year |
| Flare Gas Molecular Weight = | 44.10 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Propane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 3.06E+04 | lb./year |
| | 1.53E+01 | ton/year |
| Propane Emissions = | 3.06E+04 | lb./year |
| | 1.53E+01 | ton/year |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: CR | | DATE: | 01/29/14 |
| SUBJECT: | VOC emissions - Butane - Seal Leak Scenario 3 - Leaks directed to flare | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

**VOC Flare Emissions Calculations**

Emissions (lb/event) = Seal leak gas volume ∗ coversion factor (CF) * Molecular Weight * Weight Fraction

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per event
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 0 percent (No control efficiency for PER calculations)
Volume of Gas Uncombusted = 262,800 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume leaked (100%) = | 262,800 | scf/year |
| Flare Gas Molecular Weight = | 58.12 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Butane = | 1.00000 | |
| Efficiency = | 0% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 4.03E+04 | lb./year |
| | 2.02E+01 | ton/year |
| Butane Emissions = | 4.03E+04 | lb./year |
| | 2.02E+01 | ton/year |

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | CR | DATE: | 01/29/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Ethane - Scenario 1 - Leaks directed to flare. | | |
| BASED ON: | Potential emissions rate, client information and references for Emission Factors, including : Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. Global warming potential factors are selected for a 100-year horizon, which are consistent with all climate change programs via the Intergovernmental Panel on Climate Change. | | |

Emissions = Seal leak gas volume ∗ Emission Factor(EF) *Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Seal leak gas volume = | 262,800 | scf/year |
| LHV (ethane)= | 1,630 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) | Global Warming Potential (GWP) |
|---|---|---|---|
| $CO_2$ | 62.64 | 138.06 | 1 |
| $N_2O$ | 0.0006 | 0.0013 | 310 |
| $CH_4$ | 0.003 | 0.0066 | 21 |

| $CO_2$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 5.91E+04 | 2.96E+01 |

| $N_2O$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 5.66E-01 | 2.83E-04 | 1.76E+02 | 8.78E-02 |

| $CH_4$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 2.83E+00 | 1.42E-03 | 5.95E+01 | 2.97E-02 |

1kg = 2.204 lbs.
1 ton = 2,000 lbs.

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | CR | DATE: | 01/29/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Propane - Scenario 2 - Leaks directed to flare. | | |
| BASED ON: | Potential Emissions Rate, client information and Reference for Emission Factors including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. Global warming potential factors are selected for a 100-year horizon, which are consistent with all climate change programs via the Intergovernmental Panel on Climate Change. | | |

Emissions = Seal leak gas volume ∗ Emission Factor(EF) *Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Seal leak gas volume = | 262,800 | scf/year |
| LHV (propane) = | 2,370 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) | Global Warming Potential (GWP) |
|---|---|---|---|
| $CO_2$ | 61.46 | 135.46 | 1 |
| $N_2O$ | 0.0006 | 0.0013 | 310 |
| $CH_4$ | 0.003 | 0.0066 | 21 |

| $CO_2$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 8.44E+04 | 4.22E+01 |

| $N_2O$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 8.24E-01 | 4.12E-04 | 2.55E+02 | 1.28E-01 |

| $CH_4$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 4.12E+00 | 2.06E-03 | 8.65E+01 | 4.32E-02 |

1 kg = 2.204 lbs.
1 ton = 2,000 lbs.

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | CR | DATE: | 01/29/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Butane - Scenario 3 - Leaks directed to flare. | | |
| BASED ON: | Potential Emissions Rate, client information and Reference for Emission Factors including: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. Global warming potential factors are selected for a 100-year horizon, which are consistent with all climate change programs via the Intergovernmental Panel on Climate Change. | | |

Emissions = Seal leak gas volume ∗ Emission Factor(EF) *Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Seal leak gas volume = | 262,800 | scf/year |
| LHV (butane) = | 2,980 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) | Global Warming Potential (GWP) |
|---|---|---|---|
| $CO_2$ | 65.15 | 143.59 | 1 |
| $N_2O$ | 0.0006 | 0.0013 | 310 |
| $CH_4$ | 0.003 | 0.0066 | 21 |

| $CO_2$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 1.12E+05 | 5.62E+01 |

| $N_2O$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 1.04E+00 | 5.18E-04 | 3.21E+02 | 1.61E-01 |

| $CH_4$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 5.18E+00 | 2.59E-03 | 1.09E+02 | 5.44E-02 |

1 kg = 2.204 lbs.
1 ton = 2,000 lbs.

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/29/14 |
| SUBJECT: | Carbon monoxide emissions - Ethane - Scenario 1 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Seal leak gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Seal leak gas volume = | 262,800 | scf/year |
| LHV(ethane)= | 1,630 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs/year | Tons/year |
| Emissions | 1.58E+02 | 7.92E-02 |

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/29/14 |
| SUBJECT: | Carbon monoxide emissions - Propane - Scenario 2 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Seal leak gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Seal leak gas volume = | 262,800 | scf/year |
| LHV(propane)= | 2,370 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | lbs/year | Tons/year |
|---|---|---|
| Emissions | 2.30E+02 | 1.15E-01 |

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01/29/14 |
| SUBJECT: | Carbon monoxide emissions - Butane - Scenario 3 | | |
| BASED ON: | Potential emissions rate, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Seal leak gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor(EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Seal leak gas volume = | 262,800 | scf/year |
| LHV(butane)= | 2,980 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs/year | Tons/year |
| Emissions | 2.90E+02 | 1.45E-01 |

### 1-3.3.3 Seal Leaks Directed to the Atmosphere

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | CR | DATE: | 01/29/14 |
| SUBJECT: | VOC emissions - Delmont Facility - Fugitive Emissions - Leaks directed to atmosphere | | |
| BASED ON: | Client Information and Potential Emissions Rate | | |

**Fugitive Emissions Calculations**

Where:
Fugitive VOC Emissions (TPY) = # of Sources x Emission Factor (lbs./hr.-source) x 8,760 hrs./year x (1 ton/2,000 pounds)

| Source Category | Service | Emission Factor (lb./hr./source) | Total Number of Sources | Fugitive VOC Emissions (TPY) |
|---|---|---|---|---|
| Valves | Light Liquid | 0.0000946 | 150 | 0.062 |
| Fittings | Light Liquid | 0.0000176 | 410 | 0.032 |
| Pumps | Light Liquid | 0.001188 | 1 | 0.005 |
| Other | Light Liquid | 0.000286 | 100 | 0.125 |
| | | | **Total** | **0.224** |

# 1-4 POTENTIAL TO EMIT CALCULATIONS

## 1-4.1 Potential to Emit Summary

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 02-03-2014 |
| SUBJECT: | Annual Potential to Emit Summary - Butane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Pigging Operations Emissions Directed to the Flare | | | | | | Seal Leak Emissions Directed to the Flare | | | Seal Leak Emissions To the Atmosphere | | | Total Emissions - Butane Scenario 1(4) | | | Total Emissions - Butane Scenario 2(5) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Butane - Scenario 1(1) | | | Butane - Scenario 2(2) | | | 100% Butane | | | Fugitive Emissions(3) | | | | | | | | |
| | Emissions | | | Emissions | | | Emissions | | | | | | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** |
| $CO_2e$ | 1.23E-03 | 1.07E+01 | 5.37E-03 | 2.45E-03 | 2.15E+01 | 1.07E-02 | 1.29E-02 | 1.13E+02 | 5.64E-02 | -- | -- | -- | 1.41E-02 | 1.24E+02 | 6.18E-02 | 1.53E-02 | 1.34E+02 | 6.72E-02 |
| $CO_2$ | 1.22E-03 | 1.07E+01 | 5.35E-03 | 2.44E-03 | 2.14E+01 | 1.07E-02 | 1.28E-02 | 1.12E+02 | 5.62E-02 | -- | -- | -- | 1.41E-02 | 1.23E+02 | 6.16E-02 | 1.53E-02 | 1.34E+02 | 6.69E-02 |
| $N_2O$ | 1.12E-08 | 9.85E-05 | 4.93E-08 | 2.25E-08 | 1.97E-04 | 9.85E-08 | 1.18E-07 | 1.04E-03 | 5.18E-07 | -- | -- | -- | 1.29E-07 | 1.13E-03 | 5.67E-07 | 1.41E-07 | 1.23E-03 | 6.16E-07 |
| $CH_4$ | 5.62E-08 | 4.93E-04 | 2.46E-07 | 1.12E-07 | 9.85E-04 | 4.93E-07 | 5.91E-07 | 5.18E-03 | 2.59E-06 | -- | -- | -- | 6.47E-07 | 5.67E-03 | 2.84E-06 | 7.04E-07 | 6.16E-03 | 3.08E-06 |
| CO | 3.15E-06 | 2.76E-02 | 1.38E-05 | 6.29E-06 | 5.51E-02 | 2.76E-05 | 3.31E-05 | 2.90E-01 | 1.45E-04 | -- | -- | -- | 3.62E-05 | 3.17E-01 | 1.59E-04 | 3.94E-05 | 3.45E-01 | 1.72E-04 |
| Total VOCs | 4.38E-04 | 3.83E+00 | 1.92E-03 | 8.75E-04 | 7.67E+00 | 3.83E-03 | 4.60E-03 | 4.03E+01 | 2.02E-02 | 5.12E-02 | 4.48E+02 | 2.24E-01 | 5.62E-02 | 4.93E+02 | 2.46E-01 | 5.67E-02 | 4.96E+02 | 2.48E-01 |
| Propane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ethane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Butane | 4.38E-04 | 3.83E+00 | 1.92E-03 | 8.75E-04 | 7.67E+00 | 3.83E-03 | 4.60E-03 | 4.03E+01 | 2.02E-02 | -- | -- | -- | 5.62E-02 | 4.93E+02 | 2.46E-01 | 5.67E-02 | 4.96E+02 | 2.48E-01 |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

(1) - Scenario 1 assumes that the volume of gas flared during pigging operations is 25,000 scf/year.
(2) - Scenario 2 assumes that the volume of gas flared during pigging operations is 50,000 scf/year.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential to emit calculations.
(4) - Totals presented are the sum of the pigging operations emissions (Scenario 1), seal leak emissions directed to the flare, and seal leak emissions to the atmosphere (for total VOCs only).
(5) - Totals presented are the sum of the pigging operations emissions (Scenario 2), seal leak emissions directed to the flare, and seal leak emissions to the atmosphere (for total VOCs only).

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 02-03-2014 |
| SUBJECT: | Annual Potential to Emit Summary - Propane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Pigging Operations Emissions Directed to the Flare | | | | | | Seal Leak Emissions Directed to the Flare | | | Seal Leak Emissions To the Atmosphere | | | Total Emissions - Propane Scenario 1(4) | | | Total Emissions - Propane Scenario 2(5) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Propane - Scenario 1(1) | | | Propane - Scenario 2(2) | | | 100% Propane | | | Fugitive Emissions(3) | | | | | | | | |
| | Emissions | | | Emissions | | | Emissions | | | | | | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** |
| $CO_2e$ | 9.20E-04 | 8.06E+00 | 4.03E-03 | 1.84E-03 | 1.61E+01 | 8.06E-03 | 9.67E-03 | 8.47E+01 | 4.24E-02 | -- | -- | -- | 1.06E-02 | 9.28E+01 | 4.64E-02 | 1.15E-02 | 1.01E+02 | 5.04E-02 |
| $CO_2$ | 9.16E-04 | 8.03E+00 | 4.01E-03 | 1.83E-03 | 1.61E+01 | 8.03E-03 | 9.63E-03 | 8.44E+01 | 4.22E-02 | -- | -- | -- | 1.05E-02 | 9.24E+01 | 4.62E-02 | 1.15E-02 | 1.00E+02 | 5.02E-02 |
| $N_2O$ | 8.94E-09 | 7.84E-05 | 3.92E-08 | 1.79E-08 | 1.57E-04 | 7.84E-08 | 9.40E-08 | 8.24E-04 | 4.12E-07 | -- | -- | -- | 1.03E-07 | 9.02E-04 | 4.51E-07 | 1.12E-07 | 9.80E-04 | 4.90E-07 |
| $CH_4$ | 4.47E-08 | 3.92E-04 | 1.96E-07 | 8.94E-08 | 7.84E-04 | 3.92E-07 | 4.70E-07 | 4.12E-03 | 2.06E-06 | -- | -- | -- | 5.15E-07 | 4.51E-03 | 2.25E-06 | 5.60E-07 | 4.90E-03 | 2.45E-06 |
| CO | 2.50E-06 | 2.19E-02 | 1.10E-05 | 5.01E-06 | 4.38E-02 | 2.19E-05 | 2.63E-05 | 2.30E-01 | 1.15E-04 | -- | -- | -- | 2.88E-05 | 2.52E-01 | 1.26E-04 | 3.13E-05 | 2.74E-01 | 1.37E-04 |
| Total VOCs | 3.31E-04 | 2.90E+00 | 1.45E-03 | 6.63E-04 | 5.80E+00 | 2.90E-03 | 3.49E-03 | 3.06E+01 | 1.53E-02 | 5.12E-02 | 4.48E+02 | 2.24E-01 | 5.50E-02 | 4.82E+02 | 2.41E-01 | 5.54E-02 | 4.85E+02 | 2.42E-01 |
| Propane | 3.31E-04 | 2.90E+00 | 1.45E-03 | 6.63E-04 | 5.80E+00 | 2.90E-03 | 3.49E-03 | 3.06E+01 | 1.53E-02 | -- | -- | -- | 5.50E-02 | 4.82E+02 | 2.41E-01 | 5.54E-02 | 4.85E+02 | 2.42E-01 |
| Ethane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Butane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

(1) - Scenario 1 assumes that the volume of gas flared during pigging operations is 25,000 scf/year.
(2) - Scenario 2 assumes that the volume of gas flared during pigging operations is 50,000 scf/year.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential to emit calculations.
(4) - Totals presented are the sum of the pigging operations emissions (Scenario 1), seal leak emissions directed to the flare, and seal leak emissions to the atmosphere (for VOCs only).
(5) - Totals presented are the sum of the pigging operations emissions (Scenario 2), seal leak emissions directed to the flare, and seal leak emissions to the atmosphere (for VOCs only).

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 02-03-2014 |
| SUBJECT: | Annual Potential to Emit Summary - Ethane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Pigging Operations Emissions Directed to the Flare | | | | | | Seal Leak Emissions Directed to the Flare | | | Seal Leak Emissions To the Atmosphere | | | Total Emissions - Ethane Scenario 1(4) | | | Total Emissions - Ethane Scenario 2(5) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ethane - Scenario 1(1) | | | Ethane - Scenario 2(2) | | | 100% Ethane | | | Fugitive Emissions(3) | | | | | | | | |
| | Emissions | | | Emissions | | | Emissions | | | | | | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** |
| $CO_2e$ | 6.45E-04 | 5.65E+00 | 2.82E-03 | 1.29E-03 | 1.13E+01 | 5.65E-03 | 6.78E-03 | 5.94E+01 | 2.97E-02 | -- | -- | -- | 7.42E-03 | 6.50E+01 | 3.25E-02 | 8.07E-03 | 7.07E+01 | 3.53E-02 |
| $CO_2$ | 6.42E-04 | 5.63E+00 | 2.81E-03 | 1.28E-03 | 1.13E+01 | 5.63E-03 | 6.75E-03 | 5.91E+01 | 2.96E-02 | -- | -- | -- | 7.39E-03 | 6.48E+01 | 3.24E-02 | 8.04E-03 | 7.04E+01 | 3.52E-02 |
| $N_2O$ | 6.15E-09 | 5.39E-05 | 2.69E-08 | 1.23E-08 | 1.08E-04 | 5.39E-08 | 6.47E-08 | 5.66E-04 | 2.83E-07 | -- | -- | -- | 7.08E-08 | 6.20E-04 | 3.10E-07 | 7.70E-08 | 6.74E-04 | 3.37E-07 |
| $CH_4$ | 3.08E-08 | 2.69E-04 | 1.35E-07 | 6.15E-08 | 5.39E-04 | 2.69E-07 | 3.23E-07 | 2.83E-03 | 1.42E-06 | -- | -- | -- | 3.54E-07 | 3.10E-03 | 1.55E-06 | 3.85E-07 | 3.37E-03 | 1.69E-06 |
| CO | 1.72E-06 | 1.51E-02 | 7.54E-06 | 3.44E-06 | 3.02E-02 | 1.51E-05 | 1.81E-05 | 1.58E-01 | 7.92E-05 | -- | -- | -- | 1.98E-05 | 1.74E-01 | 8.68E-05 | 2.15E-05 | 1.89E-01 | 9.43E-05 |
| Total VOCs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.12E-02 | 4.48E+02 | 2.24E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Propane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ethane | 2.26E-04 | 1.98E+00 | 9.92E-04 | 4.53E-04 | 3.97E+00 | 1.98E-03 | 2.38E-03 | 2.09E+01 | 1.04E-02 | -- | -- | -- | 2.61E-03 | 2.29E+01 | 1.14E-02 | 2.83E-03 | 2.48E+01 | 1.24E-02 |
| Butane | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

(1) - Scenario 1 assumes that the volume of gas flared during pigging operations is 25,000 scf/year.
(2) - Scenario 2 assumes that the volume of gas flared during pigging operations is 50,000 scf/year.
(3) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both propane and butane for potential to emit calculations.
(4) - Totals presented are the sum of the pigging operations emissions (Scenario 1) and seal leak emissions directed to the flare. Seal leak emissions to the atmosphere (for VOCs only) are not included because ethane is not considered a VOC.
(5) - Totals presented are the sum of the pigging operations emissions (Scenario 2) and seal leak emissions directed to the flare Seal leak emissions to the atmosphere (for VOCs only) are not included because ethane is not considered a VOC.

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

### 1-4.2 Pigging Operations Directed to the Flare

### 1-4.2.1 Butane Emissions from Pigging Operations

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Annual Potential to Emit Summary - **Butane** | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|
| | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour(1)** | **lbs./year** | **tons/year** | **lbs./hour(1)** | **lbs./year** | **tons/year** |
| $CO_2e$ | 1.23E-03 | 1.07E+01 | 5.37E-03 | 2.45E-03 | 2.15E+01 | 1.07E-02 |
| $CO_2$ | 1.22E-03 | 1.07E+01 | 5.35E-03 | 2.44E-03 | 2.14E+01 | 1.07E-02 |
| $N_2O$ | 1.12E-08 | 9.85E-05 | 4.93E-08 | 2.25E-08 | 1.97E-04 | 9.85E-08 |
| $CH_4$ | 5.62E-08 | 4.93E-04 | 2.46E-07 | 1.12E-07 | 9.85E-04 | 4.93E-07 |
| CO | 3.15E-06 | 2.76E-02 | 1.38E-05 | 6.29E-06 | 5.51E-02 | 2.76E-05 |
| Total VOCs | 4.38E-04 | 3.83E+00 | 1.92E-03 | 8.75E-04 | 7.67E+00 | 3.83E-03 |
| Butane | 4.38E-04 | 3.83E+00 | 1.92E-03 | 8.75E-04 | 7.67E+00 | 3.83E-03 |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| | Maximum Hourly Rate | |
|---|---|---|
| | Emissions | |
| **Pollutants** | **lbs./hour(2)** | **tons/hour(2)** |
| $CO_2e$ | 1.34E+00 | 6.68E-04 |
| $CO_2$ | 1.33E+00 | 6.65E-04 |
| $N_2O$ | 1.23E-05 | 6.13E-09 |
| $CH_4$ | 6.13E-05 | 3.06E-08 |
| CO | 3.43E-03 | 1.71E-06 |
| Total VOCs | 4.77E-01 | 2.38E-04 |
| Butane | 4.77E-01 | 2.38E-04 |
| Total HAPs | 0.00E+00 | 0.00E+00 |

1 - Average rate based on annual emissions.
2 - Maximum hourly rate.

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Source Information and Assumptions - Butane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | | | | |
|---|---|---|---|---|
| Scenario 1 | Volume of gas flared | 25,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. |
| Scenario 2 | Volume of gas flared | 50,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. Once every 5 years, Smart Tools pigging operations will also occur and send the same amount (25,000 scf) of gas to the flare. |
| Lower Heating Value (BTU/scf) | | 2,980 | | |
| Flare Control Efficiency (1) | | 99.9% | | |

| Gas Composition | |
|---|---|
| Gas | Percent |
| Butane | 0-100% |

Flare Manufacturer: John Zink Co. LLC
Estimated Flare Height: 30 feet

**Expected Emissions**

Flare emissions will include products of combustion and uncombusted flared gas compounds (butane). The flared gas will consist of butane and will not contain sulfur-bearing compounds or any hazardous air pollutants (HAPs). Fugitive emissions from seal leaks will be directed to the flare for combustion. There will be some leakage (fugitive emissions) to the atmospheric side of the seal. The potential to emit (PTE) for atmospheric side seal leaks for volatile organic compounds (VOCs) are estimated to be 2.24E-01 tons/year.

**Products of Combustion**

The products of combustion from flaring the butane will include VOCs, nitrogen oxides (NOx) consisting of nitrous oxide ($N_2O$), carbon dioxide, carbon monoxide, and methane.

**Compounds from Uncombusted Flared Gas**

The flare's estimated destruction efficiency (99.9 percent) determines what fraction of the flared gas remains uncombusted. The uncombusted flared gas compounds will include butane. These calculations are based on PTE, which does include the destruction efficiency.

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

BTU = British Thermal Units
HAP = hazardous air pollutant
$N_2O$ = nitrous oxide
NOx = nitrogen oxides
PTE = potential to emit

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | VOC emissions - Butane - Scenario 1 | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 25 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| Flare Gas Molecular Weight = | 58.12000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Butane = | 1.00000 | |
| Efficiency = | 99.9% [1] | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 3.83E+00 | lb./year |
| | 1.92E-03 | ton/year |
| Butane Emissions = | 3.83E+00 | lb./year |
| | 1.92E-03 | ton/year |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | VOC emissions - Butane - Scenario 2 | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 50 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| Flare Gas Molecular Weight = | 58.12000 | lb/lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction : Butane = | 1.00000 | |
| Efficiency = | 99.9% [1] | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton= | 2,000 | lb. |
| 1 scf = | 379 | scf / lb-mole |
| Results | | |
| Total VOC Emissions = | 7.67E+00 | lb./year |
| | 3.83E-03 | ton/year |
| Butane Emissions = | 7.67E+00 | lb./year |
| | 3.83E-03 | ton/year |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: 100-NRS-T29725 | DATE 01-27-2014 |
| SUBJECT: | VOC emissions - Butane - Maximum Hourly Basis | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per hour
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 3.1 scf/hour[2]

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 3.1 | scf/hour[2] |
| Flare Gas Molecular Weight = | 58.12000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Butane = | 1.00000 | |
| Efficiency = | 99.9% | [1] |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 4.77E-01 | lb./hour |
| | 2.38E-04 | ton/hour |
| Butane Emissions = | 4.77E-01 | lb./hour |
| | 2.38E-04 | ton/hour |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.
2. Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Butane - Scenario 1 | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| LHV = | 2,980 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 65.15 | 143.59 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.07E+01 | 5.35E-03 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 9.85E-05 | 4.93E-08 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 4.93E-04 | 2.46E-07 |

1kg = 2.204 lbs.
1 ton = 2000 lbs.

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Butane - Scenario 2 | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume * Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| LHV = | 2,980 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 65.15 | 143.59 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 2.14E+01 | 1.07E-02 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.97E-04 | 9.85E-08 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 9.85E-04 | 4.93E-07 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Butane - Maximum Hourly Basis | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (0.1%) = | 3.1 | scf/hour[1] |
| LHV = | 2,980 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 65.15 | 143.59 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 1.33E+00 | 6.65E-04 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 1.23E-05 | 6.13E-09 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 6.13E-05 | 3.06E-08 |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Butane - Scenario 1 | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *coversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| LHV = | 2,980 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 2.76E-02 | 1.38E-05 |

1 ton = 2000 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Butane - Scenario 2 | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *coversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| LHV = | 2,980 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 5.51E-02 | 2.76E-05 |

1 ton = 2000 lbs.

| | | | |
|---|---|---|---|
| TETRA TECH | | | |
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Butane - Maximum Hourly Basis | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *coversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 3.1 | scf/hour[1] |
| LHV = | 2,980 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 3.43E-03 | 1.71E-06 |

1. Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

1 ton = 2000 lbs.

### 1-4.2.2 Propane Emissions from Pigging Operations

TETRA TECH

| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
|---|---|---|---|
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Annual Potential to Emit Summary - Propane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|
| | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour[1]** | **lbs./year** | **tons/year** | **lbs./hour[1]** | **lbs./year** | **tons/year** |
| $CO_2e$ | 9.20E-04 | 8.06E+00 | 4.03E-03 | 1.84E-03 | 1.61E+01 | 8.06E-03 |
| $CO_2$ | 9.16E-04 | 8.03E+00 | 4.01E-03 | 1.83E-03 | 1.61E+01 | 8.03E-03 |
| $N_2O$ | 8.94E-09 | 7.84E-05 | 3.92E-08 | 1.79E-08 | 1.57E-04 | 7.84E-08 |
| $CH_4$ | 4.47E-08 | 3.92E-04 | 1.96E-07 | 8.94E-08 | 7.84E-04 | 3.92E-07 |
| CO | 2.50E-06 | 2.19E-02 | 1.10E-05 | 5.01E-06 | 4.38E-02 | 2.19E-05 |
| Total VOCs | 3.31E-04 | 2.90E+00 | 1.45E-03 | 6.63E-04 | 5.80E+00 | 2.90E-03 |
| Propane | 3.31E-04 | 2.90E+00 | 1.45E-03 | 6.63E-04 | 5.80E+00 | 2.90E-03 |
| TOTAL HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| | Maximum Hourly Rate | |
|---|---|---|
| | Emissions | |
| **Pollutants** | **lbs./hour[2]** | **tons/hour[2]** |
| $CO_2e$ | 1.12E+00 | 5.58E-04 |
| $CO_2$ | 1.11E+00 | 5.56E-04 |
| $N_2O$ | 1.08E-05 | 5.42E-09 |
| $CH_4$ | 5.42E-05 | 2.71E-08 |
| CO | 3.03E-03 | 1.52E-06 |
| Total VOCs | 4.02E-01 | 2.01E-04 |
| Propane | 4.02E-01 | 2.01E-04 |
| Total HAPs | 0.00E+00 | 0.00E+00 |

1 - Average rate based on annual emissions.
2 - Maximum hourly rate.

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Source Information and Assumptions - Propane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | | | | |
|---|---|---|---|---|
| Scenario 1 | Volume of gas flared | 25,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. |
| Scenario 2 | Volume of gas flared | 50,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. Once every 5 years, Smart Tools pigging operations will also occur and send the same amount (25,000 scf) of gas to the flare. |
| Lower Heating Value (BTU/scf) | | 2,370 | | |
| Flare Control Efficiency (1) | | 99.9% | | |

| Gas Composition | |
|---|---|
| Gas | Percent |
| Propane | 0-100% |

Flare Manufacturer: John Zink Co. LLC
Estimated Flare Height: 30 feet

**Expected Emissions**

Flare emissions will include products of combustion and uncombusted flared gas compounds (propane). The flared gas will consist of propane and will not contain sulfur-bearing compounds or any hazardous air pollutants (HAPs). Fugitive emissions from seal leaks will be directed to the flare for combustion. There will be some leakage (fugitive emissions) to the atmospheric side of the seal. The potential to emit (PTE) for atmospheric side seal leaks for VOCs are estimated to be 2.24E-01 tons/year.

**Products of Combustion**

The products of combustion from flaring the propane will include volatile organic compounds (VOCs), nitrogen oxides (NOx) consisting of nitrous oxide ($N_2O$), carbon dioxide, carbon monoxide, and methane.

**Compounds from Uncombusted Flared Gas**

The flare's estimated destruction efficiency (99.9 percent) determines what fraction of the flared gas remains uncombusted. The uncombusted flared gas compounds will include propane. These calculations are based on PTE, which does include the destruction efficiency.

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

BTU = British Thermal Units
HAP = hazardous air pollutant
$N_2O$ = nitrous oxide

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | VOC emissions - Propane - Scenario 1 | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 25 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| Flare Gas Molecular Weight = | 44.00000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Propane = | 1.00000 | |
| Efficiency = | 99.9% | [1] |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 2.90E+00 | lb./year |
| | 1.45E-03 | ton/year |
| Propane Emissions = | 2.90E+00 | lb./year |
| | 1.45E-03 | ton/year |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | VOC emissions - Propane - Scenario 2 | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 50 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| Flare Gas Molecular Weight = | 44.00000 | lb/lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Propane = | 1.00000 | |
| Efficiency = | 99.9% | [1] |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb-mole |
| Results | | |
| Total VOC Emissions = | 5.80E+00 | lb./year |
| | 2.90E-03 | ton/year |
| Propane Emissions = | 5.80E+00 | lb./year |
| | 2.90E-03 | ton/year |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: 100-NRS-T29725 | DATE 01-27-2014 |
| SUBJECT: | VOC emissions - Propane - Maximum Hourly Basis | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 3.5 scf/hour[2]

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 3.5 | scf/hour[2] |
| Flare Gas Molecular Weight = | 44.00000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction : Propane = | 1.00000 | |
| Efficiency = | 99.9% | [1] |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 4.02E-01 | lb./hour |
| | 2.01E-04 | ton/hour |
| Propane Emissions = | 4.02E-01 | lb./hour |
| | 2.01E-04 | ton/hour |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.
2. Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Propane - Scenario 1 | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| LHV = | 2,370 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 61.46 | 135.46 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 8.03E+00 | 4.01E-03 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 7.84E-05 | 3.92E-08 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 3.92E-04 | 1.96E-07 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Propane - Scenario 2 | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| LHV = | 2,370 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 61.46 | 135.46 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 1.61E+01 | 8.03E-03 |

| $N_2O$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 1.57E-04 | 7.84E-08 |

| $CH_4$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 7.84E-04 | 3.92E-07 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Propane - Maximum Hourly Basis | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (0.1%) = | 3.5 | scf/hour[1] |
| LHV = | 2,370 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 61.46 | 135.46 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 1.11E+00 | 5.56E-04 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 1.08E-05 | 5.42E-09 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 5.42E-05 | 2.71E-08 |

1. Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Propane - Scenario 1 | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| LHV = | 2,370 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 2.19E-02 | 1.10E-05 |

1 ton = 2000 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Propane - Scenario 2 | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| LHV = | 2,370 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 4.38E-02 | 2.19E-05 |

1 ton = 2000 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Propane - Maximum Hourly Basis | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 3.5 | scf/hour[1] |
| LHV = | 2,370 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 3.03E-03 | 1.52E-06 |

### 1-4.2.3 Ethane Emissions from Pigging Operations

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Annual Potential to Emit Summary - **Ethane** | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Scenario 1 | | | Scenario 2 | | |
|---|---|---|---|---|---|---|
| | Emissions | | | Emissions | | |
| **Pollutants** | **lbs./hour[1]** | **lbs./year** | **tons/year** | **lbs./hour[1]** | **lbs./year** | **tons/year** |
| $CO_2e$ | 6.45E-04 | 5.65E+00 | 2.82E-03 | 1.29E-03 | 1.13E+01 | 5.65E-03 |
| $CO_2$ | 6.42E-04 | 5.63E+00 | 2.81E-03 | 1.28E-03 | 1.13E+01 | 5.63E-03 |
| $N_2O$ | 6.15E-09 | 5.39E-05 | 2.69E-08 | 1.23E-08 | 1.08E-04 | 5.39E-08 |
| $CH_4$ | 3.08E-08 | 2.69E-04 | 1.35E-07 | 6.15E-08 | 5.39E-04 | 2.69E-07 |
| CO | 1.72E-06 | 1.51E-02 | 7.54E-06 | 3.44E-06 | 3.02E-02 | 1.51E-05 |
| Total VOCs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| Ethane | 2.26E-04 | 1.98E+00 | 9.92E-04 | 4.53E-04 | 3.97E+00 | 1.98E-03 |
| TOTAL HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| | Maximum Hourly Rate | |
|---|---|---|
| | Emissions | |
| **Pollutants** | **lbs./hour[2]** | **tons/hour[2]** |
| $CO_2e$ | 9.30E-01 | 4.65E-04 |
| $CO_2$ | 9.27E-01 | 4.63E-04 |
| $N_2O$ | 8.88E-06 | 4.44E-09 |
| $CH_4$ | 4.44E-05 | 2.22E-08 |
| CO | 2.48E-03 | 1.24E-06 |
| Total VOCs | 0.00E+00 | 0.00E+00 |
| Ethane | 1.63E-04 | 1.63E-04 |
| Total HAPs | 0.00E+00 | 0.00E+00 |

1 - Average rate based on annual emissions.
2 - Maximum hourly rate.

$CH_4$ = Methane
CO = Carbon Monoxide
$CO_2$ = Carbon Dioxide
$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#resul
$N_2O$ = Nitrous Oxide
Total HAPs = Hazardous Air Pollutants
Total VOCs = Volatile Organic Compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-14 |
| SUBJECT: | Source Information and Assumptions - Ethane | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | | | | |
|---|---|---|---|---|
| Scenario 1 | Volume of gas flared | 25,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. |
| Scenario 2 | Volume of gas flared | 50,000 | scf/year | The enclosed flare will only be used during maintenance operations. Maintenance operations (pigging) will occur once per year. Gas volume flared includes 25,000 scf directed to the flare during maintenance. Once every 5 years, Smart Tools pigging operations will also occur and send the same amount (25,000 scf) of gas to the flare. |
| Lower Heating Value (BTU/scf) | | 1,630 | | |
| Flare Control Efficiency (1) | | 99.9% | | |

| Gas Composition | |
|---|---|
| Gas | Percent |
| Ethane | 0-100% |

Flare Manufacturer: John Zink Co. LLC
Estimated Flare Height: 30 feet

**Expected Emissions**

Flare emissions will include products of combustion and uncombusted flared gas compounds (ethane). The flared gas will consist of ethane and will not contain sulfur-bearing compounds or any hazardous air pollutants (HAPs). Fugitive emissions from seal leaks will be directed to the flare for combustion. There will be some leakage (fugitive emissions) to the atmospheric side of the seal. The potential to emit (PTE) for atmospheric side seal leaks for ethane is estimated to be 2.24E-01 tons/year.

**Products of Combustion**

The products of combustion from flaring the ethane will include nitrogen oxides (NOx) consisting of nitrous oxide ($N_2O$), carbon dioxide, carbon monoxide, and methane.

**Compounds from Uncombusted Flared Gas**

The flare's estimated destruction efficiency (99.9 percent) determines what fraction of the flared gas remains uncombusted. The uncombusted flared gas compounds will include ethane. These calculations are based on PTE, which does include the destruction efficiency.

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

BTU = British Thermal Units
HAP = hazardous air pollutant
$N_2O$ = nitrous oxide

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | VOC emissions - Ethane - Scenario 1 | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 25 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| Flare Gas Molecular Weight = | 30.07000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 0.00000 | |
| Ethane = | 1.00000 | |
| Efficiency = | 99.9% | [1] |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 0.00E+00 | lb./year |
| | 0.00E+00 | ton/year |
| | 1.98E+00 | lb./year |
| Ethane Emissions = | 9.92E-04 | ton/year |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | VOC emissions - Ethane - Scenario 2 | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 50 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| Flare Gas Molecular Weight = | 30.07000 | lb/lb-mol |
| Weight Fraction: Total VOCs = | 0.00000 | |
| Ethane | 1.00000 | |
| Efficiency = | 99.9% | [1] |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb-mole |
| Results | | |
| Total VOC Emissions = | 0.00E+00 | lb./year |
| | 0.00E+00 | ton/year |
| | 3.97E+00 | lb./year |
| Ethane Emissions = | 1.98E-03 | ton/year |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | VOC emissions - Ethane - Maximum Hourly Basis | | |
| BASED ON: | Client Information and Potential to Emit | | |

## VOC Flare Emissions Calculations

Emissions = Uncombusted Flare gas volume ∗ Flare Gas Molecular Weight ∗ Weight Fraction of VOCs

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per year
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent[1]
Volume of Gas Uncombusted = 4.1 scf/hour[2]

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume uncombusted (0.1%) = | 4.1 | scf/hour[2] |
| Flare Gas Molecular Weight = | 30.07000 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 0.00000 | |
| Ethane = | 1.00000 | |
| Efficiency = | 99.9% | [1] |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC Emissions = | 0.00E+00 | lb./hour |
| | 0.00E+00 | ton/hour |
| Ethane Emissions = | 3.27E-01 | lb./hour |
| | 1.63E-04 | ton/hour |

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.
2. Maximum hourly rate calculated in maximum flow rate calculation (Attachment 1).

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Ethane - Scenario 1 | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| LHV = | 1,630 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 62.64 | 138.06 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 5.63E+00 | 2.81E-03 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 5.39E-05 | 2.69E-08 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 2.69E-04 | 1.35E-07 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Ethane - Scenario 2 | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| LHV = | 1,630 | Btu/scf |

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 62.64 | 138.06 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.13E+01 | 5.63E-03 |

| $N_2O$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.08E-04 | 5.39E-08 |

| $CH_4$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 5.39E-04 | 2.69E-07 |

1kg = 2.204 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon dioxide, nitrous oxide, and methane emissions - Ethane - Maximum Hourly Basis | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. | | |

Emissions = Flare gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

Gas Volume uncombusted (0.1%) = 4.1 scf/hour[1]

LHV = 1,630 Btu/scf

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) |
|---|---|---|
| $CO_2$ | 62.64 | 138.06 |
| $N_2O$ | 6.00E-04 | 1.32E-03 |
| $CH_4$ | 3.00E-03 | 0.01 |

| $CO_2$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 9.27E-01 | 4.63E-04 |

| $N_2O$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 8.88E-06 | 4.44E-09 |

| $CH_4$ Calculation | lbs./hour | Tons/hour |
|---|---|---|
| Emissions | 4.44E-05 | 2.22E-08 |

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Ethane - Scenario 1 | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 25 | scf/year |
| LHV = | 1,630 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.51E-02 | 7.54E-06 |

1 ton = 2000 lbs.

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Ethane - Scenario 2 | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 50 | scf/year |
| LHV = | 1,630 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 3.02E-02 | 1.51E-05 |

1 ton = 2000 lbs.

| | | | |
|---|---|---|---|
| TETRA TECH | | | |
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | DATE |
| | | 100-NRS-T29725 | 01-27-2014 |
| SUBJECT: | Carbon monoxide emissions - Ethane - Maximum Hourly Basis | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Flare gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *conversion factor (CF)

Where:

| | | |
|---|---|---|
| Flare Gas Volume uncombusted (0.1%) = | 4.1 | scf/hour[1] |
| LHV = | 1,630 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./hour | Tons/hour |
| Emissions | 2.48E-03 | 1.24E-06 |

### 1-4.3 Seal Leak Emissions

## 1-4.3.1 Seal Leak Potential to Emit Summary

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Partners MKT & TERM, L.P. (EIN 23-3102655) | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | MK | DATE: | 02/04/14 |
| SUBJECT: | Annual Potential to Emit Summary Due to Seal Leaks | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | Seal Leak Emissions Directed to the Flare | | | | | | | | | Seal Leak Emissions To the Atmosphere | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario 1 | | | Scenario 2 | | | Scenario 3 | | | Fugitive Emissions[1] | | |
| | Emissions | | | Emissions | | | Emissions | | | | | |
| **Pollutants** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs./hour** | **lbs./year** | **tons/year** | **lbs/hour** | **lbs./year** | **tons/year** |
| $CO_2e$ | 6.78E-03 | 5.94E+01 | 2.97E-02 | 9.67E-03 | 8.47E+01 | 4.24E-02 | 1.29E-02 | 1.13E+02 | 5.64E-02 | -- | -- | -- |
| $CO_2$ | 6.75E-03 | 5.91E+01 | 2.96E-02 | 9.63E-03 | 8.44E+01 | 4.22E-02 | 1.28E-02 | 1.12E+02 | 5.62E-02 | -- | -- | -- |
| $N_2O$ | 6.47E-08 | 5.66E-04 | 2.83E-07 | 9.40E-08 | 8.24E-04 | 4.12E-07 | 1.18E-07 | 1.04E-03 | 5.18E-07 | -- | -- | -- |
| $CH_4$ | 3.23E-07 | 2.83E-03 | 1.42E-06 | 4.70E-07 | 4.12E-03 | 2.06E-06 | 5.91E-07 | 5.18E-03 | 2.59E-06 | -- | -- | -- |
| CO | 1.81E-05 | 1.58E-01 | 7.92E-05 | 2.63E-05 | 2.30E-01 | 1.15E-04 | 3.31E-05 | 2.90E-01 | 1.45E-04 | -- | -- | -- |
| Total VOCs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.49E-03 | 3.06E+01 | 1.53E-02 | 4.60E-03 | 4.03E+01 | 2.02E-02 | 5.12E-02 | 4.48E+02 | 2.24E-01 |
| Propane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.49E-03 | 3.06E+01 | 1.53E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- |
| Ethane | 2.38E-03 | 2.09E+01 | 1.04E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- |
| Butane | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.60E-03 | 4.03E+01 | 2.02E-02 | | | |
| Total HAPs | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -- | -- | -- |

Footnote

(1) - The emission factors used to calculate the fugitive emissions are for total organic compounds (including non-VOCs such as methane and ethane) (USEPA, 1995). Because propane, ethane, and butane use the same emission factor, the fugitive emissions were not divided into multiple scenarios and can be applied to both Scenario 1, 2, and 3 for PTE.

Acronyms

$CH_4$ = Methane

CO = Carbon Monoxide

$CO_2$ = Carbon Dioxide

$CO_2e$ = Greenhouse Gas emissions in Carbon Dioxide Equivalent. http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results

HAPs = Hazardous Air Pollutants

$N_2O$ = Nitrous Oxide

VOCs = Volatile Organic Compounds

### 1-4.3.2 Seal Leaks Directed to the Flare

| | | | |
|---|---|---|---|
| TETRA TECH | | | |
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | MK | DATE: | 01/29/14 |
| SUBJECT: | Source Information and Assumptions - Seal Leaks Directed to Flare | | |
| BASED ON: | Client Information and other reference materials as noted in each calculation worksheet. | | |

| | | | | |
|---|---|---|---|---|
| Seal Leak Scenario 1 | Leaks directed to flare | 262,800 | scf/year | Potential to emit calculations for seal leaks that are directed to the flare. Estimated leakage has a range from 0.15 to 0.5 scfm. A leakage of 0.5 scfm was assumed as the most conservative estimate. Seal Leak Scenario 1 is based off a gas composition of 100% ethane. |
| Seal Leak Scenario 2 | Leaks directed to flare | 262,800 | scf/year | Potential to emit calculations for seal leaks that are directed to flare. Estimated leakage has a range from 0.15 to 0.5 scfm. A leakage of 0.5 scfm was assumed as the most conservative estimate. Seal Leak Scenario 2 is based off a gas composition of 100% propane. |
| Seal Leak Scenario 3 | Leaks directed to flare | 262,800 | scf/year | Potential to emit calculations for seal leaks that are directed to flare. Estimated leakage has a range from 0.15 to 0.5 scfm. A leakage of 0.5 scfm was assumed as the most conservative estimate. Seal Leak Scenario 3 is based off a gas composition of 100% butane. |
| Ethane Heating Value (BTU/scf) | | 1,630 | | |
| Propane Heating Value (BTU/scf) | | 2,370 | | |
| Butane Heating Value (BTU/scf) | | 2,980 | | |
| Flare Control Efficiency[1] | | 99.9% | | |

| Gas Composition | | | |
|---|---|---|---|
| Gas | Percent | | |
| | Seal Leak Scenario 1 | Seal Leak Scenario 2 | Seal Leak Scenario 3 |
| Ethane | 100% | 0% | 0% |
| Propane | 0% | 100% | 0% |
| Butane | 0% | 0% | 100% |

Flare Manufacturer: John Zink, Co LLC
Estimated Flare Height: 30 feet

**Expected Emissions**

Flare emissions will include products of combustion and uncombusted flared gas compounds (propane, ethane, and butane). The flared gas will consist of a mixture of propane, ethane, or butane and will not contain sulfur-bearing compounds or any hazardous air pollutants (HAPs). Fugitive emissions from seal leaks will be directed to the flare for combustion. There will be some leakage (fugitive emissions) to the atmospheric side of the seal. The potential to emit (PTE) for atmospheric side seal leaks for volatile organic compounds (VOCs) are estimated to be 2.24E-01 tons/year.

**Products of Combustion**

The products of combustion from flaring the mixture of propane, ethane, and butane will include VOCs, nitrogen oxides (NOx) consisting of nitric oxide ($N_2O$), carbon dioxide, carbon monoxide, and methane.

**Compounds from Uncombusted Flared Gas**

The flare's estimated destruction efficiency (99.9 percent) determines what fraction of the flared gas remains uncombusted. The uncombusted flared gas compounds will include propane, ethane, or butane dependant on which product is transported in the pipeline.

Footnotes

1. A 99.9% destruction efficiency is based on the stack emission study found in Attachment 5.

Acronyms

BTU = British Thermal Units
HAP = hazardous air pollutant
$N_2O$ = nitrous oxide
NOx = nitrogen oxides
PTE = potential to emit
scf = standard cubic feet
VOCs = volatile organic compounds

| TETRA TECH | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: MK | | DATE: | 02/04/14 |
| SUBJECT: | VOC emissions - Ethane - Seal Leak Scenario 1 - Leaks directed to flare | | |
| BASED ON: | Client Information and Potential to Emit | | |

**VOC Flare Emissions Calculations**

Emissions (lb/event) = Seal leak gas volume ∗ coversion factor (CF) * Molecular Weight * Weight Fraction

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per event
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent (control efficiency for PTE calculations)
Volume of Gas Uncombusted = 263 scf/year

| **VOC Calculation** | | |
|---|---|---|
| Inputs | | |
| Gas Volume leaked (0.1%) = | 263 | scf/year |
| Flare Gas Molecular Weight = | 30.07 | lb./lb-mol |
| Weight Fraction: Total VOCs (1) = | 0.00000 | |
| Weight Fraction: Ethane = | 1.00000 | |
| Efficiency = | 99.9% | |
| Conversion Factors: | | |
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |
| Results | | |
| Total VOC(1) Emissions = | 0.00E+00 | lb./year |
| | 0.00E+00 | ton/year |
| Ethane Emissions = | 2.09E+01 | lb./year |
| | 1.04E-02 | ton/year |

Footnote
1. Ethane is considered to have negligible photochemical activity per 40CFR51.100

| | | | |
|---|---|---|---|
| TETRA TECH | | | |
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: MK | | DATE: | 02/04/14 |
| SUBJECT: | VOC emissions - Propane - Seal Leak Scenario 2 - Leaks directed to flare | | |
| BASED ON: | Client Information and Potential to Emit | | |

**VOC Flare Emissions Calculations**

Emissions (lb/event) = Seal leak gas volume * coversion factor (CF) * Molecular Weight * Weight Fraction

Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per event
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent (control efficiency for PTE calculations)
Volume of Gas Uncombusted = 263 scf/year

**VOC Calculation**

Inputs

| | | |
|---|---|---|
| Gas Volume leaked (0.1%) = | 263 | scf/year |
| Flare Gas Molecular Weight = | 44.10 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Propane = | 1.00000 | |
| Efficiency = | 99.9% | |

Conversion Factors:

| | | |
|---|---|---|
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |

Results

| | | |
|---|---|---|
| Total VOC Emissions = | 3.06E+01 | lb./year |
| | 1.53E-02 | ton/year |
| Propane Emissions = | 3.06E+01 | lb./year |
| | 1.53E-02 | ton/year |

| TETRA TECH | | |
|---|---|---|
| CLIENT: Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: MK | DATE: | 02/04/14 |
| SUBJECT: VOC emissions - Butane - Seal Leak Scenario 3 - Leaks directed to flare | | |
| BASED ON: Client Information and Potential to Emit | | |

Emissions (lb/event) = Seal leak gas volume * coversion factor (CF) * Molecular Weight * Weight Fraction

**VOC Flare Emissions Calculations**

**Annual Basis**
Where:
Emissions = Total Mass of Pollutant
Flare gas volume = Amount of gas flared per event
Flare Gas Molecular Weight = Molecular Weight based on Gas Composition
Weight Fraction of VOCs = Fraction of Weight of VOCs based on Gas Composition
Control Efficiency = 99.9 percent (control efficiency for PTE calculations)
Volume of Gas Uncombusted = 263 scf/year

**VOC Calculation**

Inputs

| | | |
|---|---|---|
| Gas Volume leaked (0.1%) = | 263 | scf/year |
| Flare Gas Molecular Weight = | 58.12 | lb./lb-mol |
| Weight Fraction: Total VOCs = | 1.00000 | |
| Weight Fraction: Butane = | 1.00000 | |
| Efficiency = | 99.9% | |

Conversion Factors:

| | | |
|---|---|---|
| 1 MMBTU = | 1,000,000 | BTU |
| 1 ton = | 2,000 | lb. |
| 1 scf = | 379 | scf / lb.-mole |

Results

| | | |
|---|---|---|
| Total VOC Emissions = | 4.03E+01 | lb./year |
| | 2.02E-02 | ton/year |
| Butane Emissions = | 4.03E+01 | lb./year |
| | 2.02E-02 | ton/year |

| | | | |
|---|---|---|---|
| TETRA TECH | | | |
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | MK | DATE: | 02/04/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Ethane - Scenario 1 - Leaks directed to flare. | | |
| BASED ON: | Potential to emit, client information and reference for emission factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. Global warming potential factors are selected for a 100-year horizon, which are consistent with all climate change programs via the Intergovernmental Panel on Climate Change. | | |

Emissions = Seal Leak gas volume ∗ Emission Factor (EF) * Lower Heating Value (LHV)

Where:

| | | |
|---|---|---|
| Seal Leak gas volume (PTE) = | 263 | scf/year |
| Lower Heating Value (Ethane) = | 1,630 | Btu/scf |

| **Pollutant** | **EF (kg/mmBtu)** | **EF (lb./mmBtu)** | **Global Warming Potential (GWP)** |
|---|---|---|---|
| $CO_2$ | 62.64 | 138.06 | 1 |
| $N_2O$ | 0.0006 | 0.0013 | 310 |
| $CH_4$ | 0.003 | 0.0066 | 21 |

| $CO_2$ Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 5.91E+01 | 2.96E-02 |

| $N_2O$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 5.66E-04 | 2.83E-07 | 1.76E-01 | 8.78E-05 |

| $CH_4$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 2.83E-03 | 1.42E-06 | 5.95E-02 | 2.97E-05 |

1kg = 2.204 lbs.
1 ton = 2,000 lbs.

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | MK | DATE: | 02/04/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Delmont Station - Propane - Leaks directed to flare. | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. Global warming potential factors are selected for a 100-year horizon, which are consistent with all climate change programs via the Intergovernmental Panel on Climate Change. | | |

Emissions = Seal Leak gas volume * Emission Factor (EF) * Lower Heating Value (LHV)

Where:

Seal Leak gas volume (PTE) = 263 scf/year

Lower Heating Value (Propane) = 2,370 Btu/scf

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) | Global Warming Potential (GWP) |
|---|---|---|---|
| $CO_2$ | 61.46 | 135.46 | 1 |
| $N_2O$ | 0.0006 | 0.0013 | 310 |
| $CH_4$ | 0.003 | 0.0066 | 21 |

| $CO_2$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 8.44E+01 | 4.22E-02 |

| $N_2O$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 8.24E-04 | 4.12E-07 | 2.55E-01 | 1.28E-04 |

| $CH_4$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 4.12E-03 | 2.06E-06 | 8.65E-02 | 4.32E-05 |

1 kg = 2.204 lbs.
1 ton = 2,000 lbs.

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | MK | DATE: | 02/04/14 |
| SUBJECT: | Carbon dioxide, nitrous oxide and methane emissions - Butane - Scenario 3 - Leaks directed to flare. | | |
| BASED ON: | Potential to emit, client information and Reference for Emission Factors: Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; 40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases; Final Rule, 17Dec10, 81 pp. Global warming potential factors are selected for a 100-year horizon, which are consistent with all climate change programs via the Intergovernmental Panel on Climate Change. | | |

Emissions = Seal Leak gas volume * Emission Factor (EF) * Lower Heating Value (LHV)

**Annual Basis**

Where:

Seal Leak gas volume (PTE) = 263 scf/year

Lower Heating Value (Butane) = 2,980 Btu/scf

| Pollutant | EF (kg/mmBtu) | EF (lb./mmBtu) | Global Warming Potential (GWP) |
|---|---|---|---|
| $CO_2$ | 65.15 | 143.59 | 1 |
| $N_2O$ | 0.0006 | 0.0013 | 310 |
| $CH_4$ | 0.003 | 0.0066 | 21 |

| $CO_2$ Calculation | lbs./year | Tons/year |
|---|---|---|
| Emissions | 1.12E+02 | 5.62E-02 |

| $N_2O$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 1.04E-03 | 5.18E-07 | 3.21E-01 | 1.61E-04 |

| $CH_4$ Calculation | | | $CO_2$ Equivalent (CO2e) | |
|---|---|---|---|---|
| | lbs./year | Tons/year | lbs./year | Tons/year |
| Emissions | 5.18E-03 | 2.59E-06 | 1.09E-01 | 5.44E-05 |

1 kg = 2.204 lbs.

1 ton = 2,000 lbs.

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | MK | DATE: | 02/04/14 |
| SUBJECT: | Carbon monoxide emissions - Ethane - Leaks directed to flare. | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Seal leak gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *coversion factor (CF)

Where:

| | | |
|---|---|---|
| Seal Leak gas volume (PTE) = | 263 | scf/year |
| LHV = | 1,630 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 1.58E-01 | 7.92E-05 |

1 ton = 2000 lbs.

TETRA TECH

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: MK | | DATE: | 02/04/14 |
| SUBJECT: | Carbon monoxide (CO) emissions - Propane - Leaks directed to flare. | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Seal leak gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *coversion factor (CF)

Where:

| | | |
|---|---|---|
| Seal Leak gas volume (PTE) = | 263 | scf/year |
| LHV = | 2,370 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 2.30E-01 | 1.15E-04 |

1 ton = 2000 lbs.

| | | | |
|---|---|---|---|
| TETRA TECH | | | |
| CLIENT: | Sunoco Pipeline L.P. | JOB NUMBER: | 100-NRS-T29725 |
| PREPARED BY: | MK | DATE: | 02/04/14 |
| SUBJECT: | Carbon monoxide emissions - Butane - Leaks directed to flare. | | |
| BASED ON: | Potential to emit, client information, and emission factor reference for flare operatons presented in Table 13.5-1 in Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, AP-42, US EPA, 1995. | | |

Emissions (lb/event) = Seal leak gas volume ∗ Lower Heating Value (LHV) ∗ Emission Factor (EF) *coversion factor (CF)

**Annual Basis**

Where:

| | | |
|---|---|---|
| Seal Leak gas volume (PTE) = | 263 | scf/year |
| LHV = | 2,980 | Btu/scf |
| EF = | 0.37 | lb/mmBtu |
| CF = | 1 MMBtu/1,000,000 Btu | |

| CO Calculation | | |
|---|---|---|
| | lbs./year | Tons/year |
| Emissions | 2.90E-01 | 1.45E-04 |

1 ton = 2000 lbs.

### 1-4.3.3 Seal Leaks Directed to the Atmosphere

| | | | |
|---|---|---|---|
| CLIENT: | Sunoco Pipeline L.P. | NUMBER: | 100-NRS-T29725 |
| PREPARED BY: MK | | DATE: | 02/04/14 |
| SUBJECT: | VOC emissions - Fugitive Emissions - Leaks directed to atmosphere | | |
| BASED ON: | Client Information and Potential to Emit | | |

**Fugitive Emissions Calculations**

Where:
Fugitive VOC Emissions (TPY) = # of Sources x Emission Factor (lbs./hr.-source) x 8,760 hrs./year x (1 ton/2,000 pounds)

| Source Category | Service | Emission Factor (lb./hr./source) | Total Number of Sources | Fugitive VOC Emissions (TPY) |
|---|---|---|---|---|
| Valves | Light Liquid | 0.0000946 | 150 | 0.062 |
| Fittings | Light Liquid | 0.0000176 | 410 | 0.032 |
| Pumps | Light Liquid | 0.001188 | 1 | 0.005 |
| Other | Light Liquid | 0.000286 | 100 | 0.125 |
| | | | **Total** | **0.224** |

# ATTACHMENT 2

# AGGREGATION ANALYSIS

**Aggregation Analysis for Mount Union Station Enclosed Flare**

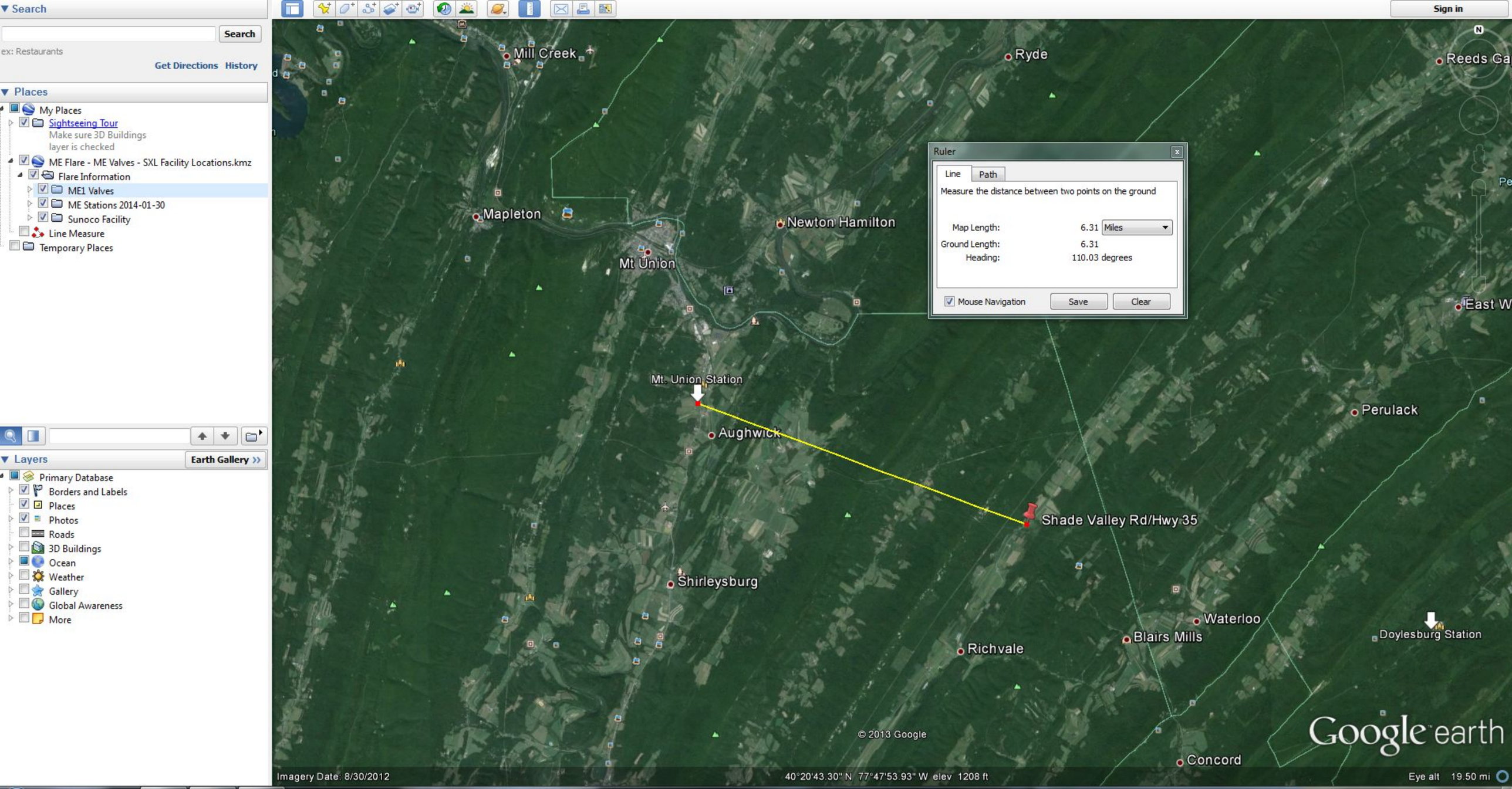
An Aggregation Analysis has been completed on the basis of the facility definition contained in 25 PA Code Section 121.1, Guidance for Performing Single Stationary Source Determinations for Oil and Gas Industries (PADEP 270-0810-006). The entire state of Pennsylvania is considered a "moderate" ozone nonattainment area for nitrogen oxides (NOx) and volatile organic compounds (VOCs) because Pennsylvania is a jurisdiction in the Ozone Transport Region (Section 184 of the Clean Air Act). For non-attainment New Source Review (NSR) purposes, Pennsylvania defines a "facility" to mean "an air contamination source or combination of air contamination sources located on one or more contiguous or adjacent properties and which is owned and operated by the same person under common control."

PADEP guidance (270-0810-006) states that if two or more air contamination sources are determined to be a single source with emissions, which collectively meet or exceed the major source thresholds and meet the nonattainment NSR criteria stated above, they should be treated as a single air contamination source for non-attainment NSR permitting purposes.

The closest property owned or operated by Sunoco Pipeline L.P. or by the same person under common control is approximately 6.3 miles from the Mount Union Station enclosed flare location. Attachment 2-1 illustrates the distance from the Mount Union Station flare (identified as Mt. Union Station) to the closest common control facility (identified as Shade Valley Rd/Hwy 35). Aggregate emission calculations were not performed because these properties are greater than a quarter mile from each other and are not considered contiguous or adjacent.

**2-1**

**MAP SHOWING CLOSEST COMMON CONTROL PROPERTY TO ENCLOSED FLARE LOCATION**


Search
Search
ex: Restaurants
Get Directions History
Places
My Places
Sightseeing Tour
Make sure 3D Buildings layer is checked
ME Flare - ME Valves - SXL Facility Locations.kmz
Flare Information
ME1 Valves
ME Stations 2014-01-30
Sunoco Facility
Line Measure
Temporary Places
Layers
Earth Gallery
Primary Database
Borders and Labels
Places
Photos
Roads
3D Buildings
Ocean
Weather
Gallery
Global Awareness
More
Sign in
Mill Creek
Ryde
Reeds Ga
Mapleton
Newton Hamilton
Mt Union
East W
Mt. Union Station
Aughwick
Perulack
Shade Valley Rd/Hwy 35
Shirleysburg
Waterloo
Blairs Mills
Richvale
Doylesburg Station
Concord
Ruler
Line
Path
Measure the distance between two points on the ground
Map Length: 6.31 Miles
Ground Length: 6.31
Heading: 110.03 degrees
Mouse Navigation
Save
Clear
© 2013 Google
Google earth
Imagery Date: 8/30/2012
40°20'43.30" N 77°47'53.93" W elev 1208 ft
Eye alt 19.50 mi

# ATTACHMENT 3

# APPLICABILITY DETERMINATION

**Applicability Determination for Mount Union Station Enclosed Flare**

In accordance with, 25 PA Code § 127.203a, Applicability Determination, this document provides the required applicability determination emissions increase calculations for regulated New Source Review (NSR) pollutants associated with the installation of an enclosed flare at Mount Union Station as part of the Sunoco Pipeline L.P. Mariner East pipeline construction project.

Potential emissions rate (PER) and potential to emit (PTE) for all pollutants expected to be emitted based on the composition of liquefied natural gas carried in the pipeline were calculated (see Attachment 1). From August 2014 to July 2015 the pipeline will transport batches of either 95% liquid butane or 95% liquid propane. From July 2015 on the pipeline is slated for pure liquid ethane. According to the definition of volatile organic compounds (VOCs) found in 25 PA Code § 121.1, Definitions, ethane is not considered a VOC because it is listed as having negligible photochemical reactivity in 40 CFR 51.100 relating to definitions. Therefore, emissions calculations based on pure liquid ethane do not result in any VOC emissions. Scenarios assuming that the liquefied natural gas stream consists of 100% propane or 100% butane do include VOC emissions in the PER and PTE calculations because both of those chemicals are considered VOCs. Pollutants emitted by the proposed new emission unit (enclosed flare) include carbon dioxide, nitrous oxide, methane, carbon monoxide, propane, ethane, butane, and total VOCs. Applicability determinations apply to regulated NSR pollutants. Total VOCs, nitrous oxide, and carbon monoxide are the only regulated NSR pollutants that will be emitted by the proposed new emission unit and therefore are the focus of this applicability determination.

The PER (i.e., assuming a flare control efficiency of 0 percent) for total VOCs is 18.4 tons per year if assuming a liquefied natural gas composition of 100% propane, and 24.2 tons per year assuming a liquefied natural gas composition of 100% butane. No VOC emissions would occur when transporting pure ethane. The PTE (i.e., assuming a flare control efficiency of 99.9 percent) for total VOCs is 0.24 tons per year assuming a liquefied natural gas composition of 100% propane and 0.25 tons per year assuming a liquefied natural gas composition of 100% butane. Calculations for the PER and PTE are presented in Attachment 1.

According to the definition of “significant” found at 25 PA Code § 121.1.Definitions, the PTE for total VOCs is not significant even though the entire Commonwealth of Pennsylvania is considered a “moderate” ozone nonattainment area, because the PTE for total VOCs is less than 25 tons per year. The emissions increase of total VOCs at Mount Union Station is the PTE from the new emissions unit (enclosed flare) as described in 25 PA Code § 127.203a (1)(i)(B). The total VOC net emissions increase in this case is also the PTE per 25 PA Code § 127.203a (1)(ii)(A). Based on the total VOC emissions increase and net emissions, the installation of the enclosed flare is not considered a major modification because it does not cause a significant emissions increase or a significant net emissions increase of total VOCs based on PTE [25 PA Code § 127.203a (1)].

The PER for nitrous oxide is $4.9 \times 10^{-4}$ tons per year assuming a liquefied natural gas composition of 100% propane, $6.2 \times 10^{-4}$ tons per year assuming a liquefied natural gas composition of 100% butane, and $3.4 \times 10^{-4}$ tons per year assuming a liquefied natural gas composition of 100% ethane. The PTE for nitrous oxide is $4.9 \times 10^{-7}$ tons per year assuming a liquefied natural gas composition of 100% propane, and $6.2 \times 10^{-7}$ tons per year assuming a liquefied natural gas composition of 100% butane, and $3.4 \times 10^{-7}$ tons per year assuming a liquefied natural gas composition of 100% ethane. According to the definition of “de minimis emissions increase” found at 25 PA Code § 121.1, Definitions, the PTE for nitrous oxide is de minimis. The emissions increase of nitrous oxide at the Mount Union Station is the PTE from the new emissions unit (enclosed flare) as described in 25 PA Code § 127.203a (4)(ii).

The PER for carbon monoxide is $1.4 \times 10^{-1}$ tons per year assuming a liquefied natural gas composition of 100% propane, $1.7 \times 10^{-1}$ tons per year assuming a liquefied natural gas composition of 100% butane, and $9.4 \times 10^{-2}$ tons per year assuming a liquefied natural gas composition of 100% ethane. The PTE for carbon monoxide is $1.4 \times 10^{-4}$ tons per year assuming a liquefied natural gas composition of 100% propane, and

$1.7x10^{-4}$ tons per year assuming a liquefied natural gas composition of 100% butane, and $9.4x10^{-5}$ tons per year assuming a liquefied natural gas composition of 100% ethane. According to the definition of "de minimis emissions increase" found at 25 PA Code § 121.1, Definitions, the PTE for carbon monoxide is de minimis. The emissions increase of carbon monoxide at the Mount Union Station is the PTE from the new emissions unit (enclosed flare) as described in 25 PA Code § 127.203a (4)(ii).

# ATTACHMENT 4

# FLARE DESIGN SPECIFICATIONS, INSPECTION, AND MAINTENANCE

# Manufacturer Recommended Maintenance

JOHN ZINK HAMWORTHY COMBUSTION

**RECOMMENDED MAINTENANCE FORM**
**PRODUCTION FLARE**

12/13

| SYSTEM COMPONENT | INTERVAL | DATE | INITIALS | COMMENTS |
|---|---|---|---|---|
| **General** | | | | |
| Confirm all covers are secure. | monthly | | | |
| Inspect enclosures for moisture. | monthly | | | |
| Confirm no gas or liquid leaks exist. | monthly | | | |
| Confirm all threaded connections are tight. | annually | | | |
| Replace all thermocouples. | annually | | | |
| Calibrate instruments and flow meter. | annually | | | |
| **Flare** | | | | |
| Record flame arrester differential pressure. | monthly | | | |
| Inspect exterior paint. | monthly | | | |
| Conduct recommended System Testing. | quarterly | | | |
| Inspect internal insulation. | quarterly | | | |
| Inspect foundation and anchor bolts. | annually | | | |
| Clean sight port, flare tip, and flame arrester. | annually | | | |
| Conduct emissions performance test. | annually | | | |
| **Pilot** | | | | |
| Record pilot gas pressure. | monthly | | | |
| Inspect mixer for debris or moisture. | monthly | | | |
| Clean mixer and orifice. | quarterly | | | |
| Clean solenoid. | annually | | | |
| Replace electrode. | annually | | | |

# ATTACHMENT 5

# STACK EMISSIONS STUDY FOR ZTOF025X15PF

AIR HYGIENE, INC.

Testing Solutions for a Better World

# STACK EMISSIONS STUDY
# EPA 40 CFR PART 60 SUBPART OOOO
# FOR THE
# ZTOF040X30PF UNIT
# PREPARED FOR
# JOHN ZINK, CO LLC
# AT THE
# TULSA R&D FACILITY
# TULSA, OKLAHOMA
# MARCH 10-13, 2014

**Corporate Headquarters**
1600 W Tacoma Street
Broken Arrow, OK 74012

AIR HYGIENE, INC.

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Humble, TX 77338
Shreveport, LA 71115
Miami, FL 33101
Philadelphia, PA 19136

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# MARCH 10-13, 2014

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## APPENDICES


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**Stack Emissions Study**
**ZTOF040X30PF Unit**
**John Zink, Co LLC**
**Tulsa R&D Facility**
**Tulsa, Oklahoma**
**March 10-13, 2014**

## 1.0 INTRODUCTION

Air Hygiene International, Inc. (Air Hygiene) has completed the emissions testing study for carbon monoxide (CO), total hydrocarbons (THC), flow, visual emission (VE), moisture ($H_2O$), carbon dioxide ($CO_2$), and oxygen ($O_2$) from the exhaust of the ZTOF040X30PF Unit for John Zink, Co LLC at the Tulsa R&D Facility near Tulsa, Oklahoma. This report details the background, results, process description, and the sampling/analysis methodology of the stack sampling survey conducted on March 10-13, 2014.

## 1.1 TEST PURPOSE AND OBJECTIVES

The purpose of the test was to conduct compliance emission test to document levels of selected pollutants at four ramp-up ramp-down test loads (0-30-0%, 30-70-30%, 70-100-70%, and 90-100%). The information will be used to confirm compliance with United States Code of Federal Regulations (CFR), Title 40 (40 CFR), Part 60 (40 CFR 60), Subpart OOOO. The specific objective was to determine the emission concentration of CO, THC, flow, visual emission, $H_2O$, $CO_2$, and $O_2$ from the exhaust of John Zink, Co LLC's ZTOF040X30PF Unit.

## 1.2 SUMMARY OF TEST PROGRAM

The following list details pertinent information related to this specific project:

1.2.1 Participating Organizations
- Environment Protection Agency (EPA)
- John Zink, Co LLC
- Air Hygiene

1.2.2 Industry
- Oil and Natural Gas Storage Transport and Processing

1.2.3 Air Permit and Federal Requirements
- 40 CFR 60, Subpart OOOO

1.2.4 Plant Location
- Tulsa R&D Facility near Tulsa, Oklahoma
- 11920 E Apache St., Tulsa, OK 74116

1.2.5 Equipment Tested
- ZTOF040X30PF Unit

1.2.6 Emission Points
- For all gases, three sample points in the exhaust duct from the ZTOF040X30PF Unit, determined according 40 CFR 60 Subpart OOOO
- For all moisture, flow and fixed gas testing, 20 sampling points in the exhaust duct from the ZTOF040X30PF Unit
- For visual emission, one sample visual observation point from the exit of the exhaust duct to the atmosphere from the ZTOF040X30PF Unit

1.2.7 Pollutants Measured

- CO
- THC
- Flow
- Visual Emission
- $H_2O$
- $CO_2$
- $O_2$

1.2.8 Dates of Emission Test

- March 10-13, 2014

## 1.3 KEY PERSONNEL

| | | |
|---|---|---|
| John Zink, Co LLC: | Aron Katz | 918-234-2791 |
| Air Hygiene | Min Sum Lee | 918-307-8865 |
| Air Hygiene: | Tim Page | 918-307-8865 |
| Air Hygiene: | Matt McBride | 918-307-8865 |

## 2.0 SUMMARY OF TEST RESULTS

Results from the sampling conducted on John Zink, Co LLC's ZTOF040X30PF Unit located at the Tulsa R&D Facility on March 10-13, 2014 are summarized in the following table and relate only to the items tested.

**TABLE 2.1**
**ZTOF040X30PF 0-30-0 LOAD DATA SUMMARY**

| Parameter | 0-30-0 Load, Run - 4.0X30PF R1 | 0-30-0 Load, Run - 4.0X30PF R2 | 0-30-0 Load, Run - 4.0X30PF R3 | Average |
|---|---|---|---|---|
| Date (mm/dd/yy) | 03/11/14 | 03/11/14 | 03/11/14 | -- |
| Start Time (hh:mm:ss) | 13:16:00 | 15:27:00 | 16:48:00 | -- |
| End Time (hh:mm:ss) | 14:20:00 | 16:31:00 | 17:53:00 | -- |
| Run Duration (min / run) | 61 | 61 | 61 | 61 |
| Bar. Pressure (in. Hg) | 29.49 | 29.41 | 29.40 | 29.43 |
| Amb. Temp. (°F) | 83 | 87 | 84 | 85 |
| Rel. Humidity (%) | 32 | 26 | 28 | 29 |
| Spec. Humidity (lb water / lb air) | 0.007782 | 0.007200 | 0.007045 | 0.007342 |
| Wind Speed (mph) | 5.0 | 5.0 | 5.0 | 5.0 |
| Wind Direction (--) | SE | S | S | -- |
| Inlet Gas Canister Pressure Start (inHg) | -30.00 | -21.20 | -10.80 | -- |
| Inlet Gas Canister Pressure Stop (inHg) | -21.20 | -10.80 | -0.05 | -- |
| Gross Fuel Heating Value (Btu/ft3) | 2,541 | 2,541 | 2,541 | 2,541 |
| Stack Flow (M2) (DSCFH) | 96,745 | 90,702 | 87,523 | 91,657 |
| Stack Moisture (Method 4) | 7.3 | 6.4 | 5.3 | 6.3 |
| Gross Fuel Heating Value (Btu/ft$^3$) | 2,540.8 | 2,540.8 | 2,540.8 | 2,540.80 |
| Average Inlet Fuel Flowrate (SCFH) | 1,123.9 | 1,097.7 | 1,091.7 | 1,104.41 |
| Average Inlet Mass Fuel Flowrate (lb/hr) | 130.5 | 127.5 | 126.8 | 128.27 |
| % Excess Air | 196.0 | 196.0 | 225.1 | 205.70 |
| $CO_2$ (%) - Modified method 3C | 5.91 | 5.91 | 5.53 | 5.78 |
| $O_2$ (%) - Modified Method 3C | 14.00 | 14.00 | 14.60 | 14.20 |
| $N_2$ (%) - Modified Method 3C | 80.10 | 80.10 | 79.90 | 80.03 |
| Visual Emission (mm:ss) | 0:00 | 0:00 | 0:00 | 0.00 |
| CO (ppmvd) | 1.06 | 0.50 | 0.76 | 0.77 |
| CO (ppm@3%$CO_2$) | 0.54 | 0.26 | 0.41 | 0.40 |
| THC (ppmvw) | 0.11 | 0.06 | 0.06 | 0.07 |
| THC (ppm@3%$CO_2$) | 0.05 | 0.03 | 0.03 | 0.04 |
| THC (lb/hr) | 0.00 | 0.00 | 0.00 | 0.00 |
| VOC Destruction Efficiency (%) | 99.999 | 100.000 | 99.999 | 99.999 |

**TABLE 2.2**
**ZTOF040X30PF 30-70-30 LOAD DATA SUMMARY**

| Parameter | 30-70-30 Load, Run - 4.0X30PF R4 | 30-70-30 Load, Run - 4.0X30PF R5 | 30-70-30 Load, Run - 4.0X30PF R6 | Average |
|---|---|---|---|---|
| Date (mm/dd/yy) | 03/12/14 | 03/12/14 | 03/12/14 | -- |
| Start Time (hh:mm:ss) | 8:34:00 | 10:00:00 | 11:23:00 | -- |
| End Time (hh:mm:ss) | 9:40:00 | 11:08:00 | 12:25:00 | -- |
| Run Duration (min / run) | 61 | 61 | 61 | 61 |
| Bar. Pressure (in. Hg) | 30.21 | 30.26 | 30.26 | 30.24 |
| Amb. Temp. (°F) | 53 | 60 | 66 | 60 |
| Rel. Humidity (%) | 40 | 33 | 25 | 33 |
| Spec. Humidity (lb water / lb air) | 0.003355 | 0.003560 | 0.003330 | 0.003415 |
| Wind Speed (mph) | 5.0 | 14.0 | 12.0 | 10.3 |
| Wind Direction (--) | N | N | N | -- |
| Inlet Gas Canister Pressure Start (inHg) | -30.00 | -19.30 | -10.15 | -19.82 |
| Inlet Gas Canister Pressure Stop (inHg) | -19.30 | -10.15 | -0.02 | -9.82 |
| Gross Fuel Heating Value (Btu/ft3) | 2,556 | 2,556 | 2,556 | 2,556 |
| Stack Flow (M2) (DSCFH) | 178,215 | 192,325 | 201,263 | 190,601 |
| Stack Moisture (Method 4) | 5.3 | 5.4 | 5.4 | 5.4 |
| Gross Fuel Heating Value (Btu/$ft^3$) | 2,555.5 | 2,555.5 | 2,555.5 | 2,555.50 |
| Average Inlet Fuel Flowrate (SCFH) | 2,411.6 | 2,437.9 | 2,550.5 | 2,466.64 |
| Average Inlet Mass Fuel Flowrate (lb/hr) | 280.1 | 283.1 | 296.2 | 286.49 |
| % Excess Air | 196.0 | 193.0 | 225.1 | 204.70 |
| $CO_2$ (%) - Modified method 3C | 5.90 | 5.90 | 5.50 | 5.77 |
| $O_2$ (%) - Modified Method 3C | 14.00 | 14.00 | 14.60 | 14.20 |
| $N_2$ (%) - Modified Method 3C | 80.10 | 80.10 | 79.90 | 80.03 |
| Visual Emission (mm:ss) | 0:00 | 0:00 | 0:00 | 0:00 |
| CO (ppmvd) | 1.17 | 1.01 | 1.20 | 1.13 |
| CO (ppm@3%$CO_2$) | 0.60 | 0.52 | 0.65 | 0.59 |
| THC (ppmvw) | 0.15 | 0.07 | 0.06 | 0.09 |
| THC (ppm@3%$CO_2$) | 0.08 | 0.03 | 0.03 | 0.05 |
| THC (lb/hr) | 0.00 | 0.00 | 0.00 | 0.00 |
| VOC Destruction Efficiency (%) | 99.999 | 99.999 | 100.000 | 99.999 |

**TABLE 2.3**
**ZTOF040X30PF 70-100-70 LOAD DATA SUMMARY**

| Parameter | 70-100-70 Load, Run - 4.0X30PF R7 | 70-100-70 Load, Run - 4.0X30PF R8 | 70-100-70 Load, Run - 4.0X30PF R9 | Average |
|---|---|---|---|---|
| Date (mm/dd/yy) | 03/12/14 | 03/12/14 | 03/13/14 | -- |
| Start Time (hh:mm:ss) | 13:19:00 | 16:30:00 | 8:40:04 | -- |
| End Time (hh:mm:ss) | 14:22:00 | 17:33:00 | 9:43:00 | -- |
| Run Duration (min / run) | 61 | 61 | 61 | 61 |
| Bar. Pressure (in. Hg) | 30.26 | 30.20 | 30.19 | 30.22 |
| Amb. Temp. (°F) | 58 | 72 | 57 | 62 |
| Rel. Humidity (%) | 28 | 21 | 34 | 28 |
| Spec. Humidity (lb water / lb air) | 0.002809 | 0.003443 | 0.003300 | 0.003184 |
| Wind Speed (mph) | 6.0 | 9.0 | 1.0 | 10.7 |
| Wind Direction (--) | NW | N | SW | -- |
| Inlet Gas Canister Pressure Start (inHg) | -30.00 | -20.31 | -10.20 | -- |
| Inlet Gas Canister Pressure Stop (inHg) | -20.31 | -10.20 | -0.02 | -- |
| Gross Fuel Heating Value (Btu/ft3) | 2,494 | 2,494 | 2,494 | 2,494 |
| Stack Flow (M2) (DSCFH) | 307,067 | 280,468 | 284,135 | 290,557 |
| Stack Moisture (Method 4) | 6.4 | 6.0 | 5.3 | 5.9 |
| Gross Fuel Heating Value (Btu/ft$^3$) | 2,493.7 | 2,493.7 | 2,493.7 | 2,493.70 |
| Average Inlet Fuel Flowrate (SCFH) | 3,851.9 | 3,769.3 | 3,719.8 | 3,780.34 |
| Average Inlet Mass Fuel Flowrate (lb/hr) | 445.3 | 437.8 | 395.3 | 426.13 |
| % Excess Air | 278.2 | 230.9 | 210.5 | 239.87 |
| $CO_2$ (%) - Modified method 3C | 5.30 | 5.50 | 5.70 | 5.50 |
| $O_2$ (%) - Modified Method 3C | 15.40 | 14.70 | 14.30 | 14.80 |
| $N_2$ (%) - Modified Method 3C | 79.30 | 79.80 | 79.90 | 79.67 |
| Visual Emission (mm:ss) | 0:00 | 0:00 | 0:00 | 0:00 |
| CO (ppmvd) | 0.03 | 0.29 | 0.55 | 0.29 |
| CO (ppm@3%$CO_2$) | 0.02 | 0.16 | 0.29 | 0.15 |
| THC (ppmvw) | 0.06 | 0.02 | 0.07 | 0.05 |
| THC (ppm@3%$CO_2$) | 0.04 | 0.01 | 0.03 | 0.03 |
| THC (lb/hr) | 0.00 | 0.00 | 0.00 | 0.00 |
| VOC Destruction Efficiency (%) | 99.999 | 100.000 | 99.999 | 100.000 |

**TABLE 2.4**
**ZTOF040X30PF 90-100 LOAD DATA SUMMARY**

| Parameter | 90-100 Load, Run - 4.0X30PF R10 | 90-100 Load, Run - 4.0X30PF R11 | 90-100 Load, Run - 4.0X30PF R12 | Average |
|---|---|---|---|---|
| Date (mm/dd/yy) | 03/13/14 | 03/13/14 | 03/13/14 | -- |
| Start Time (hh:mm:ss) | 10:27:04 | 12:50:04 | 14:05:04 | -- |
| End Time (hh:mm:ss) | 11:29:00 | 13:52:00 | 15:07:00 | -- |
| Run Duration (min / run) | 61 | 61 | 61 | 61 |
| Bar. Pressure (in. Hg) | 30.20 | 30.15 | 30.09 | 30.15 |
| Amb. Temp. (°F) | 63 | 66 | 71 | 67 |
| Rel. Humidity (%) | 28 | 17 | 14 | 20 |
| Spec. Humidity (lb water / lb air) | 0.003365 | 0.002269 | 0.002222 | 0.002619 |
| Wind Speed (mph) | 3.0 | 8.0 | 5.0 | 5.3 |
| Wind Direction (--) | SW | W | W | -- |
| Inlet Gas Canister Pressure Start (inHg) | -30.00 | -19.50 | -9.70 | -- |
| Inlet Gas Canister Pressure Stop (inHg) | -19.50 | -9.70 | 0.05 | -- |
| Gross Fuel Heating Value (Btu/ft3) | 2,552 | 2,552 | 2,552 | 2,552 |
| Stack Flow (M2) (DSCFH) | 291,965 | 284,219 | 296,509 | 290,898 |
| Stack Moisture (Method 4) | 5.8 | 6.4 | 6.1 | 6.1 |
| Gross Fuel Heating Value (Btu/ft$^3$) | 2,552.0 | 2,552.0 | 2,552.0 | 2,552.00 |
| Average Inlet Fuel Flowrate (SCFH) | 4,024.5 | 4,013.8 | 4,057.9 | 4,032.08 |
| Average Inlet Mass Fuel Flowrate (lb/hr) | 467.4 | 463.5 | 471.3 | 467.41 |
| % Excess Air | 205.2 | 192.4 | 192.6 | 196.73 |
| $CO_2$ (%) - Modified method 3C | 5.80 | 6.10 | 6.10 | 6.00 |
| $O_2$ (%) - Modified Method 3C | 14.20 | 13.90 | 13.90 | 14.00 |
| $N_2$ (%) - Modified Method 3C | 80.00 | 80.00 | 80.10 | 80.03 |
| Visual Emission (mm:ss) | 0:00 | 0:00 | 0:00 | 0:00 |
| CO (ppmvd) | 0.26 | 0.00 | 0.02 | 0.10 |
| CO (ppm@3%$CO_2$) | 0.13 | 0.00 | 0.01 | 0.05 |
| THC (ppmvw) | 0.06 | 0.07 | 0.09 | 0.07 |
| THC (ppm@3%$CO_2$) | 0.03 | 0.03 | 0.05 | 0.04 |
| THC (lb/hr) | 0.00 | 0.00 | 0.00 | 0.00 |
| VOC Destruction Efficiency (%) | 100.000 | 99.999 | 99.999 | 99.999 |

All testing was conducted according to the requirement of 40 CFR 60.5413 and 40 CFR 60.5412.

## 3.0 SOURCE OPERATION

## 3.1 PROCESS DESCRIPTION

An Enclosed ZTOF Production Flare is designed to destroy safely various organic compounds generated by production activities. The Flare Control Panel initiates pilot ignition, monitors operating conditions, and discontinues operation if an unacceptable condition occurs. A burner management system, which includes a flame safeguard package, monitors specific parameters and discontinues operation if an unsafe condition occurs. A dedicated thermocouple detects pilot flame. Typical shutdown scenarios include:

**Flame Failure:**
Flame Failure occurs when the pilot thermocouple is unable to detect the presence of pilot flame. When Flame Failure occurs, system operation discontinues. Upon determining the source of a fault condition and completing the necessary corrective action, a system reset is required to begin operation again.

A typical operating sequence consists of:
**Mode Selection**
Select either automatic or manual system operation. Automatic mode attempts operation whenever sufficient power is applied. Manual mode requires operator interaction at the panel to initiate operation.

**Ignition Sequence**
The pilot gas solenoid valve opens automatically, supplying gas to the pilot, and the ignition transformer energizes. The ignition transformer continues as the pilot thermocouple verifies flame is present. The pilot gas solenoid valve remains open.

**Gas Supply**
Once pilot flame is detected and sufficient inlet pressure exists, the main gas valve opens, supplying gas to the flare. While the pilot thermocouple verifies flame is present, system operation continues.

## 3.2 SAMPLING LOCATION

The sample ports were located approximately 30 feet above grade level on the exhaust system. The stack had a 4 feet inner diameter and was equipped with two, 4 inch ports oriented at 90 degrees. The ports were 6 duct diameters downstream from the flare tip and 1.25 duct diameters upstream from the stack exit to the atmosphere. THC and CO samples for gaseous emissions were continuously drawn from the exhaust system at one sample port with three sampling points located at 16.7 percent, 50 percent, and 83.3 percent of the stack diameter. All visual emission observation was made by viewing the point where the exhaust system exited to the atmosphere at the top of the exhaust stack. All fuel sampling was continuously drawn from the fuel supply system with silonite-coated stainless steel evacuated canister from a tap located at 8 pipe diameter, 24 inches upstream of the fuel monitoring system. Due to refractor have interfered the flow and temperature reading, the outer traverse points were omitted to collect sample. All flow, fixed gases and moisture sampling was continuously drawn from the exhaust system at two ports with 20 points across the stack according to Method 1.

## 4.0 SAMPLING AND ANALYTICAL PROCEDURES

## 4.1 TEST METHODS

The emission test on the ZTOF040X30PF Unit at the Tulsa R&D Facility was performed following United States Environmental Protection Agency (EPA) methods described by the Code of Federal Regulations (CFR). Table 4.1 outlines the specific methods performed on March 10-13, 2014.

**TABLE 4.1**
**SUMMARY OF SAMPLING METHODS**

| Pollutant or Parameter | Sampling Method | Analysis Method |
|---|---|---|
| Sample Point Location | EPA Method 1 | Equal Area Method |
| Stack Flow Rate | EPA Method 2 | S-Type Pitot Tube |
| Fuel Flow Rate | EPA Method 2a | Volume Displacement |
| $CO_2$, $O_2$, Methane | EPA Method 3C | Gas Chromatograph-TCD |
| Stack Moisture Content | EPA Method 4 | Gravimetric Analysis |
| Carbon Monoxide | EPA Method 10 | Nondispersive Infrared Analyzer |
| Visual Emission | EPA Method 22 | Visual Observation |
| Total Hydrocarbons | EPA Method 25a | Flame Ionization Detector |
| Fuel Content Analysis | ASTM D 1945-03, ASTM D 3588-98 | Gas Chromatograph |

## 4.2 INSTRUMENT CONFIGURATION AND OPERATIONS FOR GAS ANALYSIS

The sampling and analysis procedures used during these tests conform with the methods outlined in the Code of Federal Regulations (CFR), Title 40, Part 60, Appendix A, Methods 1, 2, 2a, 3c 4, 10, 22, 25a, ASTM D1945-03, and ASTM D3588-98 .

Figure 4.1 depicts the sample system used for the CO, THC, $CO_2$, and $O_2$ tests. A heated stainless steel probe was inserted into the sample port of the stack to extract gas measurements from the emission stream at three points located at 16.7, 50, and 83.3 percent across the stack diameter. The gas sample was continuously pulled through the probe and transported, via heat-traced Teflon® tubing, a stainless steel minimum-contact condenser designed to dry the sample. Transportation of the sample, through Teflon® tubing, continued into the sample manifold within the mobile laboratory via a stainless steel/Teflon® diaphragm pump. From the manifold, the sample was partitioned to the CO analyzers through rotameters that controlled the flow rate of the sample. Exhaust samples were routed to the THC analyzer prior to gas conditioning.

Figure 4.1 shows that the sample system was also equipped with a separate path through which a calibration gas could be delivered to the probe and back through the entire sampling system. This allowed for convenient performance of system bias checks as required by the testing methods.

All instruments were housed in an air-conditioned, trailer-mounted mobile laboratory. Gaseous calibration standards were provided in aluminum cylinders with the concentrations certified by the vendor. EPA Protocol No. 1 was used to determine the cylinder concentrations where applicable (i.e. CO calibration gases).

Table 4.2 provides a description of the analyzers used for the instrument portion of the tests. All data from the continuous monitoring instruments were recorded on a Logic Beach Portable Data Logging System Hyperlogger which retrieves calibrated electronic data from each instrument every one second and reports an average of the collected data every 30 seconds. Data records can be found in Appendix A and B of this report.

Figure 4.2 represents the sample system used for moisture and flow testing. An inconel probe with an inconel 3/8 inches tubing, pitots tube and thermocouple were inserted into the sample ports of the stack to extract gas measurements from the emission stream through a glass impinger train. Flow rates were monitored with oil filled manometers and total sample volumes were measured with a dry gas meter. Tedlar bags were collected at the exit of this train.

Three test runs for each of the firing rate at 0-30-0 percent, 30-70-30 percent, 70-100-70 percent, and 90-100 percent (ramp up, ramp down) of approximately 61 minutes each were conducted on the ZTOF040X30PF Unit for CO, THC, $CO_2$, and $O_2$.

Figure 4.3 represents the inlet sampling system in accordance with Method 2A, 40 CFR part 60 to measure inlet gas flow rate, pressure and temperature. Fuel sample was collected at 24 inches upstream from gas flow meter.

The stack gas analysis for $O_2$ and $CO_2$ concentrations was performed in accordance with procedures set forth in EPA Method 3C. The sample were collected in a tedlar bag and analyzed by GC-TCD at an offsite laboratory.

CO emission concentrations were quantified in accordance with procedures set forth in EPA Method 10. A continuous nondispersive infrared (NDIR) analyzer was used for this purpose.

THC emission concentrations were quantified in accordance with procedures set forth in EPA Method 25a. A continuous flame ionization (FID) analyzer was used for this purpose.

**TABLE 4.2**
**ANALYTICAL INSTRUMENTATION**

| Parameter | Manufacturer and Model | Range | Sensitivity | Detection Principle |
|---|---|---|---|---|
| CO | Thermo 48C | User may select up to 10,000 ppm | 0.1 ppm | Infrared absorption, gas filter correlation detector, microprocessor based linearization. |
| THC | Thermo 51C | User may select up to 10,000 ppm | 0.1 ppm | Flame Ionization Detector |

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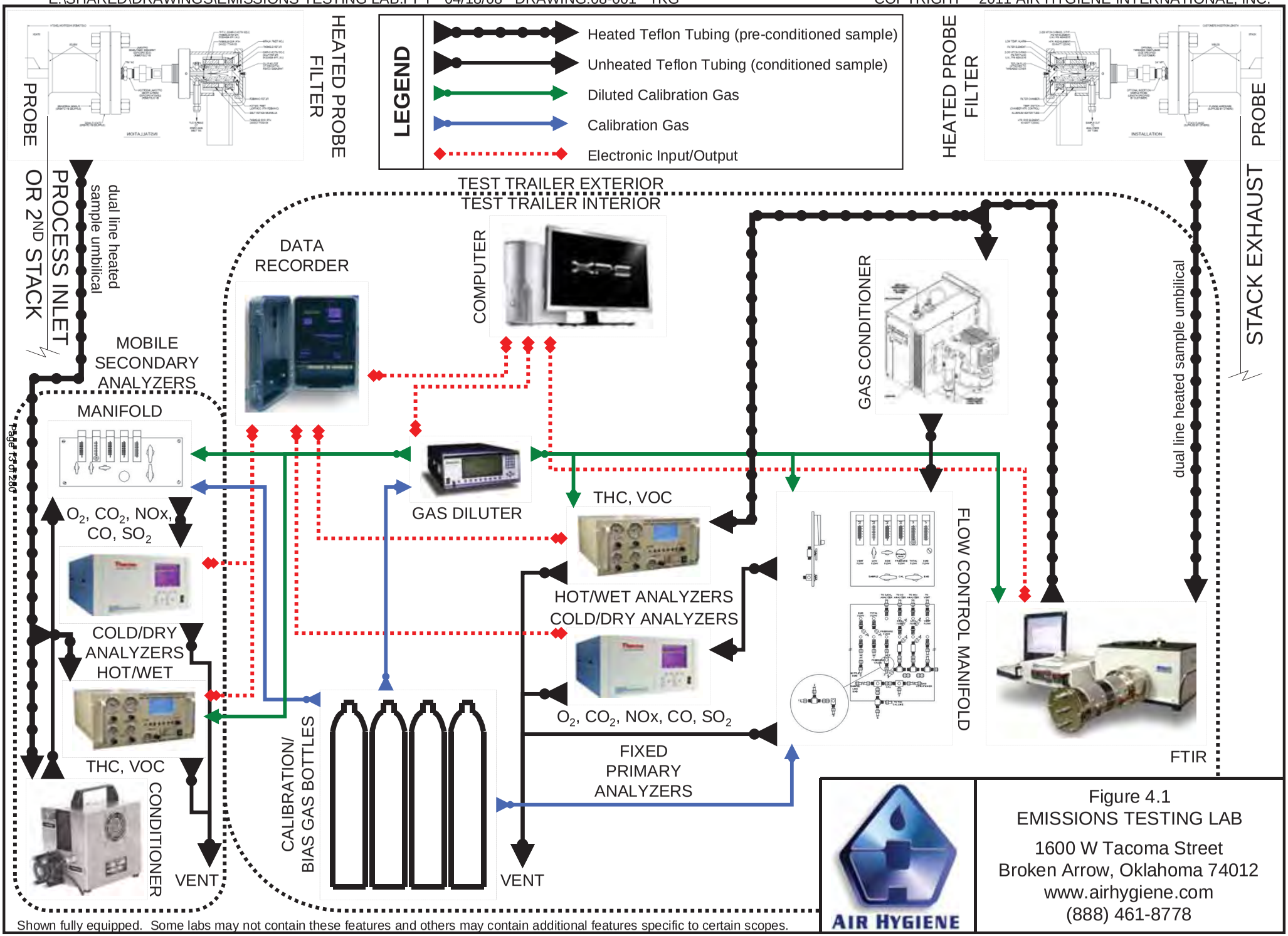


Shown fully equipped. Some labs may not contain these features and others may contain additional features specific to certain scopes.

AIR HYGIENE

Figure 4.1
EMISSIONS TESTING LAB

1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
www.airhygiene.com
(888) 461-8778

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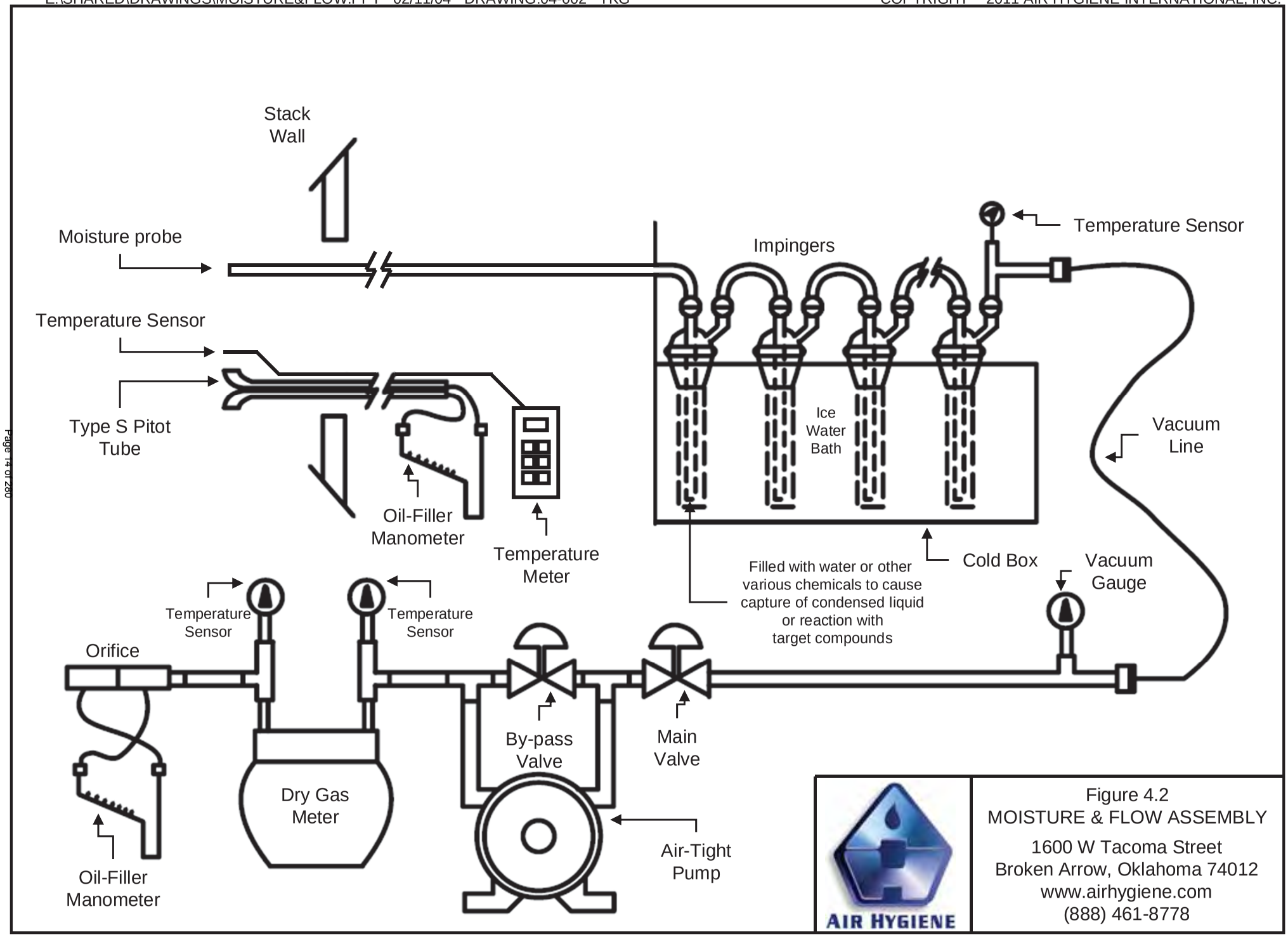
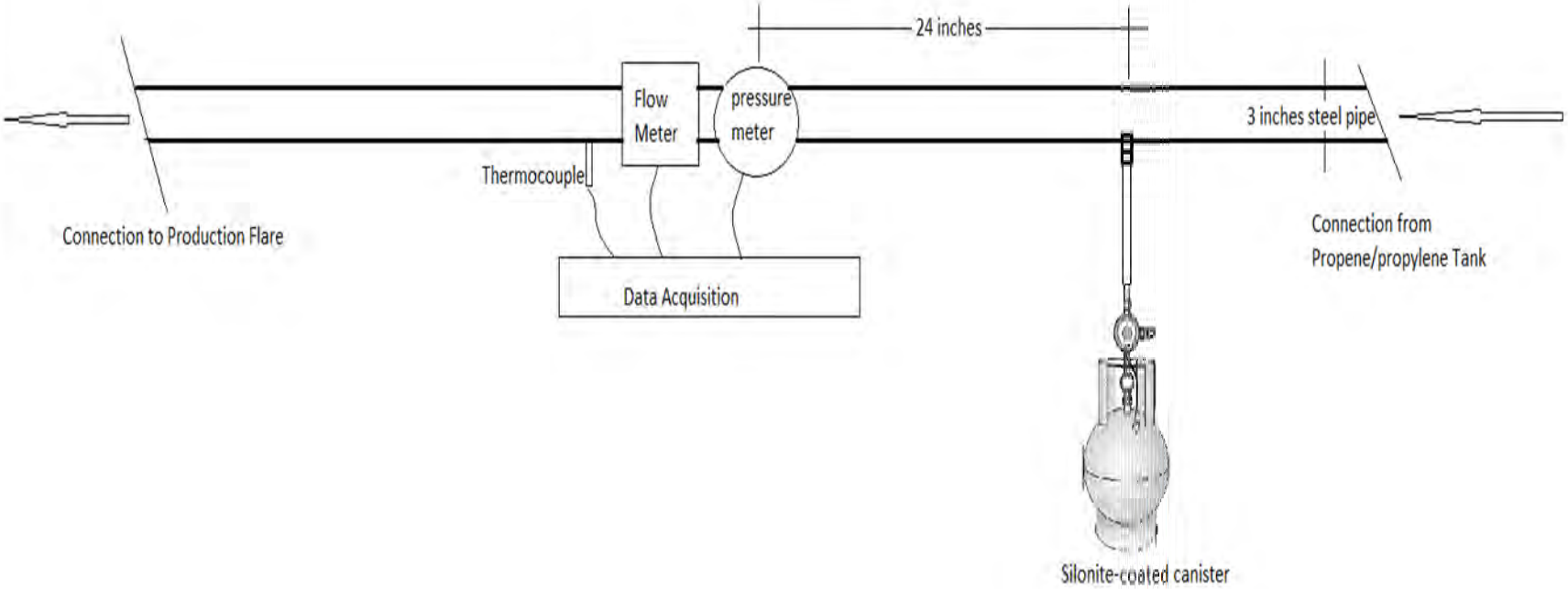



Figure 4.2
MOISTURE & FLOW ASSEMBLY

1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
www.airhygiene.com
(888) 461-8778




AIR HYGIENE

Figure 4.3

FUEL SAMPLING SETUP

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Broken Arrow, Oklahoma 74012

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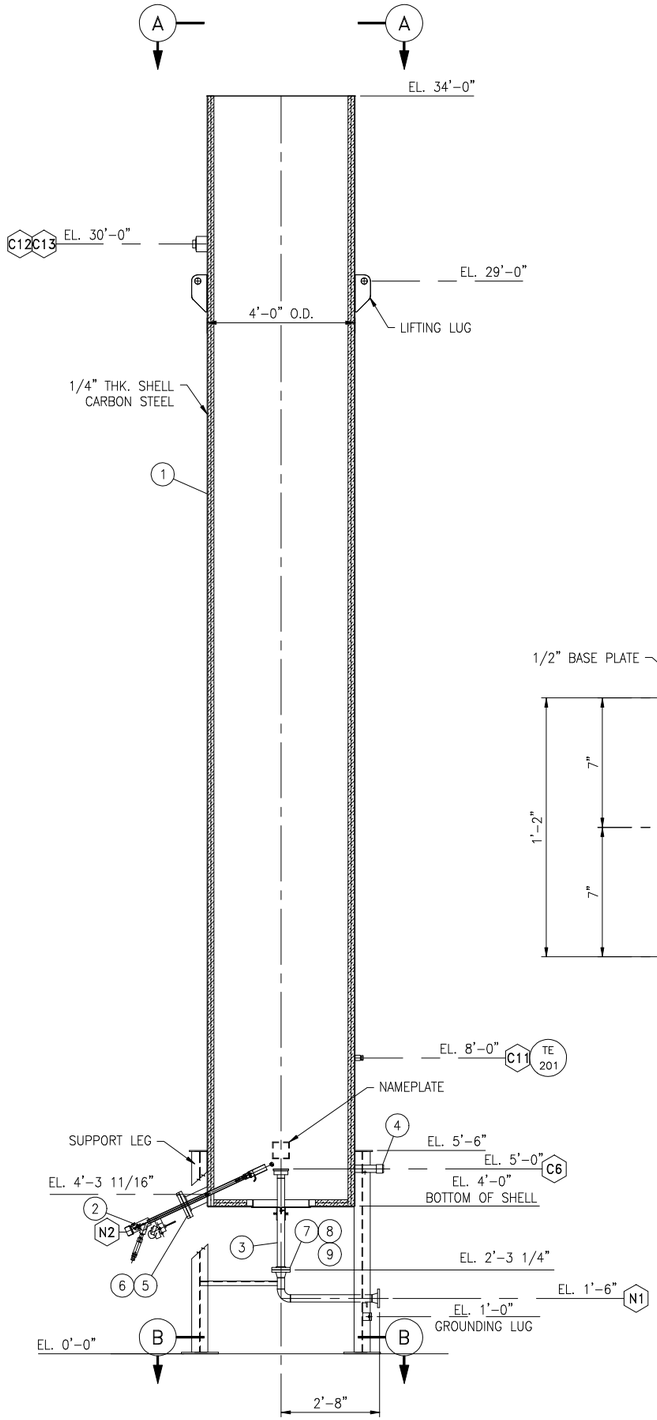
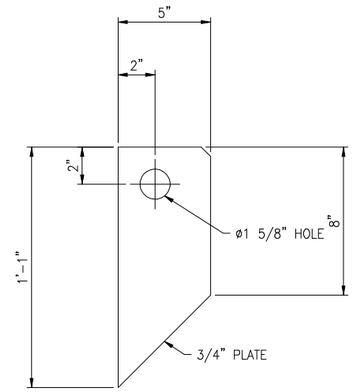
(888) 461-8778

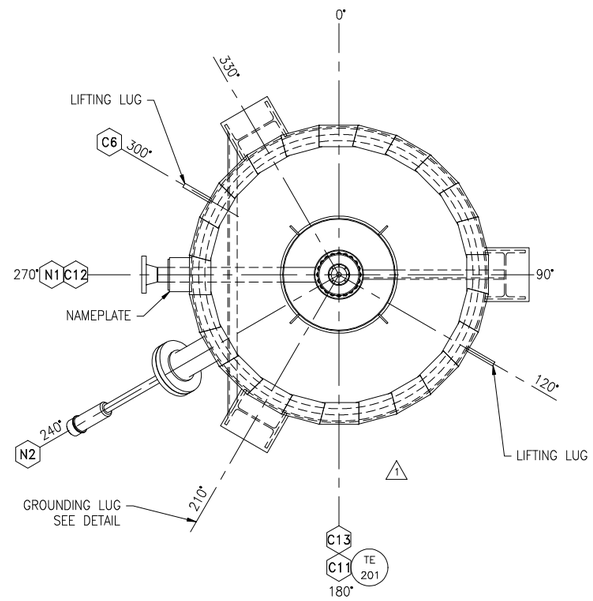



ELEVATION
(NOT TRUE ORIENTATION)

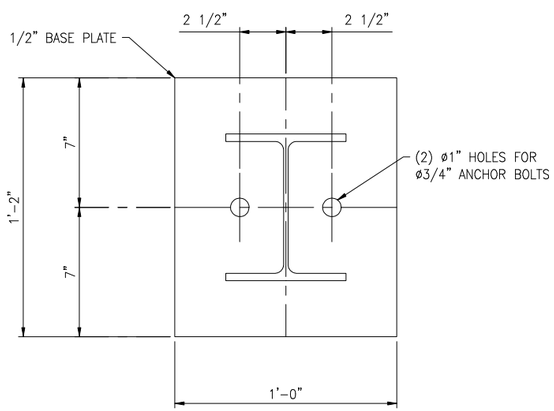
MK: D-701-1



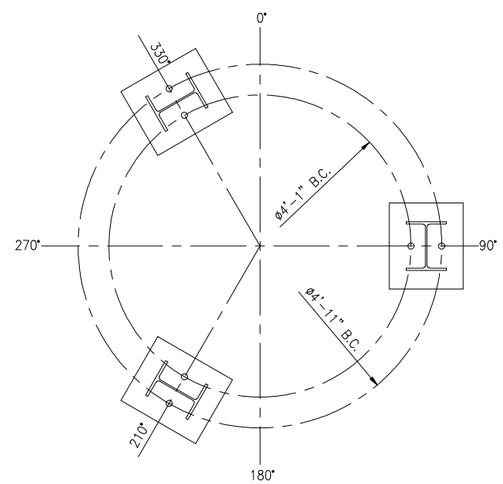

LIFTING LUG DETAIL
TYPICAL TWO PLACES @
120° AND 300°



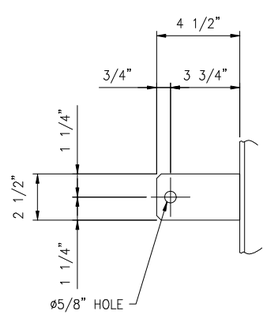

VIEW A-A
(TRUE ORIENTATION)




BASE PLATE DETAIL
(TYP 3 PLACES)




SECTION B-B
(TRUE ORIENTATION)




GROUND LUG DETAIL

PARTS LIST

| ITEM | QTY | DESCRIPTION | MK: NO | MATERIAL |
|---|---|---|---|---|
| 1 | 1 | ENCLOSED ZTOF FLARE | D-701-1 | |
| 2 | 1 | KE-1D PILOT ASSEMBLY | D-302-1 | |
| 3 | 1 | 2" FLARE TIP | D-730-1 | |
| 4 | 1 | 2" SIGHT PORT | CA-ST-0600-1 | |
| 5 | 4 | BOLT, HEX HD: 5/8" x 2 1/2" LG (PLATED) | HB-5-2 1/2 | A-307 |
| 6 | 4 | NUT, REG HEX: 5/8-11NC (PLATED) | HN-5 | A-307 |
| 7 | 1 | GASKET: 2" 150# RF 1/16"THK DONEX 660 | G-2-150R | NON-ASB |
| 8 | 4 | BOLT, STUD: 5/8-NC X 0'-3 1/2" LG (PLATED) | SB-5-3 1/2 | A-193-B7 |
| 9 | 8 | NUT, HVY HEX: 5/8"-10NC (PLATED) | HHN-5 | A-194-2H |
| | | | | |
| | | | | |

NOZZLE LEGEND

| MK | QTY | DESCRIPTION |
|---|---|---|
| N1 | 1 | GAS CONNECTION: 2" 150# F.F.W.N. |
| N2 | 1 | PILOT MTG CONN: 4" 150# R.F.S.O |
| | | |
| | | |
| | | |
| | | |
| | | |
| C6 | 1 | SIGHT PORT - 2" MNPT |
| C11 | 1 | THERMOCOUPLE CONN - 1" FNPT WITH PLUG |
| C12-13 | 2 | SAMPLE PORT 4" FNPT WITH PLUG |
| | | |

DESIGN DATA

WINDLOAD (PER ASCE 7-10, EXP. C) 120 M.P.H.
SEISMIC (IBC 2009) SITE CLASS E
SHEAR @ BASE 2,000 LB
MOMENT @ BASE 44,500 LB-FT
DEADLOAD 5,500 LB
SHELL DESIGN TEMPERATURE 500° F
CORROSION ALLOWANCE 0.0

INSULATION LEGEND

A: (1) OVERLAPPING LAYER OF 1" THICK 8 LB DENSITY, 2300° F. BACKED WITH (1) LAYER, 1" THICK 6 LB DENSITY, 2300° F. ON 310 STAINLESS STEEL PINS AND KEEPERS.

LIFTING NOTES

A: MAIN CRANE AT TOP REQUIRES SPREADER BAR, (NOT SUPPLIED BY JOHN ZINK CO.)
B: LIFTING LUGS DESIGNED FOR 13 1/2 TON CROSBY ANCHOR SHACKLE AND VERTICAL SLINGS.

GENERAL NOTES

1. TAG NUMBERS TO BE PRECEDED BY JOHN ZINK SALES ORDER NUMBER.
2. FLARE ASSEMBLY IS NOT TO BE USED AS AN ANCHOR POINT FOR CUSTOMER PIPING.
3. PRE-TENSION ANCHOR BOLTS BY THE "TURN OF THE NUT" METHOD/AISC.
4. BOLT HOLES TO STRADDLE NORMAL CENTER LINES UNLESS NOTED.
5. FINISH EXTERIOR CARBON STEEL, SUPPORT LEGS, BOTTOM OF FLOOR PLATE, AND MANIFOLD EXTERIOR. SANDBLAST PER SSPC-SP-6 AND PRIME WITH SHERWIN WILLIAMS ZINC CLAD II PLUS #B69VZ12/B69VZ15/B69D11 (3-4 MILS D.F.T.)

FOR PARTS AND SERVICE: • TEL: 1-800-755-4252 • FAX: (918) 234-1968

| NO. | REVISION DESCRIPTION | BY | CHK | APP | DATE |
|---|---|---|---|---|---|
| | PER ENGINEERING | SAM | SAM | ADG | 05-02-14 |

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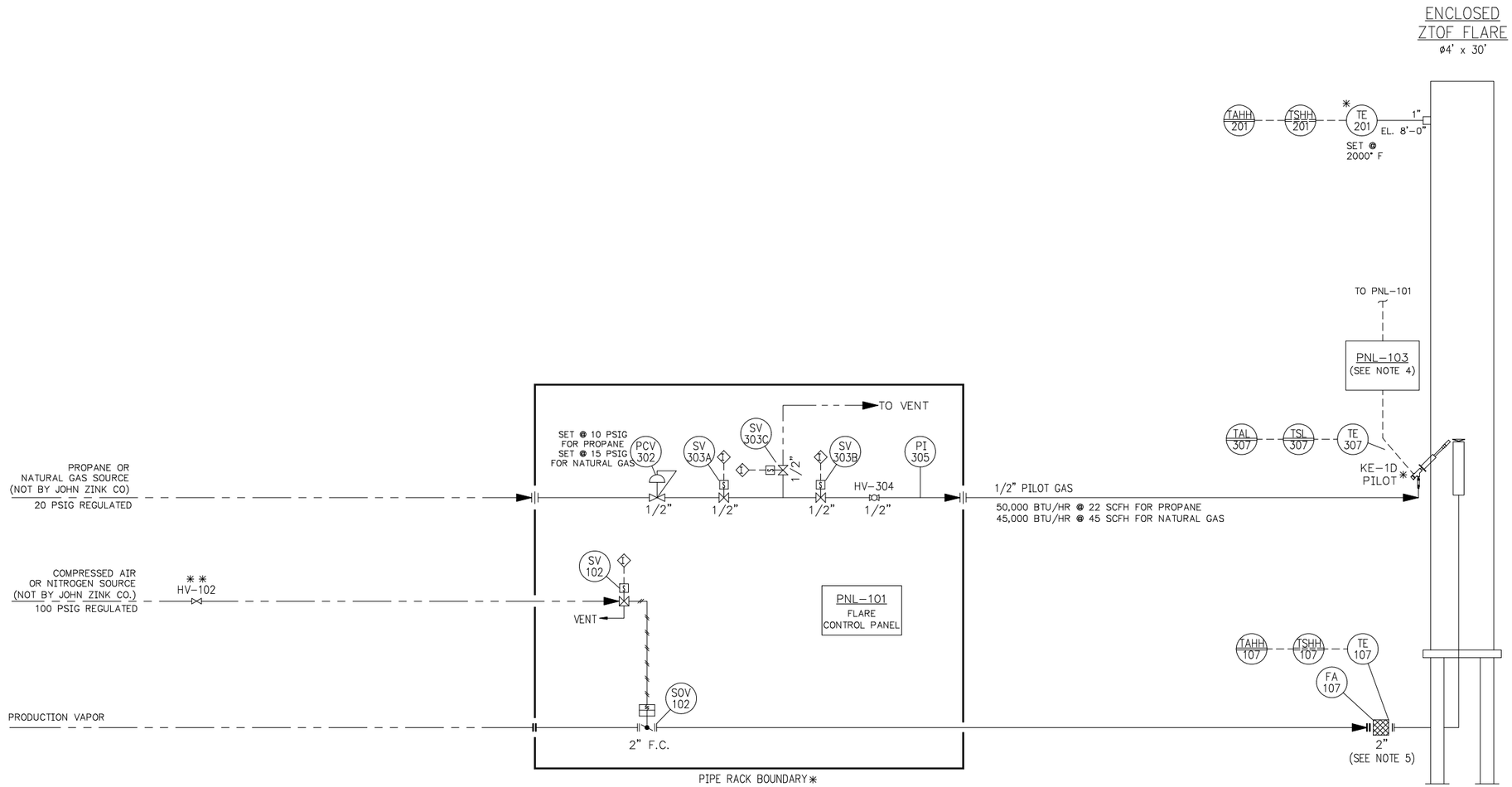
JOHN ZINK HAMWORTHY
COMBUSTION
JOHN ZINK COMPANY, LLC

FOR:
USER:
JOBSITE:
S.O. NO:
P.O. NO:
SCALE:

ENCLOSED ZTOF PRODUCTION FLARE
4'-0" O.D. x 30' H
(QUANTITY ONE)

DRAWN: DATE:
CHK: DATE:
APP: DATE:
SHEET: 1 OF 1
DRAWING NUMBER:
REV. 0

File Name: c:\users\groggg\documents\downloads\301s1r1.dwg Plot Date: 5/2/2014 8:29 AM




## LEGEND

- FIELD MOUNTED INSTRUMENT
- REMOTE PANEL MOUNTED NORMALLY ACCESSIBLE TO OPERATOR
- LOCAL PANEL MOUNTED NORMALLY ACCESSIBLE TO OPERATOR
- REMOTE SUB-PANEL MOUNTED NORMALLY INACCESSIBLE TO OPERATOR
- LOCAL SUB-PANEL MOUNTED NORMALLY INACCESSIBLE TO OPERATOR
- LOCATED IN THE PLC
- INTERLOCK TO/FROM CONTROL PANEL.
- PIPE & FITTINGS BY OTHERS (NOT BY JOHN ZINK CO.)
- ELECTRICAL INTERCONNECTIONS
- INSTRUMENT CONTROL AIR LINE
- PIPE & FITTINGS BY JOHN ZINK CO.

## NOTES:

1. ✳ - SUPPLIED BY JOHN ZINK CO. AND SHIPPED LOOSE FOR FIELD INSTALLATION.
2. ✳✳ - SUPPLIED BY OTHERS (NOT BY JOHN ZINK CO.)
3. ELECTRICAL AREA CLASSIFICATION: NON-HAZARDOUS
4. IGNITION TRANSFORMER IS INSIDE PNL-103 AND MOUNTED ON PIPERACK.
5. LOCATE FLAME ARRESTER WITH 5 DIAMETERS OF STRAIGHT UNDISTURBED FLOW UPSTREAM.

FOR PARTS AND SERVICE: • TEL: 1-800-755-4252 • FAX: (918) 234-1968

| NO. | REVISION DESCRIPTION | BY | CHK | APP | DATE |
|---|---|---|---|---|---|

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**JOHN ZINK HAMWORTHY COMBUSTION**
JOHN ZINK COMPANY, LLC

FOR:
USER:
JOBSITE:
S.O. NO:
P.O. NO:
SCALE:

PROCESS & INSTRUMENT DIAGRAM
FOR AN ENCLOSED ZTOF PRODUCTION FLARE

| DRAWN: | CHK: | APP: | SHEET: |
|---|---|---|---|
| DATE: | DATE: | DATE: | 1 OF 1 |

DRAWING NUMBER:
REV. 0

File Name: r:\active\p-vapor\9148215\drafting\drawings\150s1r0.dwg Plot Date: 4/9/2014 1:16 PM

# APPENDIX A

# TEST RESULTS AND CALCULATIONS

**TABLE A.1:**
**EMISSIONS TESTING SCHEDULE**

| Unit | Load | Test Type | Run | Date | Start | Stop | Time Sync |
|---|---|---|---|---|---|---|---|
| ZTOF040X30PF | 0-30-0 | Performance | 4.0X30PF R1 | 03/11/14 | 13:16:00 | 14:20:00 | CST |
| ZTOF040X30PF | 0-30-0 | Performance | 4.0X30PF R2 | 03/11/14 | 15:27:00 | 16:31:00 | CST |
| ZTOF040X30PF | 0-30-0 | Performance | 4.0X30PF R3 | 03/11/14 | 16:48:00 | 17:53:00 | CST |
| ZTOF040X30PF | 30-70-30 | Performance | 4.0X30PF R4 | 03/12/14 | 8:34:00 | 9:40:00 | CST |
| ZTOF040X30PF | 30-70-30 | Performance | 4.0X30PF R5 | 03/12/14 | 10:00:00 | 11:08:00 | CST |
| ZTOF040X30PF | 30-70-30 | Performance | 4.0X30PF R6 | 03/12/14 | 11:22:00 | 12:25:00 | CST |
| ZTOF040X30PF | 70-100-70 | Performance | 4.0X30PF R7 | 03/12/14 | 13:19:00 | 14:22:00 | CST |
| ZTOF040X30PF | 70-100-70 | Performance | 4.0X30PF R8 | 03/12/14 | 16:30:00 | 17:33:00 | CST |
| ZTOF040X30PF | 70-100-70 | Performance | 4.0X30PF R9 | 03/13/14 | 8:40:04 | 9:43:00 | CST |
| ZTOF040X30PF | 90-100 | Performance | 4.0X30PF R10 | 03/13/14 | 10:27:04 | 11:29:00 | CST |
| ZTOF040X30PF | 90-100 | Performance | 4.0X30PF R11 | 03/13/14 | 12:50:04 | 13:52:00 | CST |
| ZTOF040X30PF | 90-100 | Performance | 4.0X30PF R12 | 03/13/14 | 14:05:04 | 15:07:00 | CST |

**EXAMPLE CALCULATIONS (INFORMATION)**

**Specific Humidity ($RH_{sp}$)**

Note: RHsp (gr/lb) calculated using temperature, relative humidity, and barometric pressure with psychrometric chart, psychrometric calculator, or built in psychrometric algorithm.

$$RH_{sp}(lb/lb) = \left[\left(\frac{gr}{lb}\right) \times \frac{lb}{7000gr}\right]$$

$$RH_{sp} = \frac{54.47\ gr}{lb} \times \frac{1\ lb}{7000\ gr} = 0.007782 \frac{lb\ H_2O}{lb\ Air}$$

**EXAMPLE CALCULATIONS (CALIBRATION)**

**Calibration Error and Estimated Point, RM 25A, THC Analyzer**

RM 25A, (12-17-09), 8.4 Calibration Error Test. Immediately prior to the test series (within 2 hours of the start of the test), introduce zero gas and high-level calibration gas at the calibration valve assembly. Adjust the analyzer output to the appropriate levels, if necessary. Calculate the predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then introduce low-level and mid-level calibration gases successively to the measurement system. ... These differences must be less than 5 percent of the respective calibration gas value. (calc for THC analyzer mid gas, if applicable)

$$E_P = \frac{C_{Dir(H)} - C_{Dir(Z)}}{C_{V(H)} - C_{V(Z)}} \times C_{Dir(M)} + C_{Dir(Z)}$$

Eq. of a line y=mx+b

$$E_p = \frac{8.49\ ppm - 0.04\ ppm}{8.48\ ppm - 0.00\ ppm} \times 5.04\ ppm + 0.04 = 5.06\ ppm$$

$$ACE = \left(\frac{C_{Dir} - C_V}{CS}\right) \times 100$$

Eq. 7E-1

$$ACE_{THC} = \frac{5.15\ ppm - 5.06\ ppm}{5.04\ ppm} \times 100 = 1.74\ \%$$

**EXAMPLE CALCULATIONS (BIAS, DRIFT, AND CORRECTED RAW AVERAGE)**

**System Bias**

RM 7E, (12-17-09), 12.3 System Bias. For non-dilution systems, use Equation 7E-2 to calculate the system bias separately for the low-level and upscale calibration gases. (calc for THC analyzer upscale gas, Run 1 initial bias, if applicable)

$$SB = \left(\frac{C_S - C_{Dir}}{CS}\right) \times 100$$

Eq. 7E-2

$$SB = \frac{3.14\ ppm - 3.03\ ppm}{10.00\ ppm} \times 100 = 1.10\ \%$$

**Drift Assessment**

RM 7E, (12-17-09), 12.5 Drift Assessment. Use Equation 7E-4 to separately calculate the low-level and upscale drift over each test run. (calc for THC analyzer upscale drift, Run 1, if applicable)

$$D = \left|SB_{final} - SB_i\right|$$

Eq. 7E-4

$$D = |\ -0.30\ \% - 1.10\ \%\ | = 1.40\ \%$$

**Alternative Drift and Bias**

RM 7E, (12-17-09), 13.2 / 13.3 System Bias and Drift. Alternatively, the results are acceptable if |Cs – Cdir| is ≤ 0.5 ppmv or if |Cs – Cv| is ≤ 0.5 ppmv (as applicable). (calc for THC analyzer initial upscale, Run 1, if applicable)

$$SB / D_{Alt} = \left|C_S - C_{Dir}\right|$$

Eq. Section 13.2 and 13.3

$$SB / D_{Alt} = |\ 3.14\ ppm - 3.03\ ppm\ | = 0.11\ ppm$$

**Bias Adjusted Average**

RM 7E, (12-17-09), 12.6 Effluent Gas Concentration. For each test run, calculate Cavg, the arithmetic average of all valid THC concentration values (e.g., 1-minute averages). Then adjust the value of Cavg for bias, using Equation 7E-5b. (calc for THC analyzer, Run 1, if applicable)

$$C_{Gas} = \left(C_{Avg} - C_O\right) \times \left(\frac{C_{MA}}{C_M - C_O}\right)$$

Eq. 7E-5b

$$C_{Gas} = \left(0.11\ ppm - 0.00\ ppm\right) \times \left(\frac{3.04\ ppm}{3.07\ ppm - 0.00\ ppm}\right) = 0.11\ ppm$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

**EXAMPLE CALCULATIONS (RUNS)**

**Diluent-Corrected Pollutant Concentration, $CO_2$ Based**

Calculate the $CO_2$ corrected pollutant concentration, as follows: (calc for THC gas, Run 1, if applicable)

Uinsg Method 3C fixed gas analysis

$$C_{adj} = 0.12 \text{ ppm} \times \left(\frac{3.00\ \%}{5.90\ \%}\right) = 0.06 \text{ ppm@3\%}CO_2$$

**EXAMPLE CALCULATIONS (RUNS)**

**Emissions Rate (lb/hr)**

Calculation for pound per hour emission rate. Calculate, as follows: (calc for THC gas Run 1, if applicable)

$$E_{lb/hr} = \frac{C_{Gas}}{10^6} \times \frac{Q_S \times MW}{G}$$

$$E_{lb/hr} = \frac{0.12 \text{ ppm}}{10^6 \text{ ppm/part}} \times \frac{90{,}702 \text{ SCFH} \times 44.00 \text{ lb/lb-mol}}{385.23 \text{ SCF/lb-mol}} = \frac{0.001 \text{ lb}}{\text{hr}}$$

**VOC Destruction Efficiency**

Calculation for VOC destructtion Efficiency. Calculate, as follows: (calc for run 1, if applicable)

$$DE\% = \frac{130.533 - 0.001 \text{ lb/hr}}{130.533 \text{ lb/hr}} \times 100 = 99.999\ \%$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

**EXAMPLE CALCULATIONS (Reference Method 1 - Circular Stack)**

**Diameter of Stack (in.)**

$$D(in.) = L_{fw} - L_{nw}$$

D (in.) = 54.00 in. - 6.00 in. = 48.00 in.

**Area of Stack (ft$^2$)**

$$A_s(ft^2) = \pi \times \left(\frac{D}{2 \times 12}\right)^2$$

$A_s$ (ft$^2$) = 3.14 x ( $\frac{48.00 \text{ in.}}{2 \text{ x } 12\text{in./ft}}$ )$^2$ = 12.57 ft$^2$

**Stack Diameters Downstream**

$$B_D(dia.) = \frac{B}{D}$$

$B_D$ (dia.) = $\frac{288.00 \text{ in.}}{48.00 \text{ in.}}$ = 6.00 diameters

**Stack Diameters Upstream**

$$A_D(dia.) = \frac{A}{D}$$

$A_D$ (dia.) = $\frac{60.00 \text{ in.}}{48.00 \text{ in.}}$ = 1.25 diameters

**EXAMPLE CALCULATIONS (Reference Method 3C) [Values from Run 1 test]**

**Carbon Monoxide Concentration (%)**

$$\%CO = \frac{ppmCO}{10{,}000}$$

%CO (%) = $\frac{0.00 \text{ ppm}}{10{,}000 \text{ ppm/\%}}$ = 0.0000 %

**Nitrogen Concentration (%)**

$$\%N_2 = 100 - \%CO_2 - \%O_2 - \%CO$$

$\%N_2$ (%) = 100 - 5.91 % - 14.00 % - 0.00 / 10,000 % = 80.09 %

**Stack Dry Molecular Weight (lb/lb-mole)**

$$M_d(lb/lb-mol) = \sum\left(\frac{MW_{comp}}{100} \times \%component\right)$$

$M_d$ (lb/lb-mol) = ( $\frac{44 \text{ lb/lb-mol}}{100}$ x 5.91 % ) +

( $\frac{32 \text{ lb/lb-mol}}{100}$ x 14.00 %) + ( $\frac{28 \text{ lb/lb-mol}}{100}$ x [ $\frac{0.00}{10{,}000}$ + 80.09 ] ) = $\frac{29.51 \text{ lb}}{\text{lb-mol}}$

**Stack Wet Molecular Weight (lb/lb-mole)**

$$M_S(lb/lb-mol) = \left[M_d \times \left(1 - \frac{B_{WS}}{100}\right)\right] + \left[MW_{H_2O} \times \frac{B_{WS}}{100}\right]$$

$M_S$ (lb/lb-mol) = { $\frac{29.51 \text{ lb}}{\text{lb-mol}}$ x (1 - $\frac{7.28 \%}{100}$ ) } + { $\frac{18 \text{ lb}}{\text{lb-mol}}$ x $\frac{7.28 \%}{100}$ } = $\frac{28.67 \text{ lb}}{\text{lb-mol}}$

**Average Excess Air (%)**

$$\%EA_{avg}(\%) = \frac{100 \times \left[(\%O_2)_{avg} - (0.5 \times (\%CO)_{avg})\right]}{(0.264 \times (N_2)_{avg}) - \left[(\%O_2)_{avg} - (0.5 \times (\%CO)_{avg})\right]}$$

$(\%EA)_{AVG}$ = $\frac{100 \text{ x } \{ 14.00 \% - (0.5 \text{ x } 0.000 \%) \}}{(0.264 \text{ x } 80.09 \%) - \{ 14.00 \% - (0.5 \text{ x } 0.000 \%)\}}$ = 195.98 %

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

**EXAMPLE CALCULATIONS (Reference Method 2) [Values from Run 1 test]**

**Absolute Stack Pressure (in. Hg)**

$$P_S\,(in.Hg) = P_b + \frac{P_{static}}{13.6}$$

$P_s$ (in. Hg) = 29.49 in. Hg + $\frac{0.00 \text{ in. } H_2O}{13.6 \text{ in. } H_2O/\text{in. Hg}}$ = 29.49 in. Hg

**Average Stack Gas Velocity (ft/sec)**

$$v_s\,(ft/\sec) = K_p \times C_p \times \left(\sqrt{\Delta p}\right)_{avg} \times \sqrt{\frac{(t_s)_{avg} + T_u}{P_s \times M_s}}$$

$v_{sl}$ (ft/sec) =

$$\left(\frac{85.49 \text{ ft}}{\text{sec}} \frac{(\text{lb/lb-mol})(\text{in. Hg})}{(^oR)(\text{in. } H_2O)}\right)^{1/2} \times 0.82 \times 0.08 \text{ in.}H_2O^{1/2} \times \sqrt{\frac{1285.70 + 460\ ^oR}{29.49 \text{ in. Hg} \times 28.67 \text{ lb/lb-mol}}} = \frac{7.7 \text{ ft}}{\text{sec}}$$

**Average Stack Dry Standard Flow Rate (dscfh)**

$$Q_{sd}\,(dscfh) = \frac{60 \times 60 \times \left(1 - \frac{B_{ws}}{100}\right) \times v_s \times A_s \times T_{std} \times P_s}{(t_s + T_u) \times P_{std}}$$

$$Q_{sd} \text{ (dscf/hr)} = \frac{3600 \text{ sec}}{\text{hr}} \times \left(1 - \frac{7.28\ \%}{100}\right) \times \frac{7.74 \text{ ft}}{\text{sec}} \times 12.57 \text{ ft}^2 \times \frac{68.00 + 460\ ^oR}{1{,}285.70 + 460\ ^oR} \times \frac{29.49 \text{ in. Hg}}{29.92 \text{ in. Hg}} = \frac{96{,}744.76 \text{ dscf}}{\text{hr}}$$

**Average Stack Wet Flow Rate (acfm)**

$$Q_{aw}\,(acfm) = 60 \times v_s \times A_s$$

$$Q_{aw} \text{ (acf/min)} = \frac{60 \text{ sec}}{\text{min}} \times \frac{7.74 \text{ ft}}{\text{sec}} \times 12.57 \text{ ft}^2 = \frac{5{,}833.74 \text{ acf}}{\text{min}}$$

**Average Stack Wet Standard Flow Rate (ascfh)**

$$Q_{sw}\,(ascfh) = \frac{60 \times Q_{aw} \times T_{std} \times P_s}{(t_s + T_u) \times P_{std}}$$

$$Q_{sw} \text{ (ascf/hr)} = \frac{60 \text{ min}}{\text{hr}} \times \frac{5{,}833.74 \text{ acf}}{\text{min}} \times \frac{68.00 + 460\ ^oR}{1{,}285.70 + 460\ ^oR} \times \frac{29.49 \text{ in. Hg}}{29.92 \text{ in. Hg}} = \frac{104{,}346.05 \text{ ascf}}{\text{hr}}$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

**EXAMPLE CALCULATIONS (Reference Method 4) [Values from Run 1 test]**

**Water Volume Weighed (scf)**

$$V_{wsg\ (std)}(scf) = W_t \times K_5$$

$V_{wsg(std)}$ = 74.00 g x 0.04715 $ft^3/g$ = 3.490 scf

**Standard Meter Volume (dscf)**

$$V_{m(std)}(dscf) = \frac{K_1 \times Y \times V_m \times \left(P_b + \frac{\Delta H_{avg}}{13.6}\right)}{(t_m)_{avg} + T_u}$$

$$V_{m(std)} = \frac{\frac{17.65\ ^oR}{in.\ Hg} \times 0.92 \times 49.25\ dcf \times \left(29.49\ in.\ Hg + \frac{1.70\ in.\ H_2O}{13.6\ in.\ H_2O / in.\ Hg}\right)}{75.55\ ^oF + 460\ ^oR} = 44.41\ dscf$$

**Calculated Moisture Content (%)**

$$B_{ws(calc)}(\%) = 100 \times \frac{V_{wsg(std)}}{V_{wsg(std)} + V_{m(std)}}$$

$$B_{ws(calc)} = 100 \times \frac{3.49\ dscf}{3.49\ dscf + 44.41\ dscf} = 7.28\ \%$$

**Saturated Moisture Content (%)**

$$B_{ws(svp)}(\%) = 100 \times \frac{10^{6.691 - \frac{3144}{t_{s(avg)} + 390.86}}}{P_b + \frac{P_{static}}{13.6}} \leq 100$$

$$B_{ws(svp)} = 100 \times \frac{10^{\left(6.691 - \frac{3144}{1285.70\ ^oF + 390.86}\right)}}{29.49\ in.\ Hg + \frac{0.00\ in.\ H_2O}{13.6\ in.\ H_2O / in.\ Hg}} \leq 100 = 100.00\ \%$$

Note: Lack of significant figures may cause rounding errors between actual calculations and example calculations.

**RM 7E, (08-15-06), 12.1 Nomenclature. The terms used in the equations are defined as follows:**

ACE = Analyzer calibration error, percent of calibration span.
$B_{WS}$ = Moisture content of sample gas as measured by Method 4 or other approved method, percent/100.
$C_{Avg}$ = Average unadjusted gas concentration indicated by data recorder for the test run.
$C_D$ = Pollutant concentration adjusted to dry conditions.
$C_{Dir}$ = Measured concentration of a calibration gas (low, mid, or high) when introduced in direct calibration mode.
$C_{Gas}$ = Average effluent gas concentration adjusted for bias.
$C_M$ = Average of initial and final system calibration bias (or 2-point system calibration error) check responses for the upscale calibration gas.
$C_{MA}$ = Actual concentration of the upscale calibration gas, ppmv.
$C_O$ = Average of the initial and final system calibration bias (or 2-point system calibration error) check responses from the low-level (or zero) calibration gas.
$C_S$ = Measured concentration of a calibration gas (low, mid, or high) when introduced in system calibration mode.
$C_{SS}$ = Concentration of NOx measured in the spiked sample.
$C_{Spike}$ = Concentration of NOx in the undiluted spike gas.
$C_{Calc}$ = Calculated concentration of NOx in the spike gas diluted in the sample.
$C_V$ = Manufacturer certified concentration of a calibration gas (low, mid, or high).
$C_W$ = Pollutant concentration measured under moist sample conditions, wet basis.
CS = Calibration span.
D = Drift assessment, percent of calibration span.
$E_p$ = The predicted response for the low-level and mid-level gases based on a linear response line between the zero and high-level response.
$Eff_{NO2}$ = $NO_2$ to NO converter efficiency, percent.
H = High calibration gas, designator.
L = Low calibration gas, designator.
M = Mid calibration gas, designator.
NOFinal = The average NO concentration observed with the analyzer in the NO mode during the converter efficiency test in Section 16.2.2.
NOxCorr = The NOx concentration corrected for the converter efficiency.
NOxFinal = The final NOx concentration observed during the converter efficiency test in Section 16.2.2.
NOxPeak = The highest NOx concentration observed during the converter efficiency test in Section 16.2.2.
$Q_{Spike}$ = Flow rate of spike gas introduced in system calibration mode, L/min.
$Q_{Total}$ = Total sample flow rate during the spike test, L/min.
R = Spike recovery, percent.
SB = System bias, percent of calibration span.
$SB_i$ = Pre-run system bias, percent of calibration span.
$SB_f$ = Post-run system bias, percent of calibration span.
SB / $D_{Alt}$ = Alternative absolute difference criteria to pass bias and/or drift checks.
SCE = System calibration error, percent of calibration span.
$SCE_i$ = Pre-run system calibration error, percent of calibration span.
$SCE_{final}$ = Post-run system calibration error, percent of calibration span.
Z = Zero calibration gas, designator.

**40CFR60.355(b)(1), (09-20-06), Nomenclature. The terms used in the equations are defined as follows:**

$P_r$ = reference combustor inlet absolute pressure at 101.3 kilopascals ambient pressure, mm Hg
$P_o$ = observed combustor inlet absolute pressure at test, mm Hg
$H_o$ = observed humidity of ambient air, g $H_2O$/g air
e = transcendental constant, 2.718
$T_a$ = ambient temperature, K

**RM 19, (07-29-06), 12.1 Nomenclature. The terms used in the equations are defined as follows:**

AdjFactor = Percent oxygen or carbon dioxide adjustment applied to a target pollutant
$B_{wa}$ = Moisture fraction of ambient air, percent.
Btu = British thermal unit
$\%_C$ = Concentration of carbon from an ultimate analysis of fuel, weight percent.
$\%_{CO2d}$,$\%_{CO2w}$ = Concentration of carbon dioxide on a dry and wet basis, respectively, percent.
CIP / CDP = Combustor inlet pressure / compressor discharge pressure (mm Hg); note, some manufactures reference as PCD.
E = Pollutant emission rate, ng/J (lb/million Btu).
$E_a$ = Average pollutant rate for the specified performance test period, ng/J (lb/million Btu).
$E_{ao}$, $E_{ai}$ = Average pollutant rate of the control device, outlet and inlet, respectively, for the performance test period, ng/J (lb/million Btu).
$E_{bi}$ = Pollutant rate from the steam generating unit, ng/J (lb/million Btu).
$E_{bo}$ = Pollutant emission rate from the steam generating unit, ng/J (lb/million Btu).
$E_{ci}$ = Pollutant rate in combined effluent, ng/J (lb/million Btu).
$E_{co}$ = Pollutant emission rate in combined effluent, ng/J (lb/million Btu).
$E_d$ = Average pollutant rate for each sampling period (e.g.,24-hr Method 6B sample or 24-hr fuel sample) or for each fuel lot (e.g., amount of fuel bunkered), ng/J (lb/million B
$E_{di}$ = Average inlet $SO_2$ rate for each sampling period d, ng/J (lb/million Btu).
$E_g$ = Pollutant rate from gas turbine, ng/J (lb/million Btu).
$E_{ga}$ = Daily geometric average pollutant rate, ng/J (lbs/million Btu) or ppm corrected to 7 percent $O_2$.
$E_{jo}$,$E_{ji}$ = Matched pair hourly arithmetic average pollutant rate, outlet and inlet, respectively, ng/J (lb/million Btu) or ppm corrected to 7 percent $O_2$.
$E_h$ = Hourly average pollutant, ng/J (lb/million Btu).
$E_{hj}$ = Hourly arithmetic average pollutant rate for hour "j," ng/J (lb/million Btu) or ppm corrected to 7 percent $O_2$.

EXP = Natural logarithmic base (2.718) raised to the value enclosed by brackets.
Fc = Ratio of the volume of carbon dioxide produced to the gross calorific value of the fuel from Method 19
$F_d$, $F_w$, $F_c$ = Volumes of combustion components per unit of heat content, scm/J (scf/million Btu).
$ft^3$ = cubic feet
G = ideal gas conversion factor
(385.23 SCF/lb-mol at 68 deg F & 14.696 psia)
GCM = gross Btu per SCF (constant, compound based)
GCV = Gross calorific value of the fuel consistent with the ultimate analysis, kJ/kg (Btu/lb).
$GCV_p$, $GCV_r$ = Gross calorific value for the product and raw fuel lots, respectively, dry basis, kJ/kg (Btu/lb).
$\%_H$ = Concentration of hydrogen from an ultimate analysis of fuel, weight percent.
$H_b$ = Heat input rate to the steam generating unit from fuels fired in the steam generating unit, J/hr (million Btu/hr).
$H_g$ = Heat input rate to gas turbine from all fuels fired in the gas turbine, J/hr (million Btu/hr).
$\%_{H2O}$ = Concentration of water from an ultimate analysis of fuel, weight percent.
$H_r$ = Total numbers of hours in the performance test period (e.g., 720 hours for 30-day performance test period).
K = volume of combustion component per pound of component (constant)
K = Conversion factor, $10^{-5}$ (kJ/J)/(%) [$10^6$ Btu/million Btu].
$K_c$ = (9.57 scm/kg)/% [(1.53 scf/lb)/%].
$K_{cc}$ = (2.0 scm/kg)/% [(0.321 scf/lb)/%].
$K_{hd}$ = (22.7 scm/kg)/% [(3.64 scf/lb)/%].
$K_{hw}$ = (34.74 scm/kg)/% [(5.57 scf/lb)/%].
$K_n$ = (0.86 scm/kg)/% [(0.14 scf/lb)/%].
$K_o$ = (2.85 scm/kg)/% [(0.46 scf/lb)/%].
$K_s$ = (3.54 scm/kg)/% [(0.57 scf/lb)/%].
$K_{sulfur}$ = $2x10^4$ Btu/wt%-MMBtu
$K_w$ = (1.30 scm/kg)/% [(0.21 scf/lb)/%].
lb = pound
ln = Natural log of indicated value.
$L_p$,$L_r$ = Weight of the product and raw fuel lots, respectively, metric ton (ton).
$\%_N$ = Concentration of nitrogen from an ultimate analysis of fuel, weight percent.
$M_{\%}$ = mole percent
mol = mole
MW = molecular weight (lb/lb-mol)
$MW_{AIR}$ = molecular weight of air ( 28.9625 lb/lb-mole)[1]
NCM = net Btu per SCF (constant based on compound)
$\%_O$ = Concentration of oxygen from an ultimate analysis of fuel, weight percent.
$\%_{O2d}$, $\%_{O2w}$ = Concentration of oxygen on a dry and wet basis, respectively, percent.
$P_B$ = barometirc pressure, in Hg
$P_s$ = Potential SO2 emissions, percent.
$\%_S$ = Sulfur content of as-fired fuel lot, dry basis, weight percent.
$S_e$ = Standard deviation of the hourly average pollutant rates for each performance test period, ng/J (lb/million Btu).
$\%_{Sf}$ = Concentration of sulfur from an ultimate analysis of fuel, weight percent.
S(wt%) = weight percent of sulfur, per lab analysis by appropriate ASTM standard
$S_i$ = Standard deviation of the hourly average inlet pollutant rates for each performance test period, ng/J (lb/million Btu).
$S_o$ = Standard deviation of the hourly average emission rates for each performance test period, ng/J (lb/million Btu).
$\%S_p$, $\%S_r$ = Sulfur content of the product and raw fuel lots respectively, dry basis, weight percent.
SCF = standard cubic feet
SH = specific humidity, pounds of water per pound of air
$t_{0.95}$ = Values shown in Table 19-3 for the indicated number of data points n.
$T_{amb}$ = ambient temperature, $^oF$
W/D Factor = 1.0236 = conv. at 14.696 psia and
68 deg F (ref. Civil Eng. Ref. Manual, 7th Ed.)
$X_{CO2}$=$CO_2$ Correction factor, percent.
$X_k$ = Fraction of total heat input from each type of fuel k.

## Nomenclature

- %CO = carbon monoxide concentration (%)
- $\%CO_2$ = carbon dioxide concentration (%)
- $\%N_2$ = nitrogen concentration (%)
- $\%O_2$ = oxygen concentration (%)
- $\%O_{2,wet}$ = Oxygen content of gas stream, % by volume of wet gas. (Note: The oxygen percentage used in Method 201A, Equation 3 is on a wet gas basis. That means that since oxygen is typically measured on a dry gas basis, the measured percent O2 must be multiplied by the quantity (1 - $B_{ws}$) to convert to the actual volume fraction. Therefore, $\%O_{2,wet} = (1 - B_{ws}) * \%O_{2,\ dry}$)
- $(\%EA)_{avg}$ = average excess air (%)
- $(F_o)_{avg}$ = average calculated fuel factor
- $[(\Delta p)^{0.5}]_{avg}$ = Average of square roots of the velocity pressures measured during the preliminary traverse, inches W.C.
- μ = Gas viscosity, micropoise
- 12.0 = Constant calculated as 60 percent of 20.5 square inch cross-sectional area of combined cyclone head, square inches
- 17.03 = mg/milliequivalents for ammonium ion
- 22.4 = liters of ideal gas per mol of substance at $0^oC$ and 1 atm (ref. Civil Engineering Reference Manual, 7th ed. - Michael R. Lindeburg)
- $5.02 \times 10^4$ = constant derived from the molecular weight and correcting standard temperature and pressure (ref. Bay Area Air Quality Management District, Source Test Procedure ST-1B, Ammonia Integrated Sampling, Adopted January 20, 1982, Regulation 7-303)
- A = distance upstream (in.)
- $A_D$ = stack diameters upstream (dia.)
- An = Area of nozzle, square feet
- $A_s$ = area of stack ($ft^2$)
- B = distance downstream (in.)
- $B_D$ = stack diameters downstream (dia.)
- $b_f$ = Average blockage factor calculated in Equation 26, dimensionless
- $B_{wm}$ = meter moisture content (%)
- $B_{ws}$ = stack moisture content (%)
- C = Cunningham correction factor for particle diameter, Dp, and calculated using the actual stack gas temperature, dimensionless
- $C_1$ = -150.3162 (micropoise)
- $C_2$ = 18.0614 (micropoise/$K^{0.5}$) = 13.4622 (micropoise/$R^{0.5}$)
- $C_3 = 1.19183 \times 10^6$ (micropoise/$K^2$) = $3.86153 \times 10^6$ (micropoise/$R^2$)
- $C_4$ = 0.591123 (micropoise)
- $C_5$ = 91.9723 (micropoise)
- $C_6 = 4.91705 \times 10^{-5}$ (micropoise/$K^2$) = $1.51761 \times 10^{-5}$ (micropoise/$R^2$)
- $C_a$ = Acetone blank concentration, mg/mg
- $C_b$ = Concentration of NH3 ion in the back half of train (breakthrough)
- $C_f$ = Concentration of NH3 ion in the front half of train (main catch)
- $C_{fPM10}$ = Conc. of filterable $PM_{10}$, gr/dscf
- $C_{fPM2.5}$ = Conc. of filterable $PM_{2.5}$, gr/dscf
- $C_k$ = K Factor Constant, 849.8
- $C_n$ = nozzle diameter constant, 0.03575
- $C_p'$ = Coefficient for the pitot used in the preliminary traverse, dimensionless

## Nomenclature

- $C_p$ = Pitot coefficient for the combined cyclone pitot, dimensionless
- $C_{cpm}$ = Concentration of the condensable PM in the stack gas, dry basis, corrected to standard conditions, milligrams/dry standard cubic foot.
- $C_r$ = Re-estimated Cunningham correction factor for particle diameter equivalent to the actual cut size diameter and calculated using the actual stack gas temperature, dimensionless
- $D_{50}$ = Particle cut diameter, micrometers
- $D_{50(N+1)}$ = $D_{50}$ value for cyclone IV calculated during the N+1 iterative step, micrometers
- $D_{50\text{-}1}$ = Re-calculated particle cut diameters based on re-estimated $C_r$, micrometers
- $D_{50LL}$ = Cut diameter for cyclone I corresponding to the 2.25 micrometer cut diameter for cyclone IV, micrometer
- $D_{50N}$ = $D_{50}$ value for cyclone IV calculated during the Nth iterative step, micrometers
- $D_{50T}$ = Cyclone I cut diameter corresponding to the middle of the overlap zone shown in Method 201A, Figure 10 of Section 17, micrometers
- $D_e$ = equivalent stack diameter (in.)
- ΔH@ = ΔH @ 0.75 scfm (in. H2O)
- $\Delta H_{avg}$ = average orifice pressure (in. $H_2O$)
- $D_n$ = Inner diameter of sampling nozzle mounted on Cyclone I, inches
- $D_{na}$ = actual nozzle diameter (in.)
- $D_p$ = Physical particle size, micrometers
- $\Delta p$ = velocity head (in. $H_2O$)
- $\Delta p_1$ = velocity head at first current traverse point (in. $H_2O$)
- $\Delta p'_1$ = velocity head at first preliminary traverse point (in. $H_2O$)
- $\Delta p_{avg}$ = average pitot tube differential pressure (in. $H_2O$)
- $\Delta p_n$ = velocity head at subsequent current traverse point (in. $H_2O$)
- $\Delta p_{RM2}$ = method 2 velocity head (in. $H_2O$)
- $D_s$ = diameter of stack (in.)
- $F_d$ = fuel f-factor (dscf/MMBtu)
- $f_{O2}$ = stack gas fraction of $O_2$, by volume, dry basis
- I = Percent isokinetic sampling, dimensionless
- $K_1$ = standard volume correction, 17.65$^o$R/in. Hg
- $K_4$ = isokinetic conversion constant, 0.0945min•in.Hg/sec•$^o$R
- $K_5$ = water mass to std water vapor, 0.04715 $ft^3$/g
- $K_p$ = 85.49, ((ft/sec)/(pounds/mole -$^o$R))
- L = length of stack (in.)
- $L_{fw}$ = distance to far wall of stack (in.)
- $L_{nw}$ = distance to near wall of stack (in.) [reference]
- $m_{\#x}$ = weight measurements (g)
- $M_1$ = Milligrams of PM collected on the filter, less than or equal to 2.5 micrometers
- $M_2$ = Milligrams of PM recovered from Container #2 (acetone blank corrected), greater than 10 micrometers
- $M_3$ = Milligrams of PM recovered from Container #3 (acetone blank corrected), less than or equal to 10 and greater than 2.5 micrometers
- $M_4$ = Milligrams of PM recovered from Container #4 (acetone blank corrected), less than or equal to 2.5 micrometers
- $m_a$ = Mass of residue of acetone after evaporation, mg
- $m_c$ = Mass of the NH4+ added to sample to form ammonium sulfate, mg

## Nomenclature

- $m_{cpm}$ = Mass of the total condensable PM, mg
- $M_d$ = Molecular weight of dry gas, pounds/pound mole
- $m_{fb}$ = Mass of total CPM in field train recovery blank, mg
- $m_{fx}$ = final weight, avg of last two measurements (g)
- mg = Milligram
- mg/L = Milligram per liter
- $m_i$ = Mass of inorganic CPM, mg
- $m_{ib}$ = Mass of inorganic CPM in field train recovery blank, mg
- $M_n$ = total particulates (mg)
- $m_o$ = Mass of organic CPM, mg
- $m_{ob}$ = Mass of organic CPM in field train blank, mg
- $m_r$ = Mass of dried sample from inorganic fraction, mg
- $m_{tx}$ = tare weight (g)
- MW = molecular weight (lb/lb-mole)
- $M_w$ = Molecular weight of wet gas, pounds/pound mole
- N = Normality of ammonium hydroxide titrant
- $N_a$ = null angle (deg.)
- $N_{re}$ = Reynolds number, dimensionless
- $N_{tp}$ = Number of iterative steps or total traverse points
- $P_b$ = $P_{bar}$ = barometric pressure (in. Hg)
- $P_{bar}$ = barometric pressure (in. Hg)
- ppmCO = carbon monoxide concentration (ppm)
- ppmv = Parts per million by volume
- ppmw = Parts per million by weight
- $P_s$ = absolute stack pressure (in. Hg)
- $P_{static}$ = static pressure (in. $H_2O$)
- $P_{std}$ = standard pressure, 29.92 in. Hg
- $\Theta$ = total sampling time (min)
- $Q_{aw}$ = average stack wet flow rate (ascf/min)
- $Q_I$ = Sampling rate for cyclone I to achieve specified $D_{50}$
- $Q_m$ = estimated orifice flow rate, 0.750 acfm, else Vm/Q from previous run
- $Q_s$ = Sampling rate for cyclone I to achieve specified $D_{50}$
- $Q_{s(std)}$ = total cyclone flow rate at standard conditions (dscf/min)
- $Q_{sd}$ = dry standard stack flow rate (dscfm)
- $Q_{sST}$ = Dry gas sampling rate through the sampling assembly, dscfm
- $Q_{sw}$ = wet standard stack flow rate (ascfm)
- $R_{max}$ = Nozzle/stack velocity ratio parameter, dimensionless
- $R_{min}$ = Nozzle/stack velocity ratio parameter, dimensionless
- $t_1$ = Sampling time at point 1, min
- $t_m$ = average gas meter temperature ($^oF$)
- $t_m$ = average meter temperature ($^oF$)
- $T_m$ = Meter box and orifice gas temperature, $^oR$
- $t_n$ = Sampling time at point n, min
- $t_r$ = Total projected run time, min
- $T_s$ = Absolute stack gas temperature, $^oR$
- $T_{std}$ = standard temperature, $68^oF$, $528^oR$

## Nomenclature

- $T_u$ = absolute temperature offset, 460$^o$R
- $V_a$ = Volume of acetone blank, ml
- $V_{aw}$ = Volume of acetone used in sample recovery wash, ml
- $V_b$ = Volume of aliquot taken for IC analysis, ml
- $V_c$ = Quantity of water captured in impingers and silica gel, ml
- $V_f$ = final impinger volume (ml)
- $V_i$ = initial impinger volume (ml)
- $V_{ic}$ = Volume of impinger contents sample, ml
- $V_m$ = Dry gas meter volume sampled, acf
- $V_{m(std)}$ = standard meter volume (dscf)
- $v_{max}$ = Maximum gas velocity calculated from Equations 18 or 19, ft/sec
- $v_{max}$ = maximum nozzle velocity (ft/sec)
- $V_{mf}$ = final dry gas meter reading (dcf)
- $V_{mi}$ = initial dry gas meter reading (dcf)
- $v_{min}$ = Minimum gas velocity calculated from Method 201A, Equations 16 or 17, ft/sec
- $V_{ms}$ = Dry gas meter volume sampled, corrected to standard conditions, dscf
- $v_n$ = Sample gas velocity in the nozzle, ft/sec
- $v_{org}$ = organics wash volume (ml)
- $V_p$ = Volume of water added during train purge
- $v_s$ = average stack gas velocity (ft/sec)
- $v_{sl}$ = local velocity (ft/sec)
- $V_t$ = total impinger volume (ml) = ;($V_f$-$V_i$)
- $V_t$ = Volume of NH4OH titrant, ml
- $V_{w(std)}$ = volume of water vapor in gas sample at standard conditions (scf)
- $v_x$ = blank volume (ml)
- W = width of stack (in.)
- $W_{2,3,4}$ = Weight of PM recovered from Containers #2, #3, and #4, mg
- $W_a$ = Weight of blank residue in acetone used to recover samples, mg
- $W_f$ = final impinger weight (g)
- $W_i$ = initial impinger weight (g)
- $W_t$ = total impinger weight (g) = ;($W_f$-$W_i$)
- $w_x$ = blank weight of solids (g)
- Y = meter calibration factor (a.k.a gamma)
- Z = Ratio between estimated cyclone IV $D_{50}$ values, dimensionless
- γ = Dry gas meter gamma value, dimensionless
- ΔH = Meter box orifice pressure drop, inches W.C.
- ΔH@ = Pressure drop across orifice at flow rate of 0.75 scfm at standard conditions, inches W.C. (Note: Specific to each orifice and meter box.)
- $\Delta p_1$ = Velocity pressure measured at point 1, inches W.C.
- $\Delta p_{avg}$ = Average velocity pressure, inches W.C.
- $\Delta p_m$ = Observed velocity pressure using S-type pitot tube in preliminary traverse, inches W.C.
- $\Delta p_{max}$ = Maximum velocity pressure, inches W.C.
- $\Delta p_{min}$ = Minimum velocity pressure, inches W.C.
- $\Delta p_n$ = Velocity pressure measured at point n during the test run, inches W.C.
- $\Delta p_s$ = Velocity pressure calculated in Method 201a, Equation 25, inches W.C.
- $\Delta p_{s1}$ = Velocity pressure adjusted for combined cyclone pitot tube, inches W.C.

## Nomenclature

- $\Delta p_{s2}$ = Velocity pressure corrected for blockage, inches W.C.
- $\theta$ = Total run time, min
- $\rho_a$ = Density of acetone, mg/ml (see label on bottle)
- $\Sigma_n$ = total number of sampling points

# Calculations, Formulas, and Constants

The following information supports the spreadsheets for this testing project.

## Given Data:

Ideal Gas Conversion Factor = 385.23 SCF/lb-mol at 68 deg F & 14.696 psia

Fuel Heating Value is based upon Air Hygiene's fuel gas calculation sheet. All calculations are based upon a correction to 68 deg F & 14.696 psia

High Heating Values (HHV) are used for the Fuel Heating Value, F-Factor, and Fuel Flow Data per EPA requirements.

**ASTM D 3588**

| | |
|---|---|
| Molecular Weight of NOx (lb/lb-mole) = | 46.01 |
| Molecular Weight of CO (lb/lb-mole) = | 28.00 |
| Molecular Weight of $SO_2$ (lb/lb-mole) = | 64.00 |
| Molecular Weight of THC (propane) (lb/lb-mole) = | 44.00 |
| Molecular Weight of VOC (methane) (lb/lb-mole) = | 16.00 |
| Molecular Weight of $NH_3$ (lb/lb-mole) = | 17.03 |
| Molecular Weight of HCHO (lb/lb-mole) = | 30.03 |

**40CFR60, App. A., RM 19, Table 19-1**

| | |
|---|---|
| Conversion Constant for NOx = | 0.0000001194351 |
| Conversion Constant for CO = | 0.0000000726839 |
| Conversion Constant for $SO_2$ = | 0.0000001661345 |
| Conversion Constant for THC = | 0.0000001142175 |
| Conversion Constant for VOC (methane) = | 0.0000000415336 |
| Conversion Constant for $NH_3$ = | 0.0000000442074 |
| Conversion Constant for HCHO = | 0.0000000779534 |

NOTE: units are lb/ppm*ft$^3$

## Formulas:

1. Corrected Raw Average ($C_{Gas}$), 40CFR60, App. A, RM 7E, Eq. 7E-5 (08/15/06)

$$C_{Gas} = \left(C_{Avg} - C_O\right) \times \left(\frac{C_{MA}}{C_M - C_O}\right)$$

2. Correction to % $O_2$, 40CFR60, App. A, RM 20, Eq. 20-5 (11/26/02)

$$C_{adj} = C_{Gas(Target)} \times \left(\frac{20.9\% - AdjFactor}{20.9\% - C_{Gas(O2)}}\right)$$

3. Correction to % $O_2$ and ISO Conditions

$$C_{ISO} = C_{Adj} \times \sqrt{\frac{P_r}{P_o}} \times e^{(19 \times (H_O - 0.00633))} \times \left(\frac{288}{T_a}\right)^{1.53}$$

4. Method 19 stack exhaust flow (scfh)

$$Q_S = \left(\frac{FFactor \times Q_f \times HHV}{1{,}000{,}000}\right) \times \left(\frac{20.9\%}{20.9\% - C_{Gas(O2)}}\right)$$

5. Emission Rate in lb/hr

$$E_{lb/hr} = \frac{C_{Gas}}{10^6} \times \frac{Q_S \times MW}{G}$$

6. Emission Rate in tons per year

$$E_{ton/yr} = \frac{E_{lb/hr} \times hr_{year}}{2000}$$

7. Emission Concentration in lb/MMBtu ($O_2$ based)

$$E_{lb/MMBtu} = \frac{C_{Gas} \times F_d Factor \times Conv_C \times 20.9\%}{20.9\% - C_{Gas(O2)}}$$

8. Emission Concentration in g/hp*hr

$$E_{g/hp \cdot hr} = \frac{E_{lb/hr} \times 453.6}{mw \times 1314.022} \; or \; \frac{E_{lb/hr} \times 453.6}{hp}$$

# APPENDIX B

# EMISSION DATA RECORDS

## John Zink Co, LLC

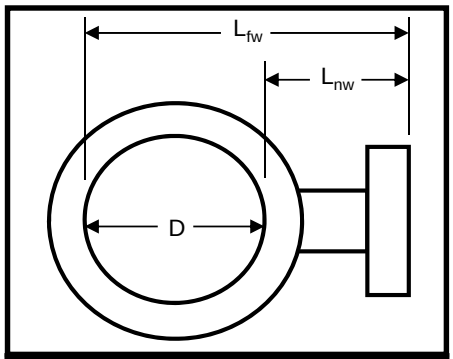
| | |
|---|---|
| **Air Permit # :** | 40 CFR 60 Sub Part OOOO |
| **Plant Name or Location:** | Tulsa R&D Facility |
| **Date:** | March 10, 2014 |
| **Project Number:** | jz-13-tulsa.ok-comp#1 |
| **Manufacturer & Equipment:** | ZTOF040X30PF |
| **Test Load:** | Multiple |
| **Tester(s) / Test Unit(s):** | MSL/TP/MM/ML/MW/210 |

| | | RUN | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **UNITS** | **4.0X30PF R1** | **4.0X30PF R2** | **4.0X30PF R3** | **4.0X30PF R4** | **4.0X30PF R5** | **4.0X30PF R6** | **4.0X30PF R7** | **4.0X30PF R8** | **4.0X30PF R9** | **4.0X30PF R10** | **4.0X30PF R11** | **4.0X30PF R12** |
| **Start Time** | hh:mm:ss | 13:16:00 | 15:27:00 | 16:48:00 | 08:40:00 | 10:00:00 | 11:23:00 | 13:19:00 | 16:30:00 | 08:40:04 | 10:27:04 | 12:50:04 | 14:05:04 |
| **End Time** | hh:mm:ss | 14:16:00 | 16:27:00 | 17:48:00 | 09:40:00 | 11:00:00 | 12:23:00 | 14:19:00 | 17:30:00 | 09:40:04 | 11:27:04 | 13:50:04 | 15:05:04 |
| **Bar. Pressure** | in. Hg | 29.49 | 29.41 | 29.40 | 30.21 | 30.26 | 30.26 | 30.26 | 30.20 | 30.19 | 30.20 | 30.15 | 30.09 |
| **Amb. Temp.** | °F | 83 | 87 | 84 | 53 | 60 | 66 | 58 | 72 | 57 | 63 | 66 | 71 |
| **Rel. Humidity** | % | 32 | 26 | 28 | 40 | 33 | 25 | 28 | 21 | 34 | 28 | 17 | 14 |
| **Spec. Humidity** | lb water / lb air | 0.007782 | 0.007200 | 0.007045 | 0.003355 | 0.003560 | 0.003330 | 0.002809 | 0.003443 | 0.003300 | 0.003365 | 0.002269 | 0.002222 |
| **Date** | mm/dd/yy | 03/11/14 | 03/11/14 | 03/11/14 | 03/12/14 | 03/12/14 | 03/12/14 | 03/12/14 | 03/12/14 | 03/13/14 | 03/13/14 | 03/13/14 | 03/13/14 |
| **Unit Number** | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Load Designator** | % | 0-30-0 | 0-30-0 | 0-30-0 | 30-70-30 | 30-70-30 | 30-70-30 | 70-100-70 | 70-100-70 | 70-100-70 | 90-100 | 90-100 | 90-100 |
| **Gross Fuel Heating Value** | Btu/ft3 | 2,541 | 2,541 | 2,541 | 2,556 | 2,556 | 2,556 | 2,494 | 2,494 | 2,494 | 2,552 | 2,552 | 2,552 |
| **Stack Flow (M2)** | dscfh | 86,125 | 85,121 | 82,138 | 178,215 | 192,325 | 201,263 | 307,067 | 280,468 | 284,135 | 291,965 | 284,219 | 296,509 |
| **Stack Moisture** | Method 4 | 7.28 | 6.40 | 5.31 | 5.34 | 5.43 | 5.43 | 6.37 | 5.99 | 5.25 | 5.83 | 6.36 | 6.08 |
| **Wind Speed** | mph | 5 | 5 | 5 | 5 | 14 | 12 | 6 | 9 | 1 | 3 | 8 | 5 |
| **Wind Direction** | -- | SE | S | S | N | N | N | NW | N | SW | SW | W | W |
| **$CO_2$ - Method 3C** | % | 5.9 | 5.9 | 5.5 | 5.9 | 5.9 | 5.5 | 5.3 | 5.5 | 5.7 | 5.8 | 6.1 | 6.1 |
| **$O_2$ - Method 3C** | % | 14.0 | 14.0 | 14.6 | 14.0 | 14.0 | 14.6 | 15.4 | 14.7 | 14.3 | 14.2 | 13.9 | 13.9 |
| **$N_2$ -Method 3C** | % | 80.1 | 80.1 | 79.9 | 80.1 | 80.1 | 79.9 | 79.3 | 79.8 | 79.9 | 80.0 | 80.0 | 80.1 |
| **Excess Air** | % | 196.0 | 196.0 | 225.1 | 196.0 | 193.0 | 225.1 | 278.2 | 230.9 | 210.5 | 205.2 | 192.4 | 192.6 |

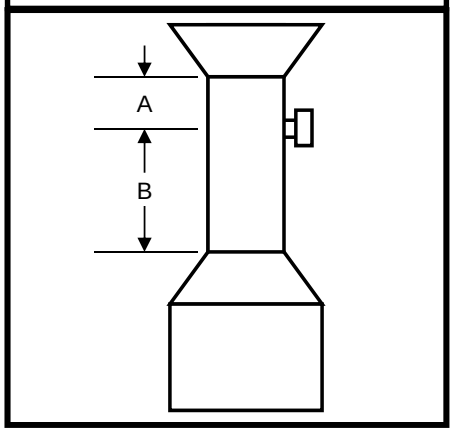
## METHOD 1 - SAMPLE AND VELOCITY TRAVERSES FOR CIRCULAR SOURCES

| | | | |
|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Date** | 03/11/14 |
| **Sampling Location** | 4.0X30PF | **Stack Type** | Circular |
| **Operator** | TP | **Ports Available** | 2 |
| **Project #** | jz-14-tulsa.ok-comp#1 | **Ports Used** | 2 |
| **Stack Size** | Large (>24 inch diameter) | **Port ID (inches)** | 4.00 |

| **Circular Stack or Duct Diameter** | | | |
|---|---|---|---|
| **Distance to Far Wall of Stack** | ($L_{fw}$) | 54.00 | in |
| **Distance to Near Wall of Stack** | ($L_{nw}$) | 6.00 | in |
| **Diameter of Stack** | (D) | 48.00 | in |
| **Area of Stack** | ($A_s$) | 12.57 | ft² |




| **Distance from Port to Disturbances** | | | |
|---|---|---|---|
| **Distance Upstream** | (A) | 60.00 | in |
| **Diameters Upstream** | ($A_D$) | 1.25 | diameters |
| **Distance Downstream** | (B) | 288.00 | in |
| **Diameters Downstream** | ($B_D$) | 6.00 | diameters |




| **Number of Traverse Points Required** | | | |
|---|---|---|---|
| **Diameters to Flow Disturbance** | | **Minimum Number of[1] Traverse Points** | |
| **Down Stream** | **Up Stream** | **Particulate Points** | **Velocity Points** |
| 2.00-4.99 | 0.50-1.24 | 24 | 16 |
| 5.00-5.99 | 1.25-1.49 | 20 | 16 |
| 6.00-6.99 | 1.50-1.74 | 16 | 12 |
| 7.00-7.99 | 1.75-1.99 | 12 | 12 |
| >= 8.00 | >=2.00 | 8 or 12[2] | 8 or 12[2] |
| **Upstream Spec** | | 20 | 16 |
| **Downstream Spec** | | 16 | 16 |
| **Traverse Pts Required** | | 20 | 16 |

[1] Check Minimum Number of Points for the Upstream and Downstream conditions, then use the largest.

[2] 8 for Circular Stacks 12 to 24 inches
12 for Circular Stacks over 24 inches

- (●) Method 1 Trav
- ( ) 12 Point PM Trav
- ( ) Velocity

| **Number of Traverse Points Used** | | | |
|---|---|---|---|
| 2 | **Ports by** | 10 | **Across** |
| 20 | **Pts Used** | 20 | **Required** |

| **Location of Traverse Points in Circular Stacks** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Traverse Point Number** | (Fraction of Stack Dimension from Inside Wall to Traverse Point) Number of Traverse Points Across the Stack | | | | | | | | |
| | **2** | **4** | **6** | **8** | **10** | **12** | **14** | **16** | **18** |
| **1** | .146 | .067 | .044 | .032 | .026 | .021 | .018 | .016 | .014 |
| **2** | .854 | .250 | .146 | .105 | .082 | .067 | .057 | .049 | .044 |
| **3** | | .750 | .296 | .194 | .146 | .118 | .099 | .085 | .075 |
| **4** | | .933 | .704 | .323 | .226 | .177 | .146 | .125 | .109 |
| **5** | | | .854 | .677 | .342 | .250 | .201 | .169 | .146 |
| **6** | | | .956 | .806 | .658 | .356 | .269 | .220 | .188 |
| **7** | | | | .895 | .774 | .644 | .366 | .283 | .236 |
| **8** | | | | .968 | .854 | .750 | .634 | .375 | .296 |
| **9** | | | | | .918 | .823 | .731 | .625 | .382 |
| **10** | | | | | .974 | .882 | .799 | .717 | .618 |
| **11** | | | | | | .933 | .854 | .780 | .704 |
| **12** | | | | | | .979 | .901 | .831 | .764 |

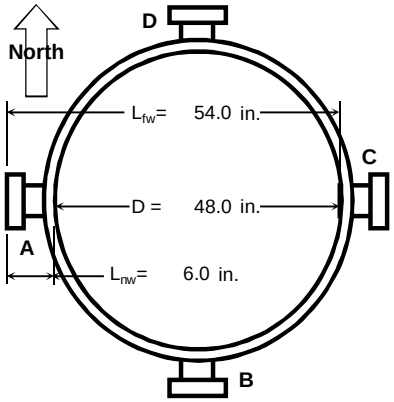
| **Traverse Point Locations** | | | |
|---|---|---|---|
| **Traverse Point Number** | **Fraction of Stack Diameter** | **Distance from Inside Wall** | **Distance Including Reference Length** |
| | | in | in |
| **1** | 0.026 | 1 2/8 | 7 2/8 |
| **2** | 0.082 | 3 7/8 | 9 7/8 |
| **3** | 0.146 | 7 | 13 |
| **4** | 0.226 | 10 7/8 | 16 7/8 |
| **5** | 0.342 | 16 3/8 | 22 3/8 |
| **6** | 0.658 | 31 5/8 | 37 5/8 |
| **7** | 0.774 | 37 1/8 | 43 1/8 |
| **8** | 0.854 | 41 | 47 |
| **9** | 0.918 | 44 1/8 | 50 1/8 |
| **10** | 0.974 | 46 6/8 | 52 6/8 |

# METHOD 1 - ISOKINETIC TRAVERSE FOR A CIRCULAR SOURCE

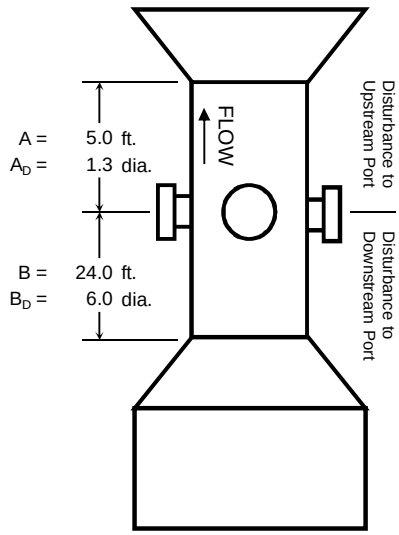
| | | | |
|---|---|---|---|
| **Company** | John Zink Co. LLC | **Date** | 03/11/14 |
| **Plant Name** | John Zink Tulsa R&D Facility | **Project #** | jz-14-tulsa.ok-comp#1 |
| **Equipment** | 4.0X30PF | **# of Ports Available** | 2 |
| **Location** | Ports | **# of Ports Used** | 2 |

| **Circular Stack or Duct Diameter** | | | |
|---|---|---|---|
| **Distance to Far Wall of Stack** | ($L_{fw}$) | 54.00 | in. |
| **Distance to Near Wall of Stack** | ($L_{nw}$) | 6.00 | in. |
| **Diameter of Stack** | (D) | 48.00 | in. |
| **Area of Stack** | ($A_s$) | 12.57 | $ft^2$ |

| **Distance from Disturbances to Port** | | | |
|---|---|---|---|
| **Distance Upstream** | (A) | 60.00 | in. |
| **Diameters Upstream** | ($A_D$) | 1.25 | diameters |
| **Distance Downstream** | (B) | 288.00 | in. |
| **Diameters Downstream** | ($B_D$) | 6.00 | diameters |

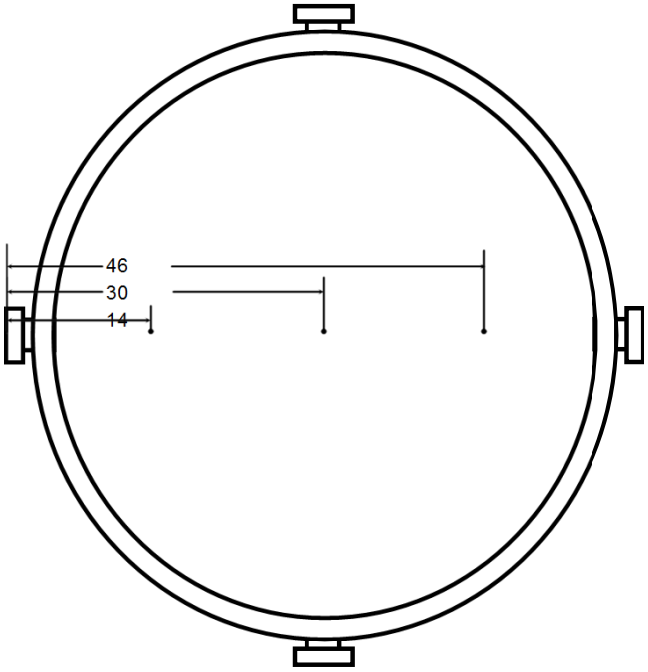



| **Number of Traverse Points Required** | | | | | |
|---|---|---|---|---|---|
| **Diameters to Flow Disturbance** | | **Minimum Number of[1] Traverse Points** | | Minimum Number of Traverse Points Comp Stratification | |
| **Down ($B_D$) Stream** | **Up ($A_D$) Stream** | **Particulate Points** | Velocity Points | Criteria | Points |
| 2.00-4.99 | 0.50-1.24 | 24 | 16 | ○ RM 7E 8.1.2 | 12 RM1 pts |
| 5.00-5.99 | 1.25-1.49 | 20 | 16 | ● OOOO Req. | 3 points |
| 6.00-6.99 | 1.50-1.74 | 16 | 12 | | |
| 7.00-7.99 | 1.75-1.99 | 12 | 12 | | |
| >= 8.00 | >=2.00 | 8 or 12[2] | 8 or 12[2] | Minimum Number of Traverse Points RATA Stratification | |
| **Upstream Spec** | | 20 | 16 | | |
| **Downstream Spec** | | 16 | 12 | | |
| **Traverse Pts Required** | | 20 | 16 | Criteria | Points |
| [1] Check Minimum Number of Points for the Upstream and Downstream conditions, then use the largest. | | | | ○ Part75/60 | 12 RM1 pts |
| | | | | ○ 75 abrv (a) | 3 points |
| [2] 8 for Circular Stacks 12 to 24 inches 12 for Circular Stacks over 24 inches | | | | ○ 75 abrv (b) | 6 points |




| **Number of Traverse Points Used** | | | | |
|---|---|---|---|---|
| 2 | **Ports by** | 3 | **Pts / port** | **Gas Sampling** |
| 1 | **Pts Used** | 3 | **Required** | |

| **Traverse Point Locations** | | | |
|---|---|---|---|
| **Traverse Point Number** | **Percent of Stack Diameter** | **Distance from Inside Wall** | **Distance Including Reference Length** |
| | % | in. | in. |
| **1** | 16.7% | 8 | 14 |
| **2** | 50.0% | 24 | 30 |
| **3** | 83.3% | 40 | 46 |
| **4** | | | |
| **5** | | | |
| **6** | | | |
| **7** | | | |
| **8** | | | |
| **9** | | | |
| **10** | | | |
| **11** | | | |
| **12** | | | |
| **13** | | | |
| **14** | | | |
| **15** | | | |
| **16** | | | |
| **17** | | | |
| **18** | | | |
| **19** | | | |
| **20** | | | |
| **21** | | | |
| **22** | | | |
| **23** | | | |
| **24** | | | |



# EMISSION DATA RECORDS

## 0-30-0% Ramp-up, Ramp-down Unit Operations Data

| METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE |
|---|

| Source Information | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Fuel Type** | Gas, Propene |

| Test Information | | | |
|---|---|---|---|
| **Project #** | | jz-14-tulsa.ok-comp#1 | |
| **Operator** | | TP | |
| **Date for Preliminary Run** | (mm/dd/yy) | 03/11/14 | |
| **Standard Temperature** | | 68 | °F |
| **Standard Pressure** | | 29.92 | in Hg |
| **Required Sample Vol.** | RM4, 8.1.1.2 | 21 | scf |
| **Run Duration** | ≤0.75 cfm | 60 | minutes |
| **Unit Number** | | 1 | |
| **Base Run Number** | | 0-30-0% | |
| **Number of Ports Available** | | 2 | |
| **Number of Ports Used** | | 2 | |
| **Port Inside Diameter** | | 4.00 | in |
| **Stack Shape** | | Circular | |

| Test Equipment Information | | | | | |
|---|---|---|---|---|---|
| **Run** | | **1** | **2** | **3** | |
| **Test Date** | (mm/dd/yy) | 03/11/14 | 03/11/14 | 03/11/14 | |
| **Load** | % or w/DB | 0-30-0 | 0-30-0 | 0-30-0 | |
| **Meter Box Number** | from ACS | SAMP-CP-0008 | SAMP-CP-0008 | SAMP-CP-0008 | |
| **Meter Calibration Factor** | (Y) | 0.924 | 0.924 | 0.924 | |
| **Orifice Meter Coefficient** | ($\Delta H_@$) | 1.700 | 1.700 | 1.700 | in $H_2O$ |
| **Pitot Identification** | from ACS | A4174 | A4174 | A4174 | |
| **Pitot Tube Coefficient** | ($C_p$) | 0.819 | 0.819 | 0.819 | |
| **Probe Number** | from ACS | SAMP-HP-0003 | SAMP-HP-0003 | SAMP-HP-0003 | |
| **Probe Length** | | 60.0 | 60.0 | 60.0 | in |
| **(SS, Glass …. ) Liner Material** | from list | inconel | inconel | inconel | |
| **Impinger Case Number** | from ACS | SAMP-BC-0012 | SAMP-BC-0012 | SAMP-BC-0012 | |

| Testing Company Information | |
|---|---|
| **Company Name** | Air Hygiene International, Inc. (Tulsa, Oklahoma) |
| **Address** | 1600 W Tacoma Street |
| **City, State Zip** | Broken Arrow, Oklahoma 74012 |
| **Project Manager** | Min Sum Lee |
| **Phone Number** | (918) 307-8865 |
| **Fax Number** | (918) 307-9131 |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] - RESULTS

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| **Historical Data** | **0-30-0%-1** | **0-30-0%-2** | **0-30-0%-3** | **Average** | **Units** |
|---|---|---|---|---|---|
| Run Start Time | 13:16 | 15:27 | 16:48 | | hh:mm |
| Run Stop Time | 14:20 | 16:31 | 17:53 | | hh:mm |
| Test Date | 03/11/14 | 03/11/14 | 03/11/14 | | mm/dd/yy |
| Meter Calibration Factor | 0.924 | 0.924 | 0.924 | | |
| Pitot Tube Coefficient | 0.819 | 0.819 | 0.819 | | |
| Initial Meter Volume | 870.231 | 919.614 | 968.243 | | $ft^3$ |
| Final Meter Volume | 919.480 | 968.007 | 1017.562 | | $ft^3$ |
| Total Meter Volume | 49.249 | 48.393 | 49.319 | 48.987 | $ft^3$ |
| Total Sampling Time | 60.00 | 60.00 | 60.00 | 60.00 | min |
| Average Meter Temperature | 75.55 | 78.40 | 79.95 | 77.97 | °F |
| Average Stack Temperature | 1285.70 | 1387.75 | 1403.00 | 1358.82 | °F |
| Barometric Pressure | 29.49 | 29.41 | 29.40 | 29.43 | in Hg |
| Stack Static Pressure | 0.00 | 0.00 | 0.00 | 0.00 | in $H_2O$ |
| Absolute Stack Pressure | 29.49 | 29.41 | 29.40 | 29.43 | in Hg |
| Average Orifice Pressure Drop | 1.70 | 1.70 | 1.70 | 1.70 | in $H_2O$ |
| Absolute Meter Pressure | 29.62 | 29.54 | 29.53 | 29.56 | in Hg |
| Avg Square Root Pitot Pressure | 0.08 | 0.07 | 0.07 | 0.07 | √(in $H_2O$) |
| **Moisture Content Data** | **0-30-0%-1** | **0-30-0%-2** | **0-30-0%-3** | **Average** | **Units** |
| Impinger Water Weight Gain | 60.40 | 54.60 | 48.80 | 54.60 | g |
| Silica Gel Weight Gain | 13.60 | 8.20 | 3.50 | 8.43 | g |
| Total Water Volume Collected | 74.13 | 62.91 | 52.39 | 63.15 | ml |
| Standard Water Vapor Volume | 3.49 | 2.96 | 2.47 | 2.97 | scf |
| Standard Meter Volume | 44.4 | 43.3 | 44.0 | 43.9 | dscf |
| Calculated Stack Moisture | 7.28 | 6.40 | 5.31 | 6.33 | % |
| Saturated Stack Moisture | 100.00 | 100.00 | 100.00 | 100.00 | % |
| Reported Stack Moisture Content | 7.28 | 6.40 | 5.31 | 6.33 | % |
| **Method 3C Gas Analysis Data** | **0-30-0%-1** | **0-30-0%-2** | **0-30-0%-3** | **Average** | **Units** |
| Carbon Dioxide Content | 5.9 | 5.9 | 5.5 | 5.8 | % |
| Oxygen Content | 14.0 | 14.0 | 14.6 | 14.2 | % |
| Nitrogen Content | 80.1 | 80.1 | 79.9 | 80.0 | % |
| Stack Dry Molecular Weight | 29.51 | 29.51 | 29.47 | 29.49 | lb/lb-mole |
| Stack Wet Molecular Weight | 28.67 | 28.77 | 28.86 | 28.77 | lb/lb-mole |
| Percent Excess Air | 196.0 | 196.0 | 225.1 | 205.7 | % |
| **Volumetric Flow Rate Data** | **0-30-0%-1** | **0-30-0%-2** | **0-30-0%-3** | **Average** | **Units** |
| Average Stack Gas Velocity | 7.74 | 7.63 | 7.34 | 7.57 | ft/sec |
| Stack Cross-Sectional Area | 12.57 | 12.57 | 12.57 | 12.57 | $ft^2$ |
| Actual Stack Flow Rate | 5,834 | 5,750 | 5,532 | 5,705 | acfm |
| Wet Standard Stack Flow Rate | 104 | 97 | 92 | 98 | wkscfh |
| Dry Standard Stack Flow Rate | 96,745 | 90,702 | 87,523 | 91,656 | dscfh |

## METHOD 3C - DETERMINATION OF DRY MOLECULAR WEIGHT BY ANALYZER

| | | | | | |
|---|---|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Preliminary Date** | 03/11/14 | | |
| **Sampling Location** | 4.0X30PF | **Operator** | TP | | |
| **Project #** | jz-14-tulsa.ok-comp#1 | **# of Ports Used** | 2 | | |
| **Fuel Type** | Gas, Propene | **Min. Fuel Factor** | N/A | **Max. Fuel Factor** | N/A |

| **Gas Analysis Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 0-30-0%-1 | | **Date** | 03/11/14 | **Run Start Time** | 13:16 | | **Run Stop Time** | 14:20 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:04 | 5.9 | 14.0 | 0.0 | 80.1 | 29.51 | 1.168 | | 196.0 | N/A |

| **Gas Analysis Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 0-30-0%-2 | | **Date** | 03/11/14 | **Run Start Time** | 15:27 | | **Run Stop Time** | 16:31 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:04 | 5.9 | 14.0 | 0.0 | 80.1 | 29.51 | 1.168 | | 196.0 | N/A |

| **Gas Analysis Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 0-30-0%-3 | | **Date** | 03/11/14 | **Run Start Time** | 16:48 | | **Run Stop Time** | 17:53 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:05 | 5.5 | 14.6 | 0.0 | 79.9 | 29.47 | 1.139 | | 225.1 | N/A |

## METHOD 4 - DETERMINATION OF MOISTURE CONTENT IN STACK GASES

| | | | |
|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Preliminary Date** | 03/11/14 |
| **Sampling Location** | 4.0X30PF | **Operator** | TP |
| **Project #** | jz-14-tulsa.ok-comp#1 | **Ports Used** | 2 |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 0-30-0%-1 | | **Date** | 03/11/14 | **Start Time** | 13:16 | **Stop Time** | 14:20 |
| **Meter Box Number** | | SAMP-CP-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 49.249 | dcf | | **Barometric Pressure** | ($P_b$) | 29.49 | in Hg |
| **Average Stack Temp** | | ($t_s$)$_{avg}$ | 1286 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | ($t_m$)$_{avg}$ | 76 | °F | | **Avg Orifice Pressure** | ($\Delta H$)$_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 717.30 | 730.70 | 577.70 | 862.40 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 677.40 | 716.10 | 571.80 | 848.80 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 39.9 | 14.6 | 5.9 | 13.6 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 74.00 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 3.489 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 44.407 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 7.28 | % | | **Final Moisture Content** | ($B_{ws}$) | 7.28 | % |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 0-30-0%-2 | | **Date** | 03/11/14 | **Start Time** | 15:27 | **Stop Time** | 16:31 |
| **Meter Box Number** | | SAMP-CP-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 48.393 | dcf | | **Barometric Pressure** | ($P_b$) | 29.41 | in Hg |
| **Average Stack Temp** | | ($t_s$)$_{avg}$ | 1388 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | ($t_m$)$_{avg}$ | 78 | °F | | **Avg Orifice Pressure** | ($\Delta H$)$_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 735.10 | 691.10 | 591.60 | 798.90 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 694.70 | 679.50 | 589.00 | 790.70 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 40.4 | 11.6 | 2.6 | 8.2 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 62.80 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.961 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 43.287 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 6.40 | % | | **Final Moisture Content** | ($B_{ws}$) | 6.40 | % |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 0-30-0%-3 | | **Date** | 03/11/14 | **Start Time** | 16:48 | **Stop Time** | 17:53 |
| **Meter Box Number** | | SAMP-CP-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 49.319 | dcf | | **Barometric Pressure** | ($P_b$) | 29.40 | in Hg |
| **Average Stack Temp** | | ($t_s$)$_{avg}$ | 1403 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | ($t_m$)$_{avg}$ | 80 | °F | | **Avg Orifice Pressure** | ($\Delta H$)$_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 756.10 | 739.10 | 579.30 | 865.90 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 717.30 | 730.70 | 577.70 | 862.40 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 38.8 | 8.4 | 1.6 | 3.5 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 52.30 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.466 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 43.974 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 5.31 | % | | **Final Moisture Content** | ($B_{ws}$) | 5.31 | % |

**METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA**

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/11/14 |
| **Operator** | TP |
| **Run Number** | 0-30-0%-1 |

| **Ideal Nozzle Diameter and IsoKinetic Factor Setup** | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1285.7 | °F |
| **Average Meter Temp** | ($t_m$) | 75.6 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.08 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 7.28 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.51 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.75 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| **Leak Checks** | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.2 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.1 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.1 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.2 | in $H_2O$ for | 15.0 | sec |

| **Sampling Equipment** | | | |
|---|---|---|---|
| **Meter Box Number** | SAMP-CP-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.5182 | in |
| **Probe Number** | SAMP-HP-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | SAMP-BC-0012 | | |

| **Pressures** | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 29.49 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 29.49 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 29.62 | in Hg |

| **Nozzle Measurements** | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| **Run Time** | | | |
|---|---|---|---|
| **Start** | 13:16 | **End** | 14:20 |

| **Weights** | **Imp 1** | **Imp 2** | **Imp 3** | **Imp 4** | **Imp 5** | **Imp 6** | **Imp 7** | **Imp 8** |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 677.4 | 716.1 | 571.8 | 848.8 | | | | |
| **Post** | 717.3 | 730.7 | 577.7 | 862.4 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| **Traverse Point #** | **Sampling Time (Θ)** | **Timer Time** | **Dry Gas Meter Reading ($V_m$)** | **Velocity Head (Δp)** | **Desired Orifice ΔH ($\Delta H_d$)** | **Actual Orifice ΔH ($\Delta H_a$)** | **Stack Temp ($t_s$)** | **Snorkel Temp (248±25°F)** | **Filter Temp (248±25°F)** | **Impinger Exit Temp (≤68°F)** | **Cond. Temp (≤--°F)** | **CPM Filter Temp (--±--°F)** | **Meter Inlet Temp ($t_{mi}$)** | **Meter Outlet Temp ($t_{mo}$)** | **Pump Vacuum** | **Square Root ΔP ($\Delta p^{1/2}$)** | **Local Stack Velocity ($v_s$)$_l$** | **Cumul. Meter Volume ($V_m$)$_{std}$** | **Cumul. Percent IsoKinetic (I)** | **Est-Run Meter Volume ($V_m$)$_{std}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 870.231 | 0.005 | 1.700 | 1.70 | 1200 | 240 | | 68 | | | 75 | 72 | 3.0 | 0.07 | 6.94 | 2.099 | | 41.981 |
| A-2 | 3.0 | 00:03:00 | 872.550 | 0.005 | 1.700 | 1.70 | 1420 | 240 | | 61 | | | 75 | 71 | 3.0 | 0.07 | 7.39 | 4.500 | | 45.000 |
| A-3 | 6.0 | 00:06:00 | 875.200 | 0.005 | 1.700 | 1.70 | 1436 | 240 | | 60 | | | 76 | 71 | 3.0 | 0.07 | 7.42 | 6.527 | | 43.517 |
| A-4 | 9.0 | 00:09:00 | 877.440 | 0.008 | 1.700 | 1.70 | 1391 | 240 | | 61 | | | 77 | 71 | 3.0 | 0.09 | 8.98 | 8.815 | | 44.077 |
| A-5 | 12.0 | 00:12:00 | 879.970 | 0.005 | 1.700 | 1.70 | 1349 | 240 | | 63 | | | 78 | 71 | 2.5 | 0.07 | 7.25 | 11.056 | | 44.224 |
| A-6 | 15.0 | 00:15:00 | 882.450 | 0.005 | 1.700 | 1.70 | 1084 | 240 | | 62 | | | 78 | 71 | 2.5 | 0.07 | 6.69 | 13.111 | | 43.704 |
| A-7 | 18.0 | 00:18:00 | 884.725 | 0.005 | 1.700 | 1.70 | 1289 | 240 | | 61 | | | 80 | 72 | 2.5 | 0.07 | 7.12 | 15.305 | | 43.729 |
| A-8 | 21.0 | 00:21:00 | 887.160 | 0.005 | 1.700 | 1.70 | 1256 | 240 | | 61 | | | 80 | 72 | 2.5 | 0.07 | 7.06 | 17.490 | | 43.725 |
| A-9 | 24.0 | 00:24:00 | 889.585 | 0.003 | 1.700 | 1.70 | 1305 | 240 | | 61 | | | 80 | 72 | 2.5 | 0.05 | 5.54 | 20.549 | | 45.663 |
| A-10 | 27.0 | 00:27:00 | 892.980 | 0.001 | 1.700 | 1.70 | 1248 | 240 | | 63 | | | 81 | 73 | 2.5 | 0.03 | 3.15 | 21.894 | | 43.788 |
| B-1 | 30.0 | 00:30:00 | 894.476 | 0.003 | 1.700 | 1.70 | 1350 | 240 | | 65 | | | 78 | 74 | 10.0 | 0.05 | 5.61 | 24.123 | | 43.859 |
| B-2 | 33.0 | 00:33:00 | 896.950 | 0.005 | 1.700 | 1.70 | 1432 | 240 | | 63 | | | 80 | 74 | 2.5 | 0.07 | 7.41 | 26.303 | | 43.839 |
| B-3 | 36.0 | 00:36:00 | 899.375 | 0.005 | 1.700 | 1.70 | 1437 | 240 | | 64 | | | 79 | 74 | 2.5 | 0.07 | 7.42 | 28.891 | | 44.448 |
| B-4 | 39.0 | 00:39:00 | 902.250 | 0.005 | 1.700 | 1.70 | 1331 | 240 | | 65 | | | 80 | 73 | 2.5 | 0.07 | 7.21 | 30.736 | | 43.909 |
| B-5 | 42.0 | 00:42:00 | 904.300 | 0.010 | 1.700 | 1.70 | 1166 | 240 | | 65 | | | 80 | 73 | 2.5 | 0.10 | 9.71 | 32.870 | | 43.826 |
| B-6 | 45.0 | 00:45:00 | 906.670 | 0.005 | 1.700 | 1.70 | 1200 | 240 | | 65 | | | 79 | 73 | 2.5 | 0.07 | 6.94 | 35.081 | | 43.852 |
| B-7 | 48.0 | 00:48:00 | 909.125 | 0.005 | 1.700 | 1.70 | 1198 | 240 | | 66 | | | 79 | 73 | 2.5 | 0.07 | 6.94 | 37.356 | | 43.948 |
| B-8 | 51.0 | 00:51:00 | 911.650 | 0.005 | 1.700 | 1.70 | 1188 | 240 | | 66 | | | 79 | 73 | 2.5 | 0.07 | 6.92 | 39.541 | | 43.934 |
| B-9 | 54.0 | 00:54:00 | 914.075 | 0.005 | 1.700 | 1.70 | 1215 | 240 | | 66 | | | 80 | 73 | 2.5 | 0.07 | 6.97 | 41.769 | | 43.967 |
| B-10 | 57.0 | 00:57:00 | 916.550 | 0.050 | 1.700 | 1.70 | 1219 | 240 | | 66 | | | 80 | 72 | 2.5 | 0.22 | 22.07 | 44.408 | | 44.408 |
| Last Pt | 60.0 | 01:00:00 | 919.480 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 919.480 | | | | | | | | | | | **Max Vac** | 10.0 | **Final Values** | | 44.408 | | |
| **Average Values** | | | | 0.01 | | 1.70 | 1286 | 240 | | 64 | | | 79 | 72 | | 0.08 | 7.74 | | | |
| | | | | | | | | | | | | | 76 | | | | | | | |

**METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA**

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/11/14 |
| **Operator** | TP |
| **Run Number** | 0-30-0%-2 |

| **Ideal Nozzle Diameter and IsoKinetic Factor Setup** | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1387.8 | °F |
| **Average Meter Temp** | ($t_m$) | 78.4 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.07 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 6.40 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.51 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.74 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| **Leak Checks** | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 1.5 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 1.5 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 1.0 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 1.0 | in $H_2O$ for | 15.0 | sec |

| **Sampling Equipment** | | | |
|---|---|---|---|
| **Meter Box Number** | SAMP-CP-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.5268 | in |
| **Probe Number** | SAMP-HP-0004 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | SAMP-BC-0012 | | |

| **Pressures** | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 29.41 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 29.41 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 29.54 | in Hg |

| **Nozzle Measurements** | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| **Run Time** | | | |
|---|---|---|---|
| **Start** | 15:27 | **End** | 16:31 |

| **Weights** | **Imp 1** | **Imp 2** | **Imp 3** | **Imp 4** | **Imp 5** | **Imp 6** | **Imp 7** | **Imp 8** |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 694.7 | 679.5 | 589.0 | 790.7 | | | | |
| **Post** | 735.1 | 691.1 | 591.6 | 798.9 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| **Traverse Point #** | **Sampling Time (Θ)** | **Timer Time** | **Dry Gas Meter Reading ($V_m$)** | **Velocity Head (Δp)** | **Desired Orifice ΔH ($\Delta H_d$)** | **Actual Orifice ΔH ($\Delta H_a$)** | **Stack Temp ($t_s$)** | **Snorkel Temp (248±25°F)** | **Filter Temp (248±25°F)** | **Impinger Exit Temp (≤68°F)** | **Cond. Temp (≤--°F)** | **CPM Filter Temp (--±--°F)** | **Meter Inlet Temp ($t_{mi}$)** | **Meter Outlet Temp ($t_{mo}$)** | **Pump Vacuum** | **Square Root ΔP ($\Delta p^{1/2}$)** | **Local Stack Velocity ($v_s$)$_l$** | **Cumul. Meter Volume ($V_m$)$_{std}$** | **Cumul. Percent IsoKinetic (I)** | **Est-Run Meter Volume ($V_m$)$_{std}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 919.614 | 0.005 | 1.700 | 1.70 | 1130 | 240 | | 66 | | | 79 | 74 | 3.5 | 0.07 | 6.79 | 2.223 | | 44.452 |
| A-2 | 3.0 | 00:03:00 | 922.090 | 0.005 | 1.700 | 1.70 | 1475 | 240 | | 68 | | | 82 | 74 | 3.5 | 0.07 | 7.49 | 4.371 | | 43.710 |
| A-3 | 6.0 | 00:06:00 | 924.490 | 0.010 | 1.700 | 1.70 | 1450 | 240 | | 68 | | | 82 | 74 | 3.5 | 0.10 | 10.52 | 6.519 | | 43.462 |
| A-4 | 9.0 | 00:09:00 | 926.890 | 0.010 | 1.700 | 1.70 | 1489 | 240 | | 66 | | | 83 | 74 | 3.5 | 0.10 | 10.63 | 8.751 | | 43.753 |
| A-5 | 12.0 | 00:12:00 | 929.385 | 0.005 | 1.700 | 1.70 | 1337 | 240 | | 63 | | | 82 | 74 | 3.5 | 0.07 | 7.22 | 10.854 | | 43.417 |
| A-6 | 15.0 | 00:15:00 | 931.735 | 0.005 | 1.700 | 1.70 | 1336 | 240 | | 62 | | | 83 | 74 | 3.5 | 0.07 | 7.22 | 12.996 | | 43.321 |
| A-7 | 18.0 | 00:18:00 | 934.130 | 0.005 | 1.700 | 1.70 | 1505 | 240 | | 63 | | | 80 | 74 | 3.5 | 0.07 | 7.55 | 15.199 | | 43.425 |
| A-8 | 21.0 | 00:21:00 | 936.586 | 0.005 | 1.700 | 1.70 | 1420 | 240 | | 57 | | | 81 | 74 | 3.5 | 0.07 | 7.38 | 17.451 | | 43.628 |
| A-9 | 24.0 | 00:24:00 | 939.100 | 0.005 | 1.700 | 1.70 | 1489 | 240 | | 60 | | | 81 | 74 | 3.5 | 0.07 | 7.52 | 19.647 | | 43.659 |
| A-10 | 27.0 | 00:27:00 | 941.550 | 0.005 | 1.700 | 1.70 | 1435 | 240 | | 61 | | | 83 | 74 | 3.5 | 0.07 | 7.41 | 21.797 | | 43.595 |
| B-1 | 30.0 | 00:30:00 | 943.955 | 0.005 | 1.700 | 1.70 | 1426 | 240 | | 60 | | | 80 | 74 | 3.5 | 0.07 | 7.40 | 23.766 | | 43.211 |
| B-2 | 33.0 | 00:33:00 | 946.150 | 0.005 | 1.700 | 1.70 | 1473 | 240 | | 61 | | | 83 | 75 | 3.5 | 0.07 | 7.49 | 25.950 | | 43.251 |
| B-3 | 36.0 | 00:36:00 | 948.595 | 0.005 | 1.700 | 1.70 | 1430 | 240 | | 61 | | | 83 | 74 | 3.5 | 0.07 | 7.40 | 28.048 | | 43.150 |
| B-4 | 39.0 | 00:39:00 | 950.940 | 0.005 | 1.700 | 1.70 | 1369 | 240 | | 61 | | | 83 | 75 | 3.5 | 0.07 | 7.28 | 30.335 | | 43.336 |
| B-5 | 42.0 | 00:42:00 | 953.500 | 0.005 | 1.700 | 1.70 | 1190 | 240 | | 62 | | | 83 | 75 | 3.5 | 0.07 | 6.92 | 32.390 | | 43.187 |
| B-6 | 45.0 | 00:45:00 | 955.800 | 0.005 | 1.700 | 1.70 | 1174 | 240 | | 62 | | | 84 | 75 | 3.5 | 0.07 | 6.88 | 34.640 | | 43.299 |
| B-7 | 48.0 | 00:48:00 | 958.320 | 0.005 | 1.700 | 1.70 | 1473 | 240 | | 62 | | | 84 | 75 | 3.5 | 0.07 | 7.49 | 36.737 | | 43.220 |
| B-8 | 51.0 | 00:51:00 | 960.670 | 0.005 | 1.700 | 1.70 | 1464 | 240 | | 62 | | | 84 | 75 | 3.5 | 0.07 | 7.47 | 39.098 | | 43.443 |
| B-9 | 54.0 | 00:54:00 | 963.315 | 0.005 | 1.700 | 1.70 | 1440 | 240 | | 63 | | | 84 | 75 | 3.5 | 0.07 | 7.42 | 41.094 | | 43.256 |
| B-10 | 57.0 | 00:57:00 | 965.550 | 0.005 | 1.700 | 1.70 | 1250 | 240 | | 63 | | | 84 | 75 | 3.5 | 0.07 | 7.04 | 43.287 | | 43.287 |
| Last Pt | 60.0 | 01:00:00 | 968.007 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 968.007 | | | | | | | | | | | **Max Vac** | 3.5 | **Final Values** | | 43.287 | | |
| **Average Values** | | | | 0.01 | | 1.70 | 1388 | 240 | | 63 | | | 82 | 74 | | 0.07 | 7.63 | | | |
| | | | | | | | | | | | | | 78 | | | | | | | |

**METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA**

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/11/14 |
| **Operator** | TP |
| **Run Number** | 0-30-0%-3 |

| Ideal Nozzle Diameter and IsoKinetic Factor Setup | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1403.0 | °F |
| **Average Meter Temp** | ($t_m$) | 80.0 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.07 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 5.31 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.47 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.72 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| Leak Checks | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.2 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.3 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.1 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.2 | in $H_2O$ for | 15.0 | sec |

| Sampling Equipment | | | |
|---|---|---|---|
| **Meter Box Number** | SAMP-CP-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.5261 | in |
| **Probe Number** | SAMP-HP-0005 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | SAMP-BC-0012 | | |

| Pressures | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 29.40 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 29.40 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 29.53 | in Hg |

| Nozzle Measurements | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| Run Time | | | |
|---|---|---|---|
| **Start** | 16:48 | **End** | 17:53 |

| Weights | Imp 1 | Imp 2 | Imp 3 | Imp 4 | Imp 5 | Imp 6 | Imp 7 | Imp 8 |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 717.3 | 730.7 | 577.7 | 862.4 | | | | |
| **Post** | 756.1 | 739.1 | 579.3 | 865.9 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| Traverse Point # | Sampling Time (Θ) | Timer Time | Dry Gas Meter Reading ($V_m$) | Velocity Head (Δp) | Desired Orifice ΔH ($\Delta H_d$) | Actual Orifice ΔH ($\Delta H_a$) | Stack Temp ($t_s$) | Snorkel Temp (248±25°F) | Filter Temp (248±25°F) | Impinger Exit Temp (≤68°F) | Cond. Temp (≤--°F) | CPM Filter Temp (--±--°F) | Meter Inlet Temp ($t_{mi}$) | Meter Outlet Temp ($t_{mo}$) | Pump Vacuum | Square Root ΔP ($\Delta p^{1/2}$) | Local Stack Velocity ($v_s$)$_l$ | Cumul. Meter Volume ($V_m$)$_{std}$ | Cumul. Percent IsoKinetic (I) | Est-Run Meter Volume ($V_m$)$_{std}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 968.243 | 0.005 | 1.700 | 1.70 | 1337 | 240 | | 58 | | | 83 | 76 | 2.5 | 0.07 | 7.21 | 2.340 | | 46.796 |
| A-2 | 3.0 | 00:03:00 | 970.865 | 0.005 | 1.700 | 1.70 | 1430 | 240 | | 56 | | | 86 | 76 | 2.5 | 0.07 | 7.39 | 4.640 | | 46.402 |
| A-3 | 6.0 | 00:06:00 | 973.450 | 0.005 | 1.700 | 1.70 | 1472 | 240 | | 57 | | | 85 | 76 | 2.5 | 0.07 | 7.47 | 6.618 | | 44.117 |
| A-4 | 9.0 | 00:09:00 | 975.670 | 0.005 | 1.700 | 1.70 | 1508 | 240 | | 58 | | | 86 | 76 | 2.5 | 0.07 | 7.54 | 8.682 | | 43.410 |
| A-5 | 12.0 | 00:12:00 | 977.990 | 0.005 | 1.700 | 1.70 | 1514 | 240 | | 59 | | | 84 | 77 | 2.5 | 0.07 | 7.56 | 10.847 | | 43.386 |
| A-6 | 15.0 | 00:15:00 | 980.420 | 0.005 | 1.700 | 1.70 | 1251 | 240 | | 60 | | | 84 | 77 | 2.5 | 0.07 | 7.03 | 13.096 | | 43.652 |
| A-7 | 18.0 | 00:18:00 | 982.945 | 0.005 | 1.700 | 1.70 | 1461 | 240 | | 60 | | | 85 | 76 | 2.5 | 0.07 | 7.45 | 15.385 | | 43.956 |
| A-8 | 21.0 | 00:21:00 | 985.515 | 0.005 | 1.700 | 1.70 | 1459 | 240 | | 60 | | | 86 | 77 | 2.5 | 0.07 | 7.45 | 17.812 | | 44.530 |
| A-9 | 24.0 | 00:24:00 | 988.245 | 0.005 | 1.700 | 1.70 | 1422 | 240 | | 60 | | | 84 | 77 | 2.5 | 0.07 | 7.38 | 19.976 | | 44.392 |
| A-10 | 27.0 | 00:27:00 | 990.675 | 0.005 | 1.700 | 1.70 | 1202 | 240 | | 61 | | | 84 | 77 | 2.5 | 0.07 | 6.93 | 21.958 | | 43.916 |
| B-1 | 30.0 | 00:30:00 | 992.900 | 0.005 | 1.700 | 1.70 | 1452 | 240 | | 63 | | | 80 | 76 | 2.5 | 0.07 | 7.44 | 24.253 | | 44.097 |
| B-2 | 33.0 | 00:33:00 | 995.465 | 0.005 | 1.700 | 1.70 | 1471 | 240 | | 60 | | | 84 | 76 | 2.5 | 0.07 | 7.47 | 26.357 | | 43.929 |
| B-3 | 36.0 | 00:36:00 | 997.825 | 0.005 | 1.700 | 1.70 | 1474 | 240 | | 61 | | | 84 | 77 | 2.5 | 0.07 | 7.48 | 28.602 | | 44.003 |
| B-4 | 39.0 | 00:39:00 | 1000.345 | 0.005 | 1.700 | 1.70 | 1299 | 240 | | 62 | | | 84 | 76 | 2.5 | 0.07 | 7.13 | 30.702 | | 43.860 |
| B-5 | 42.0 | 00:42:00 | 1002.700 | 0.005 | 1.700 | 1.70 | 1312 | 240 | | 61 | | | 84 | 76 | 2.5 | 0.07 | 7.16 | 32.975 | | 43.967 |
| B-6 | 45.0 | 00:45:00 | 1005.250 | 0.005 | 1.700 | 1.70 | 1513 | 240 | | 61 | | | 83 | 76 | 2.5 | 0.07 | 7.55 | 35.103 | | 43.879 |
| B-7 | 48.0 | 00:48:00 | 1007.635 | 0.005 | 1.700 | 1.70 | 1529 | 240 | | 61 | | | 82 | 75 | 2.5 | 0.07 | 7.58 | 37.289 | | 43.870 |
| B-8 | 51.0 | 00:51:00 | 1010.080 | 0.005 | 1.700 | 1.70 | 1484 | 240 | | 62 | | | 82 | 75 | 2.5 | 0.07 | 7.50 | 39.529 | | 43.921 |
| B-9 | 54.0 | 00:54:00 | 1012.585 | 0.005 | 1.700 | 1.70 | 1280 | 240 | | 61 | | | 83 | 75 | 2.5 | 0.07 | 7.09 | 41.909 | | 44.115 |
| B-10 | 57.0 | 00:57:00 | 1015.250 | 0.005 | 1.700 | 1.70 | 1190 | 240 | | 62 | | | 83 | 75 | 2.5 | 0.07 | 6.91 | 43.974 | | 43.974 |
| Last Pt | 60.0 | 01:00:00 | 1017.562 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 1017.562 | | | | | | | | | | | **Max Vac** | 2.5 | **Final Values** | | 43.974 | | |
| **Average Values** | | | | 0.01 | | 1.70 | 1403 | 240 | | 60 | | | 84 | 76 | | 0.07 | 7.34 | | | |
| | | | | | | | | | | | | | 80 | | | | | | | |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 7.3 | % |
| Stack Exhaust Flow (M2) | 86,125 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.49 | in. Hg |
| Relative Humidity | 32 | % |
| Ambient Temperature | 83 | $^{o}$F |
| Specific Humidity | 0.007782 | lb $H_2O$ / lb air |

0-30-0 Load, Run - 4.0X30PF R1

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/11/14 13:16:00 | 85770 | 12.18 | 8.83 | 0.24 | 6.31 | 4.43 | 86.82 | 525.16 |
| | 03/11/14 13:16:30 | 85800 | 12.83 | 8.99 | 0.34 | 5.95 | 4.43 | 86.82 | 524.76 |
| | 03/11/14 13:17:00 | 85830 | 11.99 | 10.07 | 0.35 | 6.48 | 4.43 | 86.37 | 525.16 |
| | 03/11/14 13:17:30 | 85860 | 12.39 | 9.53 | 0.26 | 6.24 | 4.43 | 85.92 | 524.43 |
| | 03/11/14 13:18:00 | 85890 | 12.80 | 7.38 | 0.22 | 6.03 | 15.22 | 85.92 | 796.30 |
| | 03/11/14 13:18:30 | 85920 | 13.82 | 6.53 | 0.10 | 5.23 | 27.13 | 86.37 | 1,275.58 |
| | 03/11/14 13:19:00 | 85950 | 13.31 | 8.33 | 0.09 | 5.42 | 28.23 | 87.27 | 1,298.59 |
| | 03/11/14 13:19:30 | 85980 | 12.40 | 4.71 | 0.08 | 6.23 | 27.13 | 87.72 | 1,284.40 |
| | 03/11/14 13:20:00 | 86010 | 12.34 | 3.02 | 0.08 | 6.33 | 27.13 | 87.72 | 1,305.08 |
| | 03/11/14 13:20:30 | 86040 | 12.64 | 1.76 | 0.08 | 6.08 | 27.13 | 88.17 | 1,299.18 |
| | 03/11/14 13:21:00 | 86070 | 12.72 | 0.90 | 0.09 | 6.05 | 27.13 | 88.17 | 1,301.85 |
| | 03/11/14 13:21:30 | 86100 | 12.98 | 0.44 | 0.08 | 5.86 | 27.13 | 88.62 | 1,299.40 |
| | 03/11/14 13:22:00 | 86130 | 12.82 | 0.36 | 0.07 | 5.92 | 27.13 | 88.62 | 1,298.90 |
| | 03/11/14 13:22:30 | 86160 | 12.70 | 0.11 | 0.08 | 5.99 | 27.13 | 89.07 | 1,295.79 |
| | 03/11/14 13:23:00 | 86190 | 12.75 | -0.05 | 0.08 | 5.99 | 27.68 | 89.07 | 1,298.80 |
| | 03/11/14 13:23:30 | 86220 | 12.84 | -0.14 | 0.08 | 5.93 | 26.57 | 89.52 | 1,300.32 |
| | 03/11/14 13:24:00 | 86250 | 12.80 | -0.01 | 0.09 | 5.95 | 26.57 | 89.52 | 1,296.46 |
| | 03/11/14 13:24:30 | 86280 | 12.81 | -0.05 | 0.08 | 5.95 | 26.57 | 89.52 | 1,297.75 |
| | 03/11/14 13:25:00 | 86310 | 12.93 | -0.13 | 0.07 | 5.84 | 26.57 | 89.07 | 1,298.85 |
| | 03/11/14 13:25:30 | 86340 | 12.83 | -0.09 | 0.07 | 5.93 | 26.57 | 89.07 | 1,296.92 |
| | 03/11/14 13:26:00 | 86370 | 12.85 | -0.20 | 0.08 | 5.88 | 26.57 | 89.52 | 1,295.55 |
| | 03/11/14 13:26:30 | 86400 | 12.87 | -0.15 | 0.07 | 5.92 | 26.57 | 89.52 | 1,292.59 |
| | 03/11/14 13:27:00 | 86430 | 12.95 | -0.13 | 0.08 | 5.84 | 26.57 | 89.52 | 1,291.58 |
| | 03/11/14 13:27:30 | 86460 | 12.80 | -0.08 | 0.08 | 5.92 | 26.57 | 89.52 | 1,293.74 |
| | 03/11/14 13:28:00 | 86490 | 12.85 | -0.02 | 0.08 | 5.92 | 27.13 | 89.52 | 1,301.43 |
| | 03/11/14 13:28:30 | 86520 | 12.68 | -0.22 | 0.07 | 6.02 | 26.57 | 89.07 | 1,304.56 |
| | 03/11/14 13:29:00 | 86550 | 12.65 | -0.20 | 0.08 | 6.07 | 26.57 | 89.07 | 1,298.96 |
| | 03/11/14 13:29:30 | 86580 | 13.24 | 0.06 | 0.09 | 5.84 | 2.77 | 88.62 | 494.26 |
| | 03/11/14 13:30:00 | 86610 | 14.95 | 12.02 | 0.11 | 4.28 | 3.88 | 88.17 | 526.73 |
| | 03/11/14 13:30:30 | 86640 | 13.58 | 10.80 | 0.17 | 5.44 | 4.43 | 87.72 | 523.10 |
| | 03/11/14 13:31:00 | 86670 | 13.20 | 0.30 | 0.27 | 5.56 | 4.43 | 87.72 | 525.90 |
| | 03/11/14 13:31:30 | 86700 | 12.13 | 1.11 | 0.23 | 6.35 | 4.43 | 87.72 | 525.22 |
| | 03/11/14 13:32:00 | 86730 | 11.03 | 0.28 | 0.17 | 7.01 | 4.43 | 87.72 | 523.74 |
| | 03/11/14 13:32:30 | 86760 | 13.17 | -0.30 | 0.32 | 5.82 | 23.25 | 88.17 | 898.09 |
| | 03/11/14 13:33:00 | 86790 | 11.89 | -0.30 | 0.13 | 6.48 | 28.79 | 89.07 | 1,306.64 |
| | 03/11/14 13:33:30 | 86820 | 12.01 | -0.46 | 0.07 | 6.54 | 27.68 | 89.52 | 1,301.51 |
| | 03/11/14 13:34:00 | 86850 | 12.46 | -0.46 | 0.07 | 6.25 | 27.68 | 89.52 | 1,301.76 |
| | 03/11/14 13:34:30 | 86880 | 12.10 | -0.45 | 0.05 | 6.47 | 27.68 | 89.97 | 1,299.90 |
| | 03/11/14 13:35:00 | 86910 | 12.20 | -0.46 | 0.08 | 6.40 | 27.68 | 89.97 | 1,302.02 |
| | 03/11/14 13:35:30 | 86940 | 12.27 | -0.46 | 0.08 | 6.34 | 27.68 | 90.42 | 1,298.62 |
| | 03/11/14 13:36:00 | 86970 | 12.15 | -0.42 | 0.06 | 6.40 | 27.13 | 90.87 | 1,301.96 |
| A2 | 03/11/14 13:36:30 | 87000 | 12.01 | -0.40 | 0.05 | 6.47 | 27.13 | 90.87 | 1,299.08 |
| | 03/11/14 13:37:00 | 87030 | 12.33 | -0.40 | 0.08 | 6.35 | 27.13 | 90.87 | 1,296.87 |
| | 03/11/14 13:37:30 | 87060 | 12.46 | -0.32 | 0.07 | 6.18 | 27.13 | 90.87 | 1,297.97 |
| | 03/11/14 13:38:00 | 87090 | 12.31 | -0.45 | 0.06 | 6.33 | 27.13 | 91.32 | 1,299.35 |
| | 03/11/14 13:38:30 | 87120 | 12.44 | -0.42 | 0.08 | 6.20 | 27.13 | 91.32 | 1,299.08 |
| | 03/11/14 13:39:00 | 87150 | 12.84 | -0.32 | 0.08 | 6.00 | 27.13 | 91.77 | 1,294.74 |
| | 03/11/14 13:39:30 | 87180 | 13.32 | 0.33 | 0.07 | 5.55 | 26.57 | 91.77 | 1,294.06 |
| | 03/11/14 13:40:00 | 87210 | 13.11 | 0.85 | 0.07 | 5.70 | 27.13 | 91.77 | 1,297.64 |
| | 03/11/14 13:40:30 | 87240 | 12.12 | 0.24 | 0.07 | 6.38 | 27.13 | 91.77 | 1,293.47 |
| | 03/11/14 13:41:00 | 87270 | 12.30 | -0.39 | 0.08 | 6.37 | 4.43 | 91.77 | 551.54 |
| | 03/11/14 13:41:30 | 87300 | 14.84 | 4.56 | 0.18 | 4.66 | 28.79 | 91.32 | 1,343.03 |
| | 03/11/14 13:42:00 | 87330 | 13.18 | 15.81 | 0.08 | 5.63 | 26.57 | 91.77 | 1,299.92 |
| | 03/11/14 13:42:30 | 87360 | 12.50 | 1.18 | 0.08 | 6.23 | 26.57 | 91.77 | 1,298.65 |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 7.3 | % |
| Stack Exhaust Flow (M2) | 86,125 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.49 | in. Hg |
| Relative Humidity | 32 | % |
| Ambient Temperature | 83 | $^{o}$F |
| Specific Humidity | 0.007782 | lb $H_2O$ / lb air |

0-30-0 Load, Run - 4.0X30PF R1

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/11/14 13:43:00 | 87390 | 12.27 | -0.19 | 0.05 | 6.42 | 26.57 | 92.21 | 1,299.81 |
| | 03/11/14 13:43:30 | 87420 | 12.95 | 0.01 | 0.07 | 5.98 | 26.57 | 92.21 | 1,296.48 |
| | 03/11/14 13:44:00 | 87450 | 12.71 | 0.19 | 0.08 | 6.10 | 26.57 | 92.21 | 1,297.75 |
| | 03/11/14 13:44:30 | 87480 | 12.85 | 0.20 | 0.08 | 5.97 | 32.39 | 92.21 | 1,344.11 |
| | 03/11/14 13:45:00 | 87510 | 11.80 | 0.11 | 0.08 | 6.52 | 2.77 | 92.21 | 474.37 |
| | 03/11/14 13:45:30 | 87540 | 11.63 | -0.29 | 0.13 | 7.06 | 3.88 | 91.77 | 520.49 |
| | 03/11/14 13:46:00 | 87570 | 13.99 | -0.28 | 0.19 | 5.13 | 3.88 | 91.32 | 523.68 |
| | 03/11/14 13:46:30 | 87600 | 13.73 | -0.25 | 0.14 | 5.31 | 3.88 | 90.87 | 523.01 |
| | 03/11/14 13:47:00 | 87630 | 13.78 | -0.19 | 0.16 | 5.26 | 3.32 | 90.42 | 522.42 |
| | 03/11/14 13:47:30 | 87660 | 13.84 | -0.16 | 0.15 | 5.12 | 14.67 | 89.97 | 996.29 |
| | 03/11/14 13:48:00 | 87690 | 12.98 | -0.01 | 0.15 | 5.77 | 27.68 | 90.87 | 1,309.12 |
| | 03/11/14 13:48:30 | 87720 | 12.55 | -0.09 | 0.08 | 6.25 | 26.57 | 91.32 | 1,296.66 |
| | 03/11/14 13:49:00 | 87750 | 12.66 | 0.00 | 0.06 | 6.09 | 26.57 | 91.77 | 1,296.48 |
| | 03/11/14 13:49:30 | 87780 | 12.66 | 0.18 | 0.07 | 6.12 | 26.57 | 92.21 | 1,299.48 |
| | 03/11/14 13:50:00 | 87810 | 12.84 | 0.14 | 0.06 | 5.97 | 26.57 | 92.21 | 1,299.48 |
| | 03/11/14 13:50:30 | 87840 | 12.83 | -0.05 | 0.06 | 5.99 | 26.57 | 92.66 | 1,300.21 |
| | 03/11/14 13:51:00 | 87870 | 12.68 | 0.23 | 0.07 | 6.09 | 26.02 | 92.66 | 1,296.98 |
| | 03/11/14 13:51:30 | 87900 | 12.68 | 0.38 | 0.07 | 6.05 | 26.57 | 92.66 | 1,298.04 |
| | 03/11/14 13:52:00 | 87930 | 12.73 | 0.39 | 0.07 | 6.06 | 26.57 | 92.21 | 1,298.47 |
| | 03/11/14 13:52:30 | 87960 | 12.94 | 0.38 | 0.08 | 5.88 | 26.57 | 92.21 | 1,294.53 |
| | 03/11/14 13:53:00 | 87990 | 13.14 | 0.14 | 0.08 | 5.76 | 26.57 | 92.66 | 1,298.31 |
| | 03/11/14 13:53:30 | 88020 | 13.06 | 0.30 | 0.08 | 5.76 | 26.57 | 92.66 | 1,297.25 |
| | 03/11/14 13:54:00 | 88050 | 12.77 | 1.90 | 0.07 | 5.99 | 26.57 | 92.66 | 1,297.25 |
| | 03/11/14 13:54:30 | 88080 | 13.08 | 0.61 | 0.07 | 5.78 | 26.57 | 92.66 | 1,298.58 |
| | 03/11/14 13:55:00 | 88110 | 13.17 | 0.06 | 0.08 | 5.72 | 26.57 | 92.66 | 1,294.76 |
| | 03/11/14 13:55:30 | 88140 | 13.13 | 0.40 | 0.07 | 5.72 | 26.57 | 92.66 | 1,297.94 |
| | 03/11/14 13:56:00 | 88170 | 13.20 | 0.19 | 0.08 | 5.67 | 27.13 | 92.66 | 1,297.56 |
| A3 | 03/11/14 13:56:30 | 88200 | 12.83 | -0.04 | 0.08 | 5.91 | 26.57 | 92.66 | 1,296.54 |
| | 03/11/14 13:57:00 | 88230 | 12.72 | -0.01 | 0.08 | 6.01 | 27.13 | 92.66 | 1,294.18 |
| | 03/11/14 13:57:30 | 88260 | 12.82 | -0.07 | 0.07 | 5.93 | 26.57 | 92.66 | 1,296.94 |
| | 03/11/14 13:58:00 | 88290 | 12.70 | -0.09 | 0.07 | 6.01 | 26.57 | 92.66 | 1,294.40 |
| | 03/11/14 13:58:30 | 88320 | 12.67 | -0.11 | 0.08 | 6.01 | 26.02 | 92.66 | 1,296.52 |
| | 03/11/14 13:59:00 | 88350 | 12.79 | -0.14 | 0.08 | 5.98 | 25.47 | 92.66 | 1,292.66 |
| | 03/11/14 13:59:30 | 88380 | 12.76 | -0.11 | 0.07 | 5.95 | 1.66 | 93.11 | 419.46 |
| | 03/11/14 14:00:00 | 88410 | 14.47 | 0.86 | 0.20 | 4.97 | 3.88 | 92.66 | 509.60 |
| | 03/11/14 14:00:30 | 88440 | 12.14 | 6.33 | 0.18 | 6.05 | 3.88 | 92.21 | 511.58 |
| | 03/11/14 14:01:00 | 88470 | 13.26 | 0.19 | 0.29 | 5.54 | 3.88 | 92.21 | 509.75 |
| | 03/11/14 14:01:30 | 88500 | 12.54 | -0.39 | 0.26 | 6.23 | 3.32 | 91.77 | 511.09 |
| | 03/11/14 14:02:00 | 88530 | 13.56 | -0.39 | 0.32 | 5.37 | 3.88 | 91.77 | 511.01 |
| | 03/11/14 14:02:30 | 88560 | 14.07 | -0.35 | 0.34 | 4.92 | 14.67 | 91.77 | 1,010.75 |
| | 03/11/14 14:03:00 | 88590 | 12.73 | -0.34 | 0.21 | 5.95 | 27.13 | 92.21 | 1,299.53 |
| | 03/11/14 14:03:30 | 88620 | 12.73 | -0.17 | 0.08 | 6.05 | 26.57 | 92.66 | 1,301.99 |
| | 03/11/14 14:04:00 | 88650 | 12.78 | -0.08 | 0.08 | 6.03 | 26.57 | 92.66 | 1,296.83 |
| | 03/11/14 14:04:30 | 88680 | 12.60 | 0.02 | 0.06 | 6.14 | 26.02 | 92.66 | 1,296.44 |
| | 03/11/14 14:05:00 | 88710 | 12.56 | -0.25 | 0.06 | 6.15 | 26.02 | 92.66 | 1,298.35 |
| | 03/11/14 14:05:30 | 88740 | 12.58 | -0.32 | 0.07 | 6.18 | 25.47 | 92.66 | 1,296.02 |
| | 03/11/14 14:06:00 | 88770 | 12.78 | -0.13 | 0.08 | 5.99 | 25.47 | 92.66 | 1,296.50 |
| | 03/11/14 14:06:30 | 88800 | 13.28 | 0.09 | 0.08 | 5.68 | 25.47 | 93.11 | 1,299.30 |
| | 03/11/14 14:07:00 | 88830 | 13.08 | 0.43 | 0.07 | 5.81 | 26.02 | 93.11 | 1,298.41 |
| | 03/11/14 14:07:30 | 88860 | 13.15 | 0.51 | 0.07 | 5.76 | 25.47 | 93.11 | 1,296.08 |
| | 03/11/14 14:08:00 | 88890 | 13.12 | 0.96 | 0.07 | 5.76 | 26.02 | 93.11 | 1,296.54 |
| | 03/11/14 14:08:30 | 88920 | 12.96 | 0.43 | 0.08 | 5.88 | 25.47 | 93.11 | 1,298.24 |
| | 03/11/14 14:09:00 | 88950 | 12.99 | 0.17 | 0.09 | 5.80 | 24.91 | 92.66 | 1,296.94 |
| | 03/11/14 14:09:30 | 88980 | 12.89 | -0.06 | 0.06 | 5.95 | 25.47 | 92.66 | 1,294.18 |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 7.3 | % |
| Stack Exhaust Flow (M2) | 86,125 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.49 | in. Hg |
| Relative Humidity | 32 | % |
| Ambient Temperature | 83 | $^{o}$F |
| Specific Humidity | 0.007782 | lb $H_2O$ / lb air |

0-30-0 Load, Run - 4.0X30PF R1

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/11/14 14:10:00 | 89010 | 13.06 | 0.23 | 0.09 | 5.77 | 24.91 | 93.11 | 1,298.72 |
| 03/11/14 14:10:30 | 89040 | 12.92 | 0.36 | 0.08 | 5.89 | 24.91 | 93.11 | 1,298.08 |
| 03/11/14 14:11:00 | 89070 | 12.89 | 0.26 | 0.06 | 5.91 | 25.47 | 93.11 | 1,293.80 |
| 03/11/14 14:11:30 | 89100 | 13.09 | 0.46 | 0.08 | 5.79 | 25.47 | 93.11 | 1,298.08 |
| 03/11/14 14:12:00 | 89130 | 12.95 | 0.42 | 0.07 | 5.83 | 24.91 | 93.11 | 1,294.22 |
| 03/11/14 14:12:30 | 89160 | 12.92 | 0.23 | 0.08 | 5.87 | 24.91 | 93.11 | 1,299.36 |
| 03/11/14 14:13:00 | 89190 | 13.02 | 0.37 | 0.07 | 5.83 | 25.47 | 93.11 | 1,294.05 |
| 03/11/14 14:13:30 | 89220 | 12.89 | 0.47 | 0.07 | 5.91 | 24.91 | 93.11 | 1,296.39 |
| 03/11/14 14:14:00 | 89250 | 12.91 | 0.34 | 0.06 | 5.90 | 24.91 | 93.56 | 1,295.11 |
| 03/11/14 14:14:30 | 89280 | 12.95 | 0.42 | 0.05 | 5.84 | 25.47 | 93.56 | 1,296.81 |
| 03/11/14 14:15:00 | 89310 | 13.11 | 0.07 | 0.09 | 5.86 | 2.77 | 93.56 | 521.69 |
| 03/11/14 14:15:30 | 89340 | 15.16 | 0.37 | 0.28 | 4.31 | 2.77 | 93.11 | 496.59 |
| 03/11/14 14:16:00 | 89370 | 14.67 | -0.14 | 0.26 | 4.54 | 2.77 | 92.66 | 501.33 |
| **RAW AVERAGE** | | **12.87** | **1.04** | **0.11** | **5.91** | **21.57** | **91.04** | **1,123.89** |

| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | (%) | (ppmvd) | (ppmvw) | (%) | (in. $H_2O$) | ($^{o}$F) | (SCFH) |
| **Bias** | **Initial Zero** | 0.07 | 0.01 | -0.01 | 0.04 | | | |
| | **Final Zero** | 0.01 | 0.05 | 0.01 | 0.01 | | | |
| | **Avg. Zero** | 0.04 | 0.03 | 0.00 | 0.03 | | | |
| | **Initial UpScale** | 12.11 | 8.78 | 3.14 | 9.40 | | | |
| | **Final UpScale** | 12.02 | 8.46 | 3.00 | 9.31 | | | |
| | **Avg. UpScale** | 12.07 | 8.62 | 3.07 | 9.36 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| EMISSIONS DATA | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.80 | 1.06 | 0.12 | 5.94 |
| **Corrected Raw Average (ppm/% wet basis)** | 11.87 | 0.98 | 0.11 | 5.51 |
| **Emission Rate (lb/hr)** | N/A | 0.01 | 0.00 | N/A |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 85,121 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.41 | in. Hg |
| Relative Humidity | 26 | % |
| Ambient Temperature | 87 | $^{o}$F |
| Specific Humidity | 0.007200 | lb $H_2O$ / lb air |

0-30-0 Load, Run - 4.0X30PF R2

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/11/14 15:27:00 | 93630 | 13.64 | 8.21 | 0.07 | 5.52 | 2.21 | 91.32 | 526.73 |
| | 03/11/14 15:27:30 | 93660 | 12.60 | 5.04 | 0.09 | 6.14 | 2.77 | 90.87 | 527.15 |
| | 03/11/14 15:28:00 | 93690 | 12.12 | 2.35 | 0.11 | 6.69 | 2.77 | 90.87 | 526.89 |
| | 03/11/14 15:28:30 | 93720 | 12.54 | 1.27 | 0.11 | 6.24 | 2.77 | 90.42 | 526.89 |
| | 03/11/14 15:29:00 | 93750 | 12.65 | 0.72 | 0.13 | 6.21 | 5.81 | 90.42 | 527.99 |
| | 03/11/14 15:29:30 | 93780 | 12.32 | 0.66 | 0.08 | 6.48 | 28.79 | 90.87 | 1,346.41 |
| | 03/11/14 15:30:00 | 93810 | 12.93 | 1.96 | 0.07 | 6.10 | 27.13 | 91.77 | 1,310.37 |
| | 03/11/14 15:30:30 | 93840 | 12.57 | 1.83 | 0.06 | 6.41 | 26.02 | 91.77 | 1,311.03 |
| | 03/11/14 15:31:00 | 93870 | 12.40 | 1.63 | 0.06 | 6.59 | 26.57 | 91.77 | 1,308.75 |
| | 03/11/14 15:31:30 | 93900 | 12.78 | 1.46 | 0.06 | 6.37 | 26.02 | 92.21 | 1,309.61 |
| | 03/11/14 15:32:00 | 93930 | 12.95 | 1.34 | 0.04 | 6.17 | 26.57 | 92.21 | 1,308.81 |
| | 03/11/14 15:32:30 | 93960 | 12.95 | 1.15 | 0.06 | 6.17 | 26.02 | 92.66 | 1,311.84 |
| | 03/11/14 15:33:00 | 93990 | 12.87 | 0.95 | 0.07 | 6.21 | 26.57 | 92.66 | 1,311.68 |
| | 03/11/14 15:33:30 | 94020 | 12.87 | 0.81 | 0.06 | 6.23 | 26.02 | 92.66 | 1,311.92 |
| | 03/11/14 15:34:00 | 94050 | 12.80 | 0.69 | 0.06 | 6.27 | 26.02 | 93.11 | 1,307.59 |
| | 03/11/14 15:34:30 | 94080 | 12.84 | 0.55 | 0.06 | 6.26 | 26.02 | 93.11 | 1,304.22 |
| | 03/11/14 15:35:00 | 94110 | 12.66 | 0.61 | 0.05 | 6.40 | 26.02 | 93.11 | 1,305.27 |
| | 03/11/14 15:35:30 | 94140 | 12.66 | 0.51 | 0.05 | 6.42 | 26.02 | 93.11 | 1,305.95 |
| | 03/11/14 15:36:00 | 94170 | 12.68 | 0.49 | 0.06 | 6.39 | 26.02 | 93.11 | 1,307.02 |
| | 03/11/14 15:36:30 | 94200 | 12.82 | 0.35 | 0.06 | 6.32 | 26.02 | 93.11 | 1,306.59 |
| | 03/11/14 15:37:00 | 94230 | 12.84 | 0.19 | 0.07 | 6.26 | 25.47 | 93.56 | 1,307.68 |
| | 03/11/14 15:37:30 | 94260 | 12.79 | 0.10 | 0.07 | 6.30 | 26.02 | 93.56 | 1,304.13 |
| | 03/11/14 15:38:00 | 94290 | 12.80 | 0.07 | 0.06 | 6.30 | 25.47 | 93.56 | 1,306.91 |
| | 03/11/14 15:38:30 | 94320 | 12.78 | 0.07 | 0.06 | 6.31 | 26.02 | 94.01 | 1,306.68 |
| | 03/11/14 15:39:00 | 94350 | 12.80 | 0.09 | 0.06 | 6.32 | 26.57 | 94.46 | 1,305.05 |
| | 03/11/14 15:39:30 | 94380 | 12.89 | 0.03 | 0.07 | 6.24 | 25.47 | 94.46 | 1,304.62 |
| | 03/11/14 15:40:00 | 94410 | 12.77 | -0.01 | 0.06 | 6.31 | 25.47 | 94.46 | 1,303.55 |
| | 03/11/14 15:40:30 | 94440 | 12.73 | 0.00 | 0.06 | 6.37 | 25.47 | 94.46 | 1,304.64 |
| | 03/11/14 15:41:00 | 94470 | 12.85 | -0.01 | 0.05 | 6.29 | 25.47 | 94.46 | 1,303.77 |
| | 03/11/14 15:41:30 | 94500 | 12.94 | 0.10 | 0.07 | 6.24 | 2.21 | 93.56 | 518.44 |
| | 03/11/14 15:42:00 | 94530 | 13.50 | 0.98 | 0.07 | 5.82 | 2.21 | 93.11 | 520.69 |
| | 03/11/14 15:42:30 | 94560 | 13.40 | 0.99 | 0.09 | 5.68 | 2.77 | 92.66 | 521.34 |
| | 03/11/14 15:43:00 | 94590 | 13.29 | 0.22 | 0.13 | 5.81 | 2.21 | 92.21 | 522.80 |
| | 03/11/14 15:43:30 | 94620 | 12.76 | 0.03 | 0.13 | 6.05 | 2.77 | 91.77 | 521.14 |
| | 03/11/14 15:44:00 | 94650 | 13.18 | -0.15 | 0.17 | 5.94 | 2.77 | 91.32 | 523.03 |
| | 03/11/14 15:44:30 | 94680 | 13.94 | -0.17 | 0.24 | 5.33 | 2.77 | 91.32 | 522.28 |
| | 03/11/14 15:45:00 | 94710 | 13.92 | -0.23 | 0.23 | 5.27 | 20.48 | 90.87 | 1,123.79 |
| | 03/11/14 15:45:30 | 94740 | 13.25 | -0.19 | 0.13 | 5.78 | 28.23 | 91.77 | 1,315.90 |
| | 03/11/14 15:46:00 | 94770 | 13.03 | 0.27 | 0.07 | 6.03 | 27.13 | 92.21 | 1,304.95 |
| | 03/11/14 15:46:30 | 94800 | 12.80 | -0.01 | 0.06 | 6.30 | 26.57 | 92.66 | 1,304.58 |
| | 03/11/14 15:47:00 | 94830 | 12.77 | -0.04 | 0.06 | 6.34 | 26.02 | 92.66 | 1,304.00 |
| A2 | 03/11/14 15:47:30 | 94860 | 12.82 | -0.03 | 0.06 | 6.34 | 26.57 | 92.66 | 1,301.63 |
| | 03/11/14 15:48:00 | 94890 | 12.83 | -0.03 | 0.05 | 6.28 | 26.57 | 93.11 | 1,305.04 |
| | 03/11/14 15:48:30 | 94920 | 12.68 | -0.03 | 0.05 | 6.15 | 26.57 | 93.11 | 1,302.97 |
| | 03/11/14 15:49:00 | 94950 | 12.57 | -0.18 | 0.05 | 6.13 | 26.02 | 93.11 | 1,303.61 |
| | 03/11/14 15:49:30 | 94980 | 12.83 | -0.28 | 0.06 | 5.94 | 26.57 | 93.11 | 1,304.70 |
| | 03/11/14 15:50:00 | 95010 | 12.83 | -0.06 | 0.06 | 5.95 | 26.02 | 93.11 | 1,304.30 |
| | 03/11/14 15:50:30 | 95040 | 12.85 | -0.14 | 0.05 | 5.96 | 25.47 | 93.56 | 1,304.10 |
| | 03/11/14 15:51:00 | 95070 | 12.85 | -0.11 | 0.06 | 5.92 | 25.47 | 94.01 | 1,303.06 |
| | 03/11/14 15:51:30 | 95100 | 12.85 | -0.12 | 0.06 | 5.94 | 25.47 | 94.01 | 1,300.50 |
| | 03/11/14 15:52:00 | 95130 | 12.91 | -0.24 | 0.05 | 5.91 | 25.47 | 94.46 | 1,300.71 |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 85,121 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.41 | in. Hg |
| Relative Humidity | 26 | % |
| Ambient Temperature | 87 | $^{o}$F |
| Specific Humidity | 0.007200 | lb $H_2O$ / lb air |

0-30-0 Load, Run - 4.0X30PF R2

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/11/14 15:52:30 | 95160 | 13.01 | 0.06 | 0.05 | 5.84 | 25.47 | 94.46 | 1,301.18 |
| | 03/11/14 15:53:00 | 95190 | 12.84 | 0.20 | 0.05 | 5.95 | 26.02 | 94.46 | 1,301.82 |
| | 03/11/14 15:53:30 | 95220 | 12.80 | 0.00 | 0.05 | 5.97 | 26.02 | 94.91 | 1,305.46 |
| | 03/11/14 15:54:00 | 95250 | 12.68 | -0.11 | 0.04 | 6.06 | 26.02 | 94.91 | 1,299.92 |
| | 03/11/14 15:54:30 | 95280 | 12.68 | -0.11 | 0.04 | 6.04 | 26.02 | 94.91 | 1,305.46 |
| | 03/11/14 15:55:00 | 95310 | 12.66 | -0.06 | 0.06 | 6.08 | 25.47 | 94.46 | 1,302.48 |
| | 03/11/14 15:55:30 | 95340 | 13.06 | 0.07 | 0.06 | 5.93 | 2.77 | 94.01 | 519.82 |
| | 03/11/14 15:56:00 | 95370 | 13.51 | 6.34 | 0.09 | 5.21 | 2.77 | 93.56 | 520.87 |
| | 03/11/14 15:56:30 | 95400 | 11.65 | 1.45 | 0.10 | 6.73 | 2.21 | 93.11 | 521.10 |
| | 03/11/14 15:57:00 | 95430 | 11.54 | -0.25 | 0.12 | 6.80 | 2.21 | 92.66 | 524.91 |
| | 03/11/14 15:57:30 | 95460 | 12.16 | -0.18 | 0.11 | 6.31 | 2.21 | 92.66 | 521.25 |
| | 03/11/14 15:58:00 | 95490 | 12.00 | -0.08 | 0.07 | 6.49 | 2.21 | 92.21 | 523.42 |
| | 03/11/14 15:58:30 | 95520 | 12.74 | -0.26 | 0.08 | 6.05 | 2.77 | 92.21 | 525.23 |
| | 03/11/14 15:59:00 | 95550 | 12.78 | -0.16 | 0.09 | 5.99 | 2.77 | 91.77 | 543.75 |
| | 03/11/14 15:59:30 | 95580 | 13.67 | 0.36 | 0.11 | 5.34 | 21.04 | 92.21 | 1,189.98 |
| | 03/11/14 16:00:00 | 95610 | 13.31 | 4.68 | 0.06 | 5.49 | 24.91 | 92.66 | 1,282.55 |
| | 03/11/14 16:00:30 | 95640 | 12.71 | 1.97 | 0.05 | 6.05 | 25.47 | 93.11 | 1,305.12 |
| | 03/11/14 16:01:00 | 95670 | 12.61 | 0.34 | 0.05 | 6.08 | 25.47 | 93.11 | 1,306.65 |
| | 03/11/14 16:01:30 | 95700 | 12.55 | 0.24 | 0.05 | 6.10 | 25.47 | 93.56 | 1,305.80 |
| | 03/11/14 16:02:00 | 95730 | 12.54 | 0.04 | 0.05 | 6.16 | 26.02 | 93.56 | 1,300.65 |
| | 03/11/14 16:02:30 | 95760 | 12.69 | -0.02 | 0.05 | 6.06 | 24.91 | 94.01 | 1,301.61 |
| | 03/11/14 16:03:00 | 95790 | 12.72 | 0.16 | 0.05 | 5.99 | 24.91 | 94.01 | 1,303.88 |
| | 03/11/14 16:03:30 | 95820 | 12.93 | 0.22 | 0.06 | 5.83 | 24.91 | 94.01 | 1,305.64 |
| | 03/11/14 16:04:00 | 95850 | 12.84 | 0.24 | 0.06 | 5.93 | 24.91 | 94.01 | 1,302.21 |
| | 03/11/14 16:04:30 | 95880 | 12.80 | 0.12 | 0.05 | 5.96 | 24.91 | 94.01 | 1,302.89 |
| | 03/11/14 16:05:00 | 95910 | 12.83 | 0.10 | 0.05 | 5.91 | 24.91 | 94.46 | 1,303.38 |
| | 03/11/14 16:05:30 | 95940 | 12.81 | -0.01 | 0.04 | 5.95 | 24.91 | 94.46 | 1,305.54 |
| | 03/11/14 16:06:00 | 95970 | 12.90 | -0.10 | 0.05 | 5.90 | 24.91 | 94.91 | 1,305.30 |
| | 03/11/14 16:06:30 | 96000 | 12.97 | 0.00 | 0.05 | 5.81 | 24.91 | 94.91 | 1,302.32 |
| | 03/11/14 16:07:00 | 96030 | 12.79 | 0.13 | 0.05 | 5.96 | 24.91 | 94.91 | 1,306.80 |
| A3 | 03/11/14 16:07:30 | 96060 | 12.84 | -0.04 | 0.05 | 5.91 | 24.91 | 95.47 | 1,303.81 |
| | 03/11/14 16:08:00 | 96090 | 12.84 | -0.09 | 0.05 | 5.96 | 24.91 | 94.91 | 1,300.44 |
| | 03/11/14 16:08:30 | 96120 | 12.92 | 0.02 | 0.05 | 5.88 | 24.91 | 94.91 | 1,301.29 |
| | 03/11/14 16:09:00 | 96150 | 12.91 | 0.26 | 0.05 | 5.90 | 24.36 | 95.47 | 1,305.58 |
| | 03/11/14 16:09:30 | 96180 | 13.05 | 0.10 | 0.05 | 5.78 | 24.91 | 95.47 | 1,303.47 |
| | 03/11/14 16:10:00 | 96210 | 12.84 | 0.00 | 0.04 | 5.94 | 24.91 | 95.47 | 1,300.86 |
| | 03/11/14 16:10:30 | 96240 | 12.72 | 0.20 | 0.04 | 6.03 | 24.91 | 95.47 | 1,303.87 |
| | 03/11/14 16:11:00 | 96270 | 12.90 | 0.03 | 0.06 | 5.92 | 2.21 | 95.47 | 519.86 |
| | 03/11/14 16:11:30 | 96300 | 14.20 | 2.99 | 0.11 | 4.91 | 2.21 | 94.46 | 523.15 |
| | 03/11/14 16:12:00 | 96330 | 13.36 | 2.41 | 0.20 | 5.71 | 2.21 | 94.01 | 524.70 |
| | 03/11/14 16:12:30 | 96360 | 13.78 | -0.22 | 0.26 | 5.15 | 2.21 | 93.11 | 526.53 |
| | 03/11/14 16:13:00 | 96390 | 13.20 | -0.34 | 0.22 | 5.53 | 2.21 | 92.66 | 526.94 |
| | 03/11/14 16:13:30 | 96420 | 12.73 | -0.42 | 0.20 | 5.98 | 2.77 | 92.66 | 525.60 |
| | 03/11/14 16:14:00 | 96450 | 12.26 | -0.45 | 0.19 | 6.30 | 2.77 | 92.21 | 523.60 |
| | 03/11/14 16:14:30 | 96480 | 13.01 | -0.45 | 0.24 | 5.88 | 9.13 | 92.21 | 872.53 |
| | 03/11/14 16:15:00 | 96510 | 12.70 | -0.29 | 0.10 | 6.06 | 25.47 | 93.11 | 1,285.07 |
| | 03/11/14 16:15:30 | 96540 | 12.78 | 0.32 | 0.05 | 6.00 | 24.91 | 93.56 | 1,301.72 |
| | 03/11/14 16:16:00 | 96570 | 12.60 | -0.30 | 0.06 | 6.12 | 24.91 | 94.01 | 1,298.49 |
| | 03/11/14 16:16:30 | 96600 | 12.41 | -0.42 | 0.05 | 6.25 | 24.36 | 94.01 | 1,294.92 |
| | 03/11/14 16:17:00 | 96630 | 12.41 | -0.30 | 0.05 | 6.32 | 24.91 | 94.01 | 1,294.92 |
| | 03/11/14 16:17:30 | 96660 | 12.76 | -0.22 | 0.04 | 6.03 | 24.91 | 94.01 | 1,295.13 |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 85,121 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.41 | in. Hg |
| Relative Humidity | 26 | % |
| Ambient Temperature | 87 | $^{o}$F |
| Specific Humidity | 0.007200 | lb $H_2O$ / lb air |

0-30-0 Load, Run - 4.0X30PF R2

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/11/14 16:18:00 | 96690 | 12.83 | 0.01 | 0.04 | 6.00 | 24.36 | 94.01 | 1,294.99 |
| 03/11/14 16:18:30 | 96720 | 12.87 | 0.29 | 0.04 | 5.97 | 24.36 | 94.01 | 1,301.23 |
| 03/11/14 16:19:00 | 96750 | 12.95 | 0.34 | 0.05 | 5.88 | 24.36 | 94.01 | 1,294.77 |
| 03/11/14 16:19:30 | 96780 | 13.06 | 0.68 | 0.05 | 5.84 | 24.36 | 94.46 | 1,300.56 |
| 03/11/14 16:20:00 | 96810 | 13.11 | 0.59 | 0.04 | 5.78 | 24.91 | 94.46 | 1,300.32 |
| 03/11/14 16:20:30 | 96840 | 13.04 | 0.55 | 0.05 | 5.85 | 24.36 | 94.46 | 1,295.20 |
| 03/11/14 16:21:00 | 96870 | 13.13 | 0.78 | 0.06 | 5.77 | 23.80 | 94.91 | 1,300.32 |
| 03/11/14 16:21:30 | 96900 | 13.17 | 0.80 | 0.06 | 5.72 | 23.80 | 94.91 | 1,299.08 |
| 03/11/14 16:22:00 | 96930 | 13.25 | 0.98 | 0.04 | 5.70 | 23.80 | 95.47 | 1,300.84 |
| 03/11/14 16:22:30 | 96960 | 13.19 | 0.92 | 0.05 | 5.70 | 24.36 | 95.47 | 1,298.26 |
| 03/11/14 16:23:00 | 96990 | 12.97 | 1.02 | 0.05 | 5.85 | 23.80 | 95.47 | 1,294.63 |
| 03/11/14 16:23:30 | 97020 | 13.25 | 1.38 | 0.05 | 5.69 | 24.36 | 95.47 | 1,295.50 |
| 03/11/14 16:24:00 | 97050 | 13.30 | 1.83 | 0.05 | 5.62 | 24.36 | 95.47 | 1,299.11 |
| 03/11/14 16:24:30 | 97080 | 13.34 | 1.78 | 0.04 | 5.61 | 23.80 | 95.47 | 1,294.63 |
| 03/11/14 16:25:00 | 97110 | 13.44 | 1.74 | 0.05 | 5.53 | 23.80 | 95.81 | 1,297.40 |
| 03/11/14 16:25:30 | 97140 | 13.49 | 1.87 | 0.06 | 5.51 | 2.21 | 95.47 | 522.10 |
| 03/11/14 16:26:00 | 97170 | 12.59 | 2.57 | 0.14 | 6.09 | 2.21 | 94.46 | 521.30 |
| 03/11/14 16:26:30 | 97200 | 12.89 | -0.09 | 0.16 | 5.89 | 2.21 | 93.56 | 522.35 |
| 03/11/14 16:27:00 | 97230 | 13.09 | -0.36 | 0.13 | 5.75 | 2.21 | 93.11 | 524.93 |
| **RAW AVERAGE** | | **12.88** | **0.58** | **0.08** | **6.01** | **19.36** | **93.54** | **1,097.69** |

| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | | | | | **(in. $H_2O$)** | **($^{o}$F)** | **(SCFH)** |
| **Bias** | **Initial Zero** | 0.01 | 0.05 | 0.01 | 0.01 | | | |
| | **Final Zero** | 0.01 | 0.14 | 0.02 | 0.04 | | | |
| | **Avg. Zero** | 0.01 | 0.10 | 0.02 | 0.03 | | | |
| | **Initial UpScale** | 12.02 | 8.46 | 3.00 | 9.31 | | | |
| | **Final UpScale** | 12.00 | 8.88 | 2.94 | 9.23 | | | |
| | **Avg. UpScale** | 12.01 | 8.67 | 2.97 | 9.27 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| **EMISSIONS DATA** | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.87 | 0.50 | 0.06 | 6.09 |
| **Corrected Raw Average (ppm/% wet basis)** | 12.05 | 0.46 | 0.06 | 5.70 |
| **Emission Rate (lb/hr)** | N/A | 0.00 | 0.00 | N/A |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 82,138 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.40 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 84 | $^{o}$F |
| Specific Humidity | 0.007045 | lb $H_2O$ / lb air |

0-30-0 Load, Run - 4.0X30PF R3

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/11/14 16:48:00 | 98490 | 13.45 | 1.01 | 0.09 | 5.44 | 2.21 | 92.21 | 534.45 |
| | 03/11/14 16:48:30 | 98520 | 12.76 | 1.45 | 0.09 | 5.85 | 2.77 | 91.77 | 526.55 |
| | 03/11/14 16:49:00 | 98550 | 13.14 | 0.60 | 0.13 | 5.70 | 2.21 | 91.32 | 523.12 |
| | 03/11/14 16:49:30 | 98580 | 13.56 | 0.49 | 0.14 | 5.25 | 2.77 | 90.87 | 523.43 |
| | 03/11/14 16:50:00 | 98610 | 13.58 | 0.44 | 0.15 | 5.51 | 2.21 | 90.42 | 524.34 |
| | 03/11/14 16:50:30 | 98640 | 12.92 | 0.37 | 0.13 | 5.83 | 24.91 | 90.87 | 1,266.20 |
| | 03/11/14 16:51:00 | 98670 | 13.48 | 2.28 | 0.06 | 5.52 | 26.57 | 91.32 | 1,300.21 |
| | 03/11/14 16:51:30 | 98700 | 13.11 | 1.82 | 0.05 | 5.77 | 26.02 | 92.21 | 1,295.27 |
| | 03/11/14 16:52:00 | 98730 | 12.88 | 0.55 | 0.05 | 5.95 | 26.02 | 92.66 | 1,304.30 |
| | 03/11/14 16:52:30 | 98760 | 12.85 | 0.34 | 0.06 | 5.97 | 26.02 | 93.11 | 1,303.07 |
| | 03/11/14 16:53:00 | 98790 | 12.80 | 0.32 | 0.06 | 6.00 | 26.57 | 93.11 | 1,306.35 |
| | 03/11/14 16:53:30 | 98820 | 12.74 | 0.33 | 0.05 | 6.07 | 26.02 | 93.56 | 1,300.62 |
| | 03/11/14 16:54:00 | 98850 | 12.71 | 0.31 | 0.05 | 6.07 | 26.02 | 94.01 | 1,312.15 |
| | 03/11/14 16:54:30 | 98880 | 12.62 | 0.26 | 0.06 | 6.11 | 26.57 | 94.01 | 1,309.58 |
| | 03/11/14 16:55:00 | 98910 | 12.41 | 0.24 | 0.05 | 6.27 | 26.02 | 94.01 | 1,310.02 |
| | 03/11/14 16:55:30 | 98940 | 12.41 | 0.20 | 0.05 | 6.28 | 26.57 | 94.46 | 1,307.70 |
| | 03/11/14 16:56:00 | 98970 | 12.58 | 0.16 | 0.05 | 6.18 | 26.02 | 94.46 | 1,309.88 |
| | 03/11/14 16:56:30 | 99000 | 12.81 | 0.17 | 0.05 | 6.00 | 26.57 | 94.91 | 1,309.09 |
| | 03/11/14 16:57:00 | 99030 | 12.95 | 0.23 | 0.04 | 5.88 | 26.02 | 95.47 | 1,314.27 |
| | 03/11/14 16:57:30 | 99060 | 12.83 | 0.27 | 0.04 | 5.97 | 26.02 | 95.47 | 1,311.66 |
| | 03/11/14 16:58:00 | 99090 | 13.11 | 0.33 | 0.05 | 5.82 | 26.02 | 95.47 | 1,313.65 |
| | 03/11/14 16:58:30 | 99120 | 12.85 | 0.42 | 0.05 | 5.94 | 26.02 | 95.47 | 1,313.22 |
| | 03/11/14 16:59:00 | 99150 | 12.85 | 0.22 | 0.04 | 5.99 | 26.02 | 95.47 | 1,309.21 |
| | 03/11/14 16:59:30 | 99180 | 12.76 | 0.21 | 0.04 | 6.06 | 26.02 | 95.47 | 1,311.78 |
| | 03/11/14 17:00:00 | 99210 | 12.98 | 0.24 | 0.05 | 5.88 | 26.02 | 95.81 | 1,309.00 |
| | 03/11/14 17:00:30 | 99240 | 12.90 | 0.34 | 0.05 | 5.92 | 26.02 | 95.81 | 1,308.20 |
| | 03/11/14 17:01:00 | 99270 | 12.81 | 0.32 | 0.05 | 5.99 | 25.47 | 95.47 | 1,310.56 |
| | 03/11/14 17:01:30 | 99300 | 12.57 | 0.25 | 0.05 | 6.17 | 26.02 | 95.47 | 1,306.69 |
| | 03/11/14 17:02:00 | 99330 | 12.48 | 0.18 | 0.05 | 6.21 | 25.47 | 95.47 | 1,255.99 |
| | 03/11/14 17:02:30 | 99360 | 12.13 | 0.20 | 0.04 | 6.33 | 2.21 | 94.91 | 526.72 |
| | 03/11/14 17:03:00 | 99390 | 12.29 | 0.29 | 0.05 | 6.46 | 2.77 | 94.01 | 528.62 |
| | 03/11/14 17:03:30 | 99420 | 13.35 | 0.52 | 0.08 | 5.72 | 2.77 | 93.56 | 528.19 |
| | 03/11/14 17:04:00 | 99450 | 13.12 | 0.39 | 0.07 | 5.69 | 2.77 | 93.11 | 527.76 |
| | 03/11/14 17:04:30 | 99480 | 13.25 | 0.26 | 0.10 | 5.74 | 2.21 | 93.11 | 529.25 |
| | 03/11/14 17:05:00 | 99510 | 13.83 | 0.39 | 0.10 | 5.14 | 2.77 | 92.66 | 529.24 |
| | 03/11/14 17:05:30 | 99540 | 12.38 | 0.32 | 0.07 | 6.22 | 3.88 | 92.66 | 613.21 |
| | 03/11/14 17:06:00 | 99570 | 13.82 | 0.32 | 0.11 | 5.25 | 24.91 | 92.66 | 1,270.12 |
| | 03/11/14 17:06:30 | 99600 | 13.37 | 5.20 | 0.05 | 5.31 | 26.02 | 93.56 | 1,302.97 |
| | 03/11/14 17:07:00 | 99630 | 12.18 | 1.62 | 0.03 | 6.37 | 25.47 | 94.01 | 1,304.43 |
| | 03/11/14 17:07:30 | 99660 | 12.49 | 0.16 | 0.03 | 6.20 | 26.02 | 94.46 | 1,299.32 |
| | 03/11/14 17:08:00 | 99690 | 12.60 | 0.19 | 0.04 | 6.08 | 25.47 | 94.46 | 1,305.16 |
| A2 | 03/11/14 17:08:30 | 99720 | 12.80 | 0.22 | 0.05 | 5.95 | 24.91 | 94.46 | 1,304.52 |
| | 03/11/14 17:09:00 | 99750 | 12.88 | 0.28 | 0.06 | 5.90 | 26.02 | 94.91 | 1,297.86 |
| | 03/11/14 17:09:30 | 99780 | 13.00 | 0.24 | 0.05 | 5.79 | 25.47 | 95.47 | 1,299.66 |
| | 03/11/14 17:10:00 | 99810 | 12.96 | 0.29 | 0.04 | 5.78 | 25.47 | 95.47 | 1,303.28 |
| | 03/11/14 17:10:30 | 99840 | 12.89 | 0.31 | 0.04 | 5.83 | 26.02 | 95.47 | 1,301.57 |
| | 03/11/14 17:11:00 | 99870 | 12.89 | 0.28 | 0.05 | 5.94 | 26.02 | 95.81 | 1,300.81 |
| | 03/11/14 17:11:30 | 99900 | 12.99 | 0.38 | 0.05 | 5.88 | 25.47 | 95.81 | 1,298.45 |
| | 03/11/14 17:12:00 | 99930 | 12.94 | 0.43 | 0.05 | 5.89 | 26.02 | 95.81 | 1,301.00 |
| | 03/11/14 17:12:30 | 99960 | 12.83 | 0.31 | 0.05 | 5.94 | 24.91 | 96.26 | 1,303.67 |
| | 03/11/14 17:13:00 | 99990 | 12.86 | 0.52 | 0.04 | 5.94 | 25.47 | 95.81 | 1,300.88 |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 82,138 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.40 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 84 | $^{o}$F |
| Specific Humidity | 0.007045 | lb $H_2O$ / lb air |

0-30-0 Load, Run - 4.0X30PF R3

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/11/14 17:13:30 | 100020 | 12.80 | 0.41 | 0.04 | 6.01 | 25.47 | 95.81 | 1,305.16 |
| | 03/11/14 17:14:00 | 100050 | 12.65 | 0.38 | 0.05 | 6.08 | 25.47 | 95.81 | 1,301.06 |
| | 03/11/14 17:14:30 | 100080 | 12.72 | 0.28 | 0.04 | 6.05 | 25.47 | 95.81 | 1,303.72 |
| | 03/11/14 17:15:00 | 100110 | 12.66 | 0.43 | 0.05 | 6.03 | 26.02 | 95.47 | 1,315.56 |
| | 03/11/14 17:15:30 | 100140 | 12.68 | 0.32 | 0.05 | 6.07 | 26.02 | 95.81 | 1,310.37 |
| | 03/11/14 17:16:00 | 100170 | 12.76 | 0.28 | 0.04 | 5.94 | 25.47 | 95.81 | 1,308.18 |
| | 03/11/14 17:16:30 | 100200 | 12.74 | 0.24 | 0.03 | 6.01 | 2.21 | 95.47 | 526.35 |
| | 03/11/14 17:17:00 | 100230 | 14.40 | 0.38 | 0.15 | 4.83 | 2.77 | 94.91 | 523.66 |
| | 03/11/14 17:17:30 | 100260 | 12.79 | 0.52 | 0.14 | 5.80 | 2.77 | 94.01 | 524.64 |
| | 03/11/14 17:18:00 | 100290 | 12.89 | 0.34 | 0.18 | 5.85 | 2.21 | 93.56 | 522.44 |
| | 03/11/14 17:18:30 | 100320 | 12.43 | 0.28 | 0.15 | 6.17 | 2.77 | 93.11 | 522.28 |
| | 03/11/14 17:19:00 | 100350 | 12.27 | 0.25 | 0.14 | 6.32 | 2.77 | 93.11 | 521.36 |
| | 03/11/14 17:19:30 | 100380 | 13.03 | 0.24 | 0.17 | 5.82 | 2.77 | 92.66 | 522.33 |
| | 03/11/14 17:20:00 | 100410 | 13.28 | 0.31 | 0.14 | 5.59 | 2.77 | 92.66 | 520.45 |
| | 03/11/14 17:20:30 | 100440 | 13.28 | 0.31 | 0.10 | 5.63 | 24.91 | 92.66 | 1,259.59 |
| | 03/11/14 17:21:00 | 100470 | 13.84 | 5.69 | 0.06 | 5.10 | 26.57 | 93.56 | 1,311.12 |
| | 03/11/14 17:21:30 | 100500 | 12.56 | 2.80 | 0.05 | 6.09 | 27.13 | 94.01 | 1,304.05 |
| | 03/11/14 17:22:00 | 100530 | 12.28 | 3.22 | 0.18 | 6.32 | 27.13 | 94.46 | 1,302.85 |
| | 03/11/14 17:22:30 | 100560 | 12.73 | 11.14 | 0.06 | 6.04 | 27.13 | 94.91 | 1,313.62 |
| | 03/11/14 17:23:00 | 100590 | 12.73 | 1.80 | 0.06 | 6.00 | 26.57 | 94.91 | 1,313.35 |
| | 03/11/14 17:23:30 | 100620 | 12.99 | 0.64 | 0.06 | 5.83 | 26.02 | 94.91 | 1,308.64 |
| | 03/11/14 17:24:00 | 100650 | 13.02 | 0.71 | 0.04 | 5.75 | 26.57 | 94.91 | 1,303.77 |
| | 03/11/14 17:24:30 | 100680 | 12.90 | 0.84 | 0.04 | 5.88 | 26.02 | 94.91 | 1,306.97 |
| | 03/11/14 17:25:00 | 100710 | 12.82 | 0.50 | 0.04 | 5.93 | 26.02 | 94.91 | 1,304.20 |
| | 03/11/14 17:25:30 | 100740 | 12.97 | 0.41 | 0.04 | 5.84 | 26.57 | 95.47 | 1,302.47 |
| | 03/11/14 17:26:00 | 100770 | 13.04 | 0.57 | 0.04 | 5.77 | 26.57 | 95.47 | 1,303.98 |
| | 03/11/14 17:26:30 | 100800 | 12.89 | 0.46 | 0.04 | 5.89 | 26.02 | 95.47 | 1,303.32 |
| | 03/11/14 17:27:00 | 100830 | 12.86 | 0.43 | 0.05 | 5.89 | 26.02 | 95.47 | 1,304.81 |
| | 03/11/14 17:27:30 | 100860 | 12.80 | 0.53 | 0.06 | 5.93 | 26.02 | 95.47 | 1,304.38 |
| | 03/11/14 17:28:00 | 100890 | 12.87 | 0.46 | 0.04 | 5.89 | 26.57 | 95.47 | 1,303.34 |
| A3 | 03/11/14 17:28:30 | 100920 | 12.81 | 0.44 | 0.04 | 5.92 | 26.02 | 95.47 | 1,305.70 |
| | 03/11/14 17:29:00 | 100950 | 12.86 | 0.38 | 0.04 | 5.91 | 26.02 | 95.81 | 1,307.65 |
| | 03/11/14 17:29:30 | 100980 | 12.96 | 0.33 | 0.04 | 5.85 | 26.57 | 95.81 | 1,320.04 |
| | 03/11/14 17:30:00 | 101010 | 12.87 | 0.39 | 0.05 | 5.96 | 26.02 | 95.81 | 1,317.22 |
| | 03/11/14 17:30:30 | 101040 | 12.86 | 0.58 | 0.05 | 5.96 | 26.57 | 95.47 | 1,325.16 |
| | 03/11/14 17:31:00 | 101070 | 12.97 | 0.56 | 0.05 | 5.92 | 19.38 | 95.47 | 1,074.54 |
| | 03/11/14 17:31:30 | 101100 | 12.02 | 0.59 | 0.04 | 6.29 | 2.21 | 94.91 | 518.31 |
| | 03/11/14 17:32:00 | 101130 | 11.84 | 0.39 | 0.10 | 6.94 | 2.21 | 94.46 | 518.62 |
| | 03/11/14 17:32:30 | 101160 | 12.27 | 0.37 | 0.09 | 6.24 | 2.21 | 93.56 | 517.02 |
| | 03/11/14 17:33:00 | 101190 | 12.39 | 0.23 | 0.10 | 6.37 | 2.21 | 93.11 | 514.29 |
| | 03/11/14 17:33:30 | 101220 | 13.25 | 0.26 | 0.11 | 5.66 | 2.21 | 93.11 | 512.93 |
| | 03/11/14 17:34:00 | 101250 | 13.51 | 0.29 | 0.12 | 5.37 | 2.21 | 92.66 | 514.67 |
| | 03/11/14 17:34:30 | 101280 | 15.28 | 1.36 | 0.91 | 4.45 | 2.21 | 92.66 | 512.19 |
| | 03/11/14 17:35:00 | 101310 | 15.89 | 9.33 | 0.89 | 3.66 | 13.56 | 92.66 | 983.90 |
| | 03/11/14 17:35:30 | 101340 | 15.26 | 5.88 | 0.39 | 4.12 | 26.02 | 92.66 | 1,299.65 |
| | 03/11/14 17:36:00 | 101370 | 13.76 | 6.69 | 0.18 | 5.23 | 26.02 | 93.11 | 1,310.91 |
| | 03/11/14 17:36:30 | 101400 | 12.93 | 1.46 | 0.12 | 5.89 | 25.47 | 93.56 | 1,298.07 |
| | 03/11/14 17:37:00 | 101430 | 12.92 | 0.66 | 0.12 | 5.99 | 25.47 | 93.56 | 1,292.25 |
| | 03/11/14 17:37:30 | 101460 | 13.34 | 0.89 | 0.13 | 5.63 | 25.47 | 93.56 | 1,302.55 |
| | 03/11/14 17:38:00 | 101490 | 12.97 | 0.88 | 0.09 | 5.72 | 26.02 | 93.56 | 1,298.05 |
| | 03/11/14 17:38:30 | 101520 | 12.35 | 0.36 | 0.05 | 6.18 | 25.47 | 93.56 | 1,305.48 |

**John Zink Co, LLC**
**March 11, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 82,138 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 29.40 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 84 | $^{o}$F |
| Specific Humidity | 0.007045 | lb $H_2O$ / lb air |

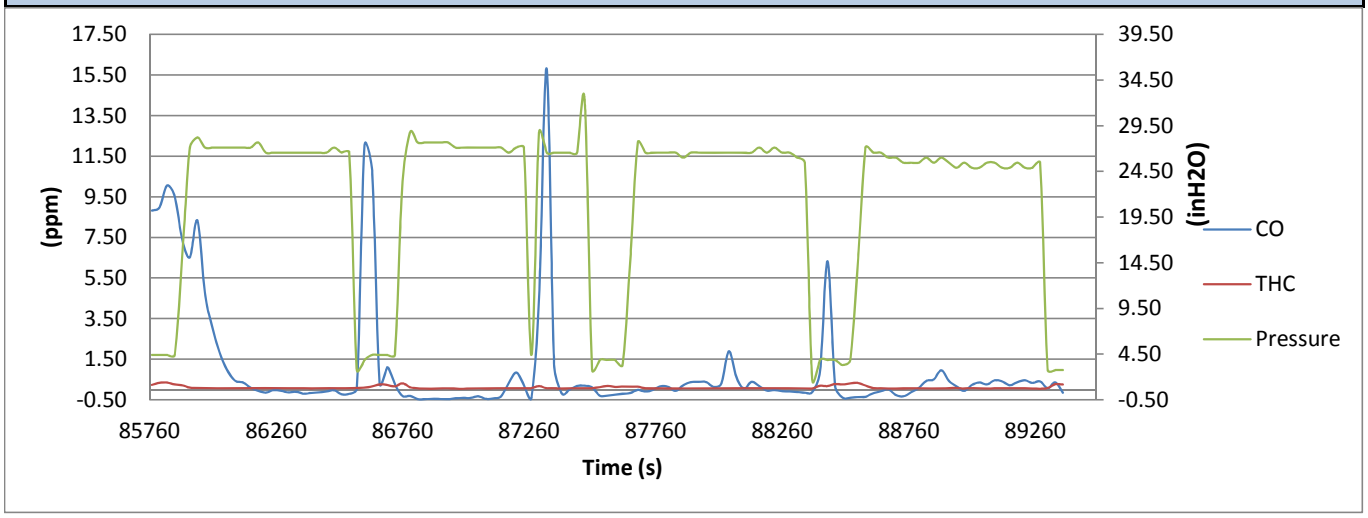
0-30-0 Load, Run - 4.0X30PF R3

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/11/14 17:39:00 | 101550 | 12.29 | 0.28 | 0.07 | 6.38 | 26.02 | 93.56 | 1,306.82 |
| 03/11/14 17:39:30 | 101580 | 12.30 | 0.22 | 0.06 | 6.40 | 25.47 | 93.56 | 1,297.08 |
| 03/11/14 17:40:00 | 101610 | 12.11 | 0.13 | 0.04 | 6.52 | 26.02 | 93.56 | 1,299.82 |
| 03/11/14 17:40:30 | 101640 | 12.57 | 0.16 | 0.05 | 6.25 | 26.02 | 93.56 | 1,298.80 |
| 03/11/14 17:41:00 | 101670 | 12.86 | 0.24 | 0.06 | 6.02 | 25.47 | 93.56 | 1,297.24 |
| 03/11/14 17:41:30 | 101700 | 12.97 | 0.44 | 0.06 | 5.93 | 26.02 | 93.56 | 1,296.05 |
| 03/11/14 17:42:00 | 101730 | 13.05 | 0.49 | 0.05 | 5.86 | 26.02 | 94.01 | 1,306.10 |
| 03/11/14 17:42:30 | 101760 | 13.04 | 0.56 | 0.05 | 5.86 | 25.47 | 94.01 | 1,295.13 |
| 03/11/14 17:43:00 | 101790 | 12.93 | 0.48 | 0.05 | 5.97 | 25.47 | 94.01 | 1,309.85 |
| 03/11/14 17:43:30 | 101820 | 13.00 | 0.41 | 0.05 | 5.94 | 26.57 | 94.46 | 1,318.60 |
| 03/11/14 17:44:00 | 101850 | 13.12 | 0.54 | 0.05 | 5.83 | 26.02 | 94.46 | 1,311.47 |
| 03/11/14 17:44:30 | 101880 | 12.93 | 0.58 | 0.04 | 5.93 | 25.47 | 94.46 | 1,300.62 |
| 03/11/14 17:45:00 | 101910 | 12.95 | 0.57 | 0.04 | 5.85 | 26.02 | 94.91 | 1,306.74 |
| 03/11/14 17:45:30 | 101940 | 13.01 | 0.50 | 0.05 | 5.84 | 20.48 | 94.91 | 1,115.48 |
| 03/11/14 17:46:00 | 101970 | 13.99 | 0.53 | 0.14 | 5.31 | 2.77 | 94.46 | 519.05 |
| 03/11/14 17:46:30 | 102000 | 15.83 | 1.57 | 0.31 | 3.65 | 2.77 | 94.01 | 518.48 |
| 03/11/14 17:47:00 | 102030 | 14.56 | 0.71 | 0.24 | 4.49 | 2.77 | 93.56 | 520.33 |
| 03/11/14 17:47:30 | 102060 | 13.10 | 0.33 | 0.27 | 5.81 | 3.32 | 93.11 | 519.00 |
| 03/11/14 17:48:00 | 102090 | 13.01 | 0.33 | 0.23 | 5.61 | 2.77 | 93.11 | 518.53 |
| **RAW AVERAGE** | | **12.99** | **0.86** | **0.09** | **5.83** | **19.57** | **94.21** | **1,091.65** |

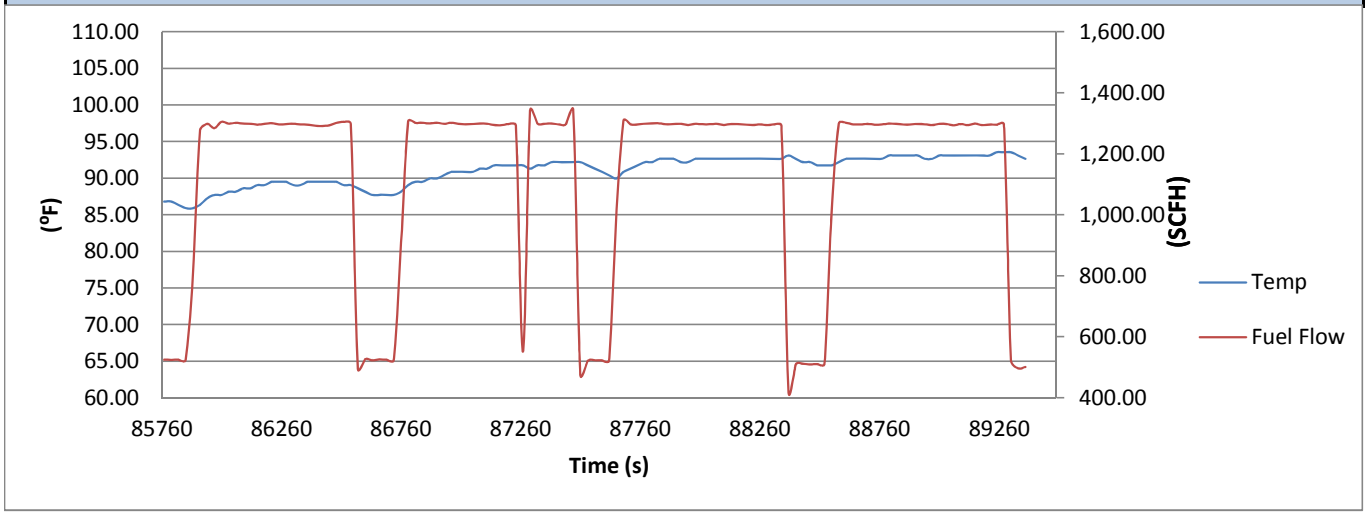
| | | $CO_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | (%) | (ppmvd) | (ppmvw) | (%) | (in. $H_2O$) | ($^{o}$F) | (SCFH) |
| **Bias** | **Initial Zero** | 0.01 | 0.14 | 0.02 | 0.04 | | | |
| | **Final Zero** | 0.01 | 0.13 | 0.04 | 0.03 | | | |
| | **Avg. Zero** | 0.01 | 0.14 | 0.03 | 0.04 | | | |
| | **Initial UpScale** | 12.00 | 8.88 | 2.94 | 9.23 | | | |
| | **Final UpScale** | 12.01 | 8.49 | 2.96 | 9.28 | | | |
| | **Avg. UpScale** | 12.01 | 8.69 | 2.95 | 9.26 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| EMISSIONS DATA | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.98 | 0.76 | 0.06 | 5.93 |
| **Corrected Raw Average (ppm/% wet basis)** | 12.29 | 0.71 | 0.06 | 5.61 |
| **Emission Rate (lb/hr)** | N/A | 0.00 | 0.00 | N/A |

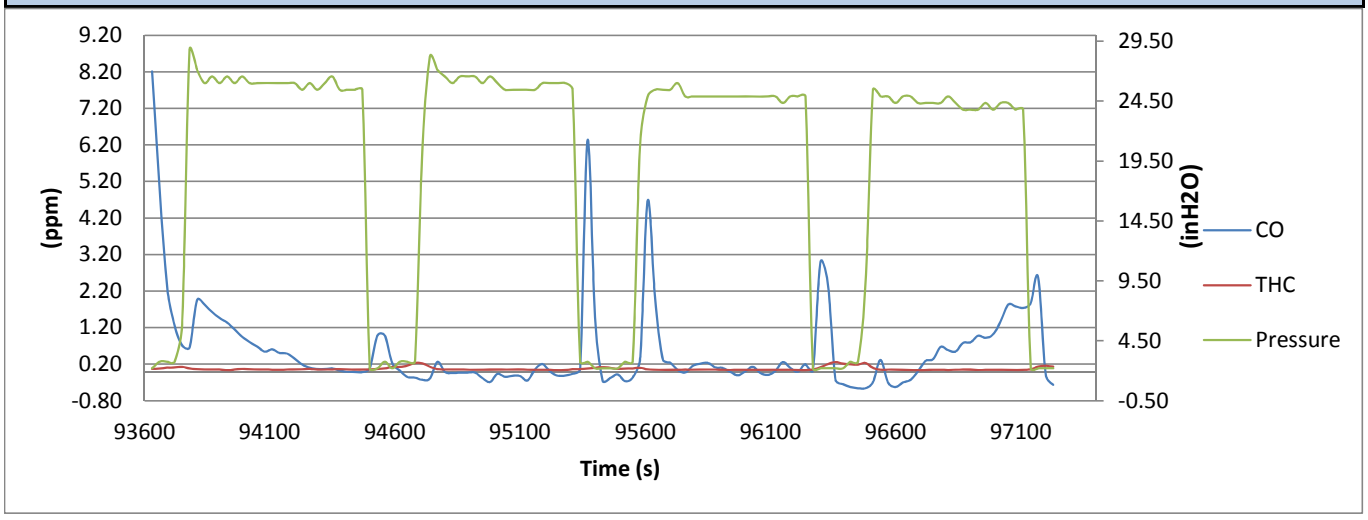
## 4.0X30PF R1



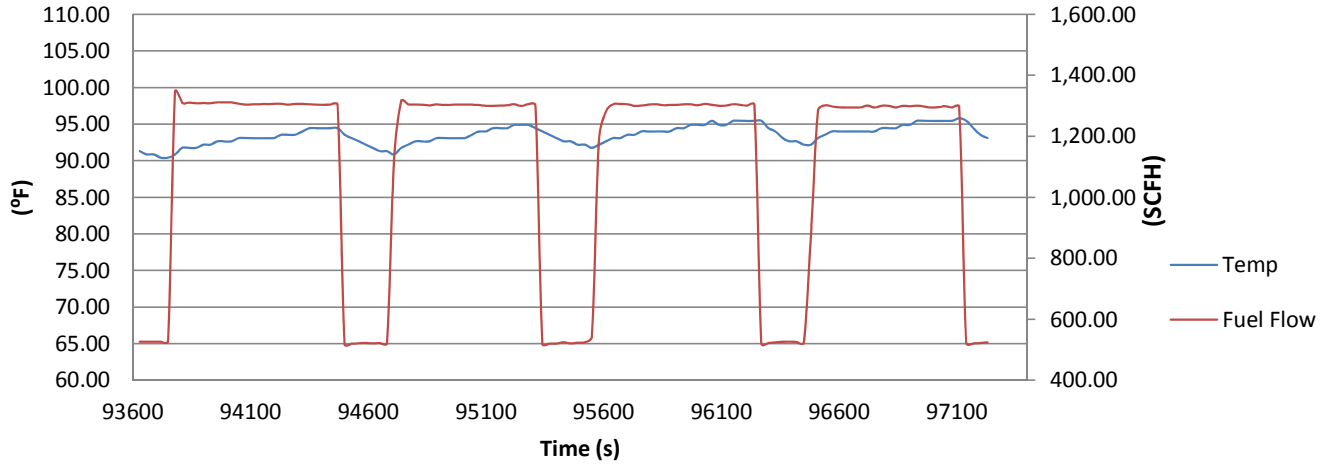

## 4.0X30PF R1



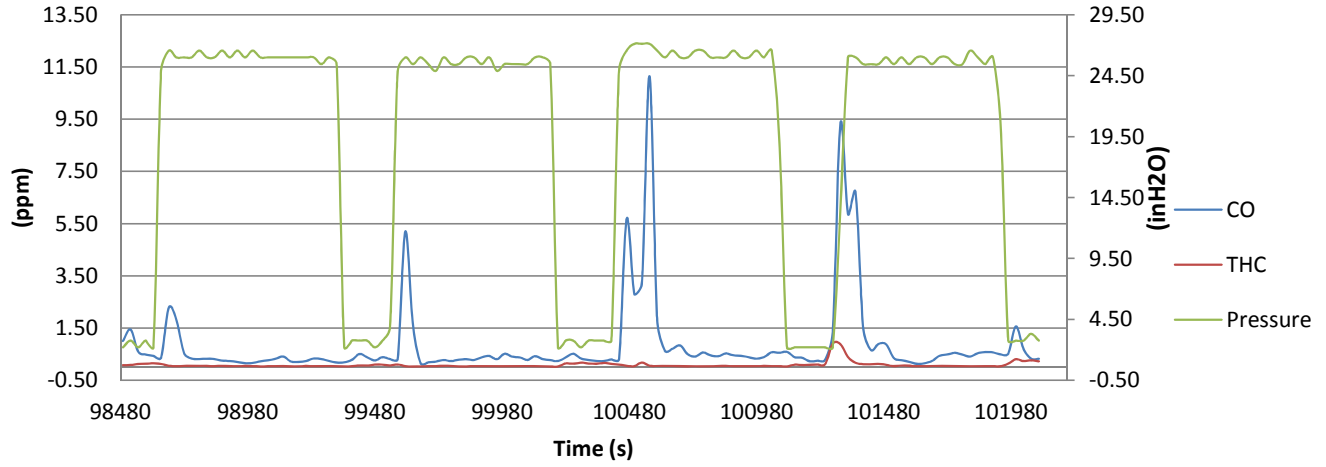

## 4.0X30PF R2



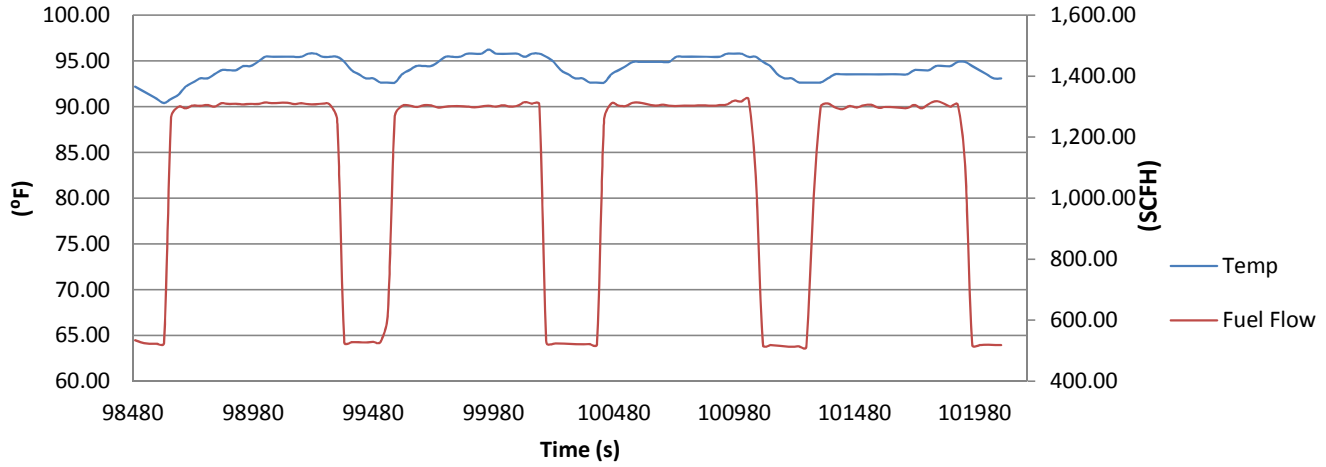
## 4.0X30PF R2

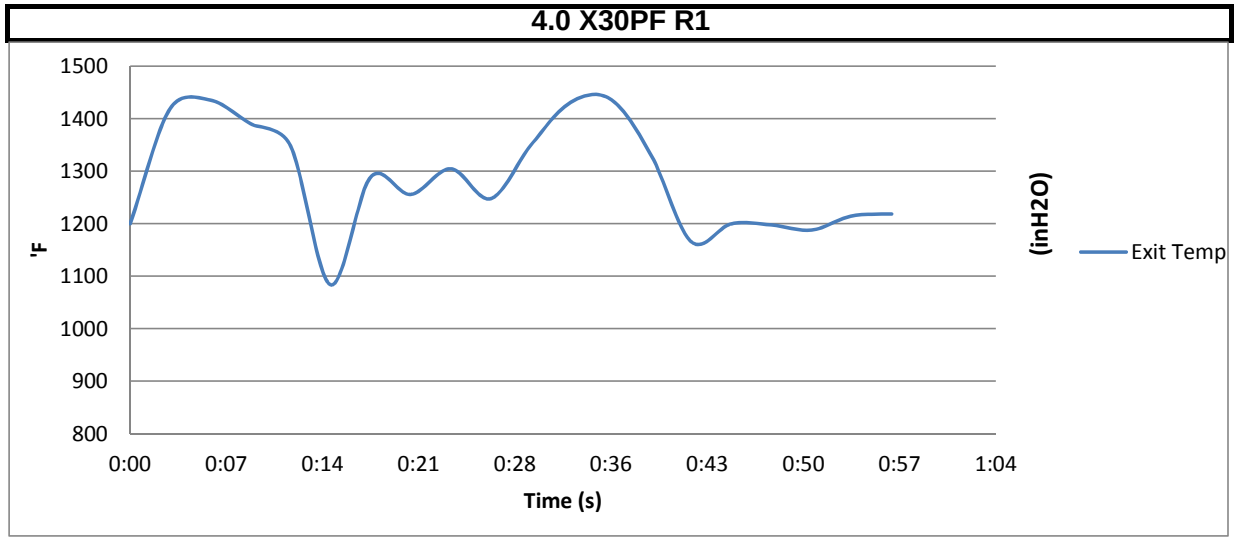


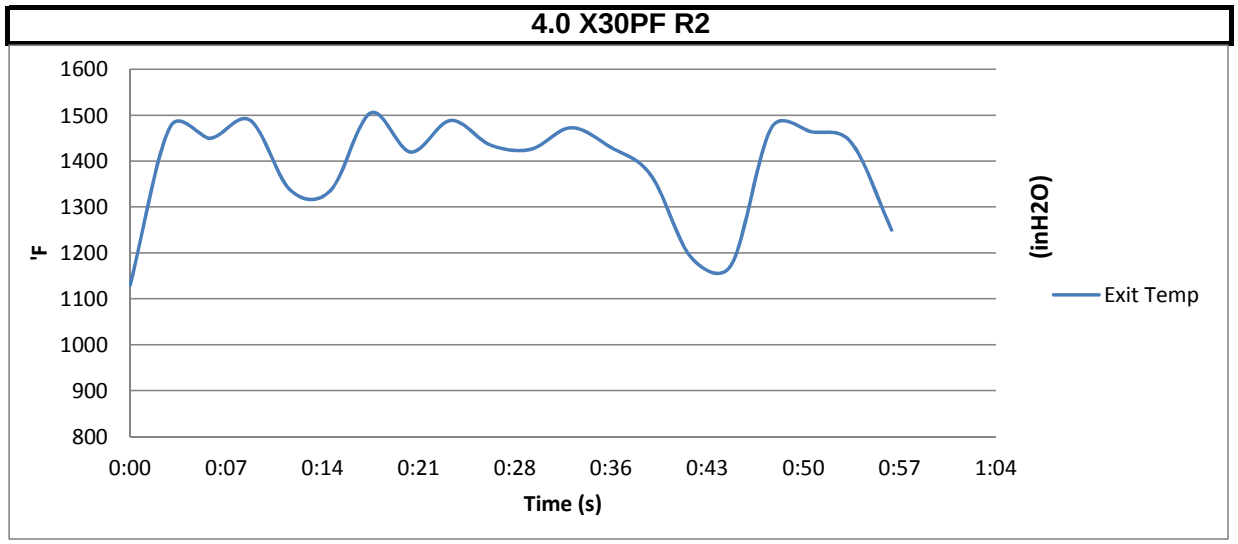

## 4.0X30PF R3

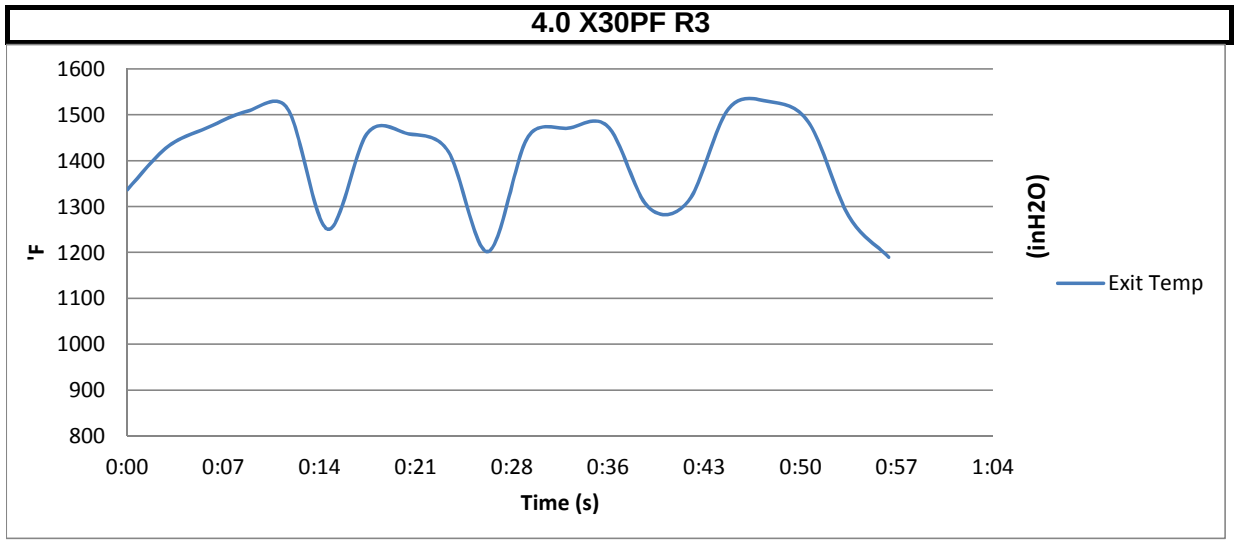



## 4.0X30PF R3




4.0 X30PF R1
1500
1400
1300
1200
1100
1000
900
800
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp


4.0 X30PF R2
1600
1500
1400
1300
1200
1100
1000
900
800
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp


4.0 X30PF R3
1600
1500
1400
1300
1200
1100
1000
900
800
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp

# EMISSION DATA RECORDS

## 30-70-30% Ramp-up, Ramp-down Unit Operations Data

| METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE |
|---|

| Source Information | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Fuel Type** | Gas, Propene |

| Test Information | | | |
|---|---|---|---|
| **Project #** | | jz-14-tulsa.ok-comp#1 | |
| **Operator** | | TP | |
| **Date for Preliminary Run** | (mm/dd/yy) | 03/11/14 | |
| **Standard Temperature** | | 68 | °F |
| **Standard Pressure** | | 29.92 | in Hg |
| **Required Sample Vol.** | RM4, 8.1.1.2 | 21 | scf |
| **Run Duration** | ≤0.75 cfm | 60 | minutes |
| **Unit Number** | | 1 | |
| **Base Run Number** | | 30-70-30% | |
| **Number of Ports Available** | | 2 | |
| **Number of Ports Used** | | 2 | |
| **Port Inside Diameter** | | 4.00 | in |
| **Stack Shape** | | Circular | |

| Test Equipment Information | | | | | |
|---|---|---|---|---|---|
| **Run** | | **4** | **5** | **6** | |
| **Test Date** | (mm/dd/yy) | 03/12/14 | 03/12/14 | 03/12/14 | |
| **Load** | % or w/DB | 30-70-30 | 30-70-30 | 30-70-30 | |
| **Meter Box Number** | from ACS | samp-cp-0008 | samp-cp-0008 | samp-cp-0008 | |
| **Meter Calibration Factor** | (Y) | 0.924 | 0.924 | 0.924 | |
| **Orifice Meter Coefficient** | ($\Delta H_@$) | 1.700 | 1.700 | 1.700 | in $H_2O$ |
| **Pitot Identification** | from ACS | A4174 | A4174 | A4174 | |
| **Pitot Tube Coefficient** | ($C_p$) | 0.819 | 0.819 | 0.819 | |
| **Probe Number** | from ACS | samp-hp-0003 | samp-hp-0003 | samp-hp-0003 | |
| **Probe Length** | | 60.0 | 60.0 | 60.0 | in |
| **(SS, Glass …. ) Liner Material** | from list | inconel | inconel | inconel | |
| **Impinger Case Number** | from ACS | SAMP-BC-0012 | SAMP-BC-0012 | SAMP-BC-0012 | |

| Testing Company Information | |
|---|---|
| **Company Name** | Air Hygiene International, Inc. (Tulsa, Oklahoma) |
| **Address** | 1600 W Tacoma Street |
| **City, State Zip** | Broken Arrow, Oklahoma 74012 |
| **Project Manager** | Min Sum Lee |
| **Phone Number** | (918) 307-8865 |
| **Fax Number** | (918) 307-9131 |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] - RESULTS

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| **Historical Data** | **30-70-30%-4** | **30-70-30%-5** | **30-70-30%-6** | **Average** | **Units** |
|---|---|---|---|---|---|
| Run Start Time | 08:34 | 10:00 | 11:22 | | hh:mm |
| Run Stop Time | 09:40 | 11:08 | 12:25 | | hh:mm |
| Test Date | 03/12/14 | 03/12/14 | 03/12/14 | | mm/dd/yy |
| Meter Calibration Factor | 0.924 | 0.924 | 0.924 | | |
| Pitot Tube Coefficient | 0.819 | 0.819 | 0.819 | | |
| **Stack Test Data** | **30-70-30%-4** | **30-70-30%-5** | **30-70-30%-6** | **Average** | **Units** |
| Initial Meter Volume | 17.782 | 64.634 | 114.870 | | $ft^3$ |
| Final Meter Volume | 64.450 | 114.633 | 162.427 | | $ft^3$ |
| Total Meter Volume | 46.668 | 49.999 | 47.557 | 48.075 | $ft^3$ |
| Total Sampling Time | 60.00 | 60.00 | 60.00 | 60.00 | min |
| Average Meter Temperature | 51.78 | 55.73 | 61.28 | 56.26 | °F |
| Average Stack Temperature | 1552.15 | 1523.00 | 1553.05 | 1542.73 | °F |
| Barometric Pressure | 30.21 | 30.26 | 30.26 | 30.24 | in Hg |
| Stack Static Pressure | 0.00 | 0.00 | 0.00 | 0.00 | in $H_2O$ |
| Absolute Stack Pressure | 30.21 | 30.26 | 30.26 | 30.24 | in Hg |
| Average Orifice Pressure Drop | 1.70 | 1.70 | 1.70 | 1.70 | in $H_2O$ |
| Absolute Meter Pressure | 30.34 | 30.39 | 30.39 | 30.37 | in Hg |
| Avg Square Root Pitot Pressure | 0.15 | 0.16 | 0.17 | 0.16 | √(in $H_2O$) |
| **Moisture Content Data** | **30-70-30%-4** | **30-70-30%-5** | **30-70-30%-6** | **Average** | **Units** |
| Impinger Water Weight Gain | 48.50 | 47.10 | 47.10 | 47.57 | g |
| Silica Gel Weight Gain | 5.50 | 11.40 | 7.90 | 8.27 | g |
| Total Water Volume Collected | 54.10 | 58.61 | 55.10 | 55.93 | ml |
| Standard Water Vapor Volume | 2.55 | 2.76 | 2.59 | 2.63 | scf |
| Standard Meter Volume | 45.1 | 48.0 | 45.2 | 46.1 | dscf |
| Calculated Stack Moisture | 5.34 | 5.43 | 5.43 | 5.40 | % |
| Saturated Stack Moisture | 100.00 | 100.00 | 100.00 | 100.00 | % |
| Reported Stack Moisture Content | 5.34 | 5.43 | 5.43 | 5.40 | % |
| **Gas Analysis Data** | **30-70-30%-4** | **30-70-30%-5** | **30-70-30%-6** | **Average** | **Units** |
| Carbon Dioxide Content | 5.9 | 5.9 | 5.5 | 5.8 | % |
| Oxygen Content | 14.0 | 14.0 | 14.6 | 14.2 | % |
| Nitrogen Content | 80.1 | 80.1 | 79.9 | 80.0 | % |
| Stack Dry Molecular Weight | 29.51 | 29.51 | 29.47 | 29.49 | lb/lb-mole |
| Stack Wet Molecular Weight | 28.89 | 28.88 | 28.85 | 28.87 | lb/lb-mole |
| Percent Excess Air | 196.0 | 196.0 | 225.1 | 205.7 | % |
| **Volumetric Flow Rate Data** | **30-70-30%-4** | **30-70-30%-5** | **30-70-30%-6** | **Average** | **Units** |
| Average Stack Gas Velocity | 15.71 | 16.69 | 17.73 | 16.71 | ft/sec |
| Stack Cross-Sectional Area | 12.57 | 12.57 | 12.57 | 12.57 | $ft^2$ |
| Actual Stack Flow Rate | 11,843 | 12,587 | 13,371 | 12,600 | acfm |
| Wet Standard Stack Flow Rate | 188 | 203 | 213 | 201 | wkscfh |
| Dry Standard Stack Flow Rate | 178,215 | 192,325 | 201,263 | 190,601 | dscfh |

## METHOD 3C - DETERMINATION OF DRY MOLECULAR WEIGHT BY ANALYZER

| | | | | | |
|---|---|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Preliminary Date** | 03/11/14 | | |
| **Sampling Location** | 4.0X30PF | **Operator** | TP | | |
| **Project #** | jz-14-tulsa.ok-comp#1 | **# of Ports Used** | 2 | | |
| **Fuel Type** | Gas, Propene | **Min. Fuel Factor** | N/A | **Max. Fuel Factor** | N/A |

| **Gas Analysis Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 30-70-30%-4 | | **Date** | 03/12/14 | **Run Start Time** | 08:34 | | **Run Stop Time** | 09:40 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:06 | 5.9 | 14.0 | 0.0 | 80.1 | 29.51 | 1.168 | | 196.0 | N/A |

| **Gas Analysis Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 30-70-30%-5 | | **Date** | 03/12/14 | **Run Start Time** | 10:00 | | **Run Stop Time** | 11:08 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:08 | 5.9 | 14.0 | 0.0 | 80.1 | 29.51 | 1.168 | | 196.0 | N/A |

| **Gas Analysis Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 30-70-30%-6 | | **Date** | 03/12/14 | **Run Start Time** | 11:22 | | **Run Stop Time** | 12:25 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:03 | 5.5 | 14.6 | 0.0 | 79.9 | 29.47 | 1.139 | | 225.1 | N/A |

## METHOD 4 - DETERMINATION OF MOISTURE CONTENT IN STACK GASES

| | | | |
|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Preliminary Date** | 03/11/14 |
| **Sampling Location** | 4.0X30PF | **Operator** | TP |
| **Project #** | jz-14-tulsa.ok-comp#1 | **Ports Used** | 2 |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 30-70-30%-4 | | **Date** | 03/12/14 | **Start Time** | 08:34 | **Stop Time** | 09:40 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 46.668 | dcf | | **Barometric Pressure** | ($P_b$) | 30.21 | in Hg |
| **Average Stack Temp** | | $(t_s)_{avg}$ | 1552 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | $(t_m)_{avg}$ | 52 | °F | | **Avg Orifice Pressure** | $(\Delta H)_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 773.60 | 700.10 | 592.60 | 804.40 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 735.10 | 691.10 | 591.60 | 798.90 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 38.5 | 9.0 | 1.0 | 5.5 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 54.00 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.546 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 45.105 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 5.34 | % | | **Final Moisture Content** | ($B_{ws}$) | 5.34 | % |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 30-70-30%-5 | | **Date** | 03/12/14 | **Start Time** | 10:00 | **Stop Time** | 11:08 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 49.999 | dcf | | **Barometric Pressure** | ($P_b$) | 30.26 | in Hg |
| **Average Stack Temp** | | $(t_s)_{avg}$ | 1523 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | $(t_m)_{avg}$ | 56 | °F | | **Avg Orifice Pressure** | $(\Delta H)_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 794.60 | 748.10 | 578.90 | 907.40 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 739.10 | 756.10 | 579.30 | 896.00 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 55.5 | -8.0 | -0.4 | 11.4 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 58.50 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.758 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 48.034 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 5.43 | % | | **Final Moisture Content** | ($B_{ws}$) | 5.43 | % |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 30-70-30%-6 | | **Date** | 03/12/14 | **Start Time** | 11:22 | **Stop Time** | 12:25 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 47.557 | dcf | | **Barometric Pressure** | ($P_b$) | 30.26 | in Hg |
| **Average Stack Temp** | | $(t_s)_{avg}$ | 1553 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | $(t_m)_{avg}$ | 61 | °F | | **Avg Orifice Pressure** | $(\Delta H)_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 809.00 | 709.40 | 595.00 | 812.30 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 773.60 | 700.10 | 592.60 | 804.40 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 35.4 | 9.3 | 2.4 | 7.9 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 55.00 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.593 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 45.201 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 5.43 | % | | **Final Moisture Content** | ($B_{ws}$) | 5.43 | % |

**METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA**

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/12/14 |
| **Operator** | TP |
| **Run Number** | 30-70-30%-4 |

| **Ideal Nozzle Diameter and IsoKinetic Factor Setup** | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1552.2 | °F |
| **Average Meter Temp** | ($t_m$) | 51.8 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.15 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 5.34 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.51 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.75 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| **Leak Checks** | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.01 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.02 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.02 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.01 | in $H_2O$ for | 15.0 | sec |

| **Sampling Equipment** | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4710 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | SAMP-BC-0012 | | |
| **Impinger Case Number** | SAMP-BC-0012 | | |

| **Pressures** | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.21 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.21 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.34 | in Hg |

| **Nozzle Measurements** | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| **Run Time** | | | |
|---|---|---|---|
| **Start** | 08:34 | **End** | 09:40 |

| **Weights** | **Imp 1** | **Imp 2** | **Imp 3** | **Imp 4** | **Imp 5** | **Imp 6** | **Imp 7** | **Imp 8** |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 735.1 | 691.1 | 591.6 | 798.9 | | | | |
| **Post** | 773.6 | 700.1 | 592.6 | 804.4 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| **Traverse Point #** | **Sampling Time (Θ)** | **Timer Time** | **Dry Gas Meter Reading ($V_m$)** | **Velocity Head (Δp)** | **Desired Orifice ΔH ($\Delta H_d$)** | **Actual Orifice ΔH ($\Delta H_a$)** | **Stack Temp ($t_s$)** | **Snorkel Temp (248±25°F)** | **Filter Temp (248±25°F)** | **Impinger Exit Temp (≤68°F)** | **Cond. Temp (≤--°F)** | **CPM Filter Temp (--±--°F)** | **Meter Inlet Temp ($t_{mi}$)** | **Meter Outlet Temp ($t_{mo}$)** | **Pump Vacuum** | **Square Root ΔP ($\Delta p^{1/2}$)** | **Local Stack Velocity ($v_s$)$_l$** | **Cumul. Meter Volume ($V_m$)$_{std}$** | **Cumul. Percent IsoKinetic (I)** | **Est-Run Meter Volume ($V_m$)$_{std}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 17.782 | 0.005 | 1.700 | 1.70 | 1460 | 240 | | 39 | | | 47 | 47 | 3.5 | 0.07 | 7.35 | 2.325 | | 46.498 |
| A-2 | 3.0 | 00:03:00 | 20.165 | 0.010 | 1.700 | 1.70 | 1431 | 240 | | 41 | | | 48 | 47 | 3.5 | 0.10 | 10.31 | 4.601 | | 46.007 |
| A-3 | 6.0 | 00:06:00 | 22.500 | 0.015 | 1.700 | 1.70 | 1606 | 240 | | 43 | | | 50 | 47 | 3.5 | 0.12 | 13.20 | 6.872 | | 45.814 |
| A-4 | 9.0 | 00:09:00 | 24.835 | 0.025 | 1.700 | 1.70 | 1602 | 240 | | 44 | | | 51 | 47 | 3.5 | 0.16 | 17.02 | 9.141 | | 45.706 |
| A-5 | 12.0 | 00:12:00 | 27.170 | 0.035 | 1.700 | 1.70 | 1626 | 240 | | 46 | | | 52 | 47 | 3.5 | 0.19 | 20.26 | 11.398 | | 45.594 |
| A-6 | 15.0 | 00:15:00 | 29.495 | 0.010 | 1.700 | 1.70 | 1508 | 240 | | 46 | | | 54 | 47 | 3.5 | 0.10 | 10.52 | 13.680 | | 45.601 |
| A-7 | 18.0 | 00:18:00 | 31.850 | 0.010 | 1.700 | 1.70 | 1436 | 240 | | 47 | | | 55 | 47 | 3.5 | 0.10 | 10.32 | 16.129 | | 46.083 |
| A-8 | 21.0 | 00:21:00 | 34.380 | 0.035 | 1.700 | 1.70 | 1635 | 240 | | 46 | | | 55 | 48 | 3.5 | 0.19 | 20.30 | 18.179 | | 45.448 |
| A-9 | 24.0 | 00:24:00 | 36.500 | 0.035 | 1.700 | 1.70 | 1680 | 240 | | 47 | | | 55 | 48 | 3.5 | 0.19 | 20.52 | 20.452 | | 45.449 |
| A-10 | 27.0 | 00:27:00 | 38.850 | 0.035 | 1.700 | 1.70 | 1664 | 240 | | 47 | | | 56 | 49 | 3.5 | 0.19 | 20.44 | 22.701 | | 45.401 |
| B-1 | 30.0 | 00:30:00 | 41.180 | 0.010 | 1.700 | 1.70 | 1468 | 240 | | 46 | | | 54 | 48 | 3.5 | 0.10 | 10.41 | 24.966 | | 45.392 |
| B-2 | 33.0 | 00:33:00 | 43.520 | 0.025 | 1.700 | 1.70 | 1548 | 240 | | 46 | | | 57 | 49 | 3.5 | 0.16 | 16.80 | 27.164 | | 45.274 |
| B-3 | 36.0 | 00:36:00 | 45.800 | 0.025 | 1.700 | 1.70 | 1556 | 240 | | 46 | | | 57 | 49 | 3.5 | 0.16 | 16.83 | 29.353 | | 45.158 |
| B-4 | 39.0 | 00:39:00 | 48.070 | 0.035 | 1.700 | 1.70 | 1567 | 240 | | 46 | | | 57 | 50 | 3.5 | 0.19 | 19.97 | 31.588 | | 45.125 |
| B-5 | 42.0 | 00:42:00 | 50.390 | 0.010 | 1.700 | 1.70 | 1498 | 240 | | 47 | | | 57 | 50 | 3.5 | 0.10 | 10.49 | 33.847 | | 45.129 |
| B-6 | 45.0 | 00:45:00 | 52.735 | 0.030 | 1.700 | 1.70 | 1578 | 240 | | 47 | | | 57 | 51 | 3.5 | 0.17 | 18.54 | 36.122 | | 45.153 |
| B-7 | 48.0 | 00:48:00 | 55.100 | 0.040 | 1.700 | 1.70 | 1585 | 240 | | 47 | | | 58 | 51 | 3.5 | 0.20 | 21.45 | 38.334 | | 45.098 |
| B-8 | 51.0 | 00:51:00 | 57.400 | 0.050 | 1.700 | 1.70 | 1594 | 240 | | 48 | | | 58 | 51 | 3.5 | 0.22 | 24.03 | 40.641 | | 45.157 |
| B-9 | 54.0 | 00:54:00 | 59.800 | 0.020 | 1.700 | 1.70 | 1531 | 240 | | 47 | | | 58 | 51 | 3.5 | 0.14 | 14.96 | 42.852 | | 45.108 |
| B-10 | 57.0 | 00:57:00 | 62.100 | 0.010 | 1.700 | 1.70 | 1470 | 240 | | 48 | | | 59 | 52 | 3.5 | 0.10 | 10.42 | 45.107 | | 45.107 |
| Last Pt | 60.0 | 01:00:00 | 64.450 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 64.450 | | | | | | | | | | | **Max Vac** | 3.5 | **Final Values** | | 45.107 | | |
| **Average Values** | | | | 0.02 | | 1.70 | 1552 | 240 | | 46 | | | 55 | 49 | | 0.15 | 15.71 | | | |
| | | | | | | | | | | | | | 52 | | | | | | | |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/12/14 |
| **Operator** | TP |
| **Run Number** | 30-70-30%-5 |

| Ideal Nozzle Diameter and IsoKinetic Factor Setup | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1523.0 | °F |
| **Average Meter Temp** | ($t_m$) | 55.7 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.16 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 5.43 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.51 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.75 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| Leak Checks | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.02 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.02 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.03 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.02 | in $H_2O$ for | 15.0 | sec |

| Sampling Equipment | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4602 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | SAMP-BC-0012 | | |
| **Impinger Case Number** | SAMP-BC-0012 | | |

| Pressures | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.26 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.26 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.39 | in Hg |

| Nozzle Measurements | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| Run Time | | | |
|---|---|---|---|
| **Start** | 10:00 | **End** | 11:08 |

| Weights | Imp 1 | Imp 2 | Imp 3 | Imp 4 | Imp 5 | Imp 6 | Imp 7 | Imp 8 |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 739.1 | 756.1 | 579.3 | 896.0 | | | | |
| **Post** | 794.6 | 748.1 | 578.9 | 907.4 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| Traverse Point # | Sampling Time (Θ) | Timer Time | Dry Gas Meter Reading ($V_m$) | Velocity Head (Δp) | Desired Orifice ΔH ($\Delta H_d$) | Actual Orifice ΔH ($\Delta H_a$) | Stack Temp ($t_s$) | Snorkel Temp (248±25°F) | Filter Temp (248±25°F) | Impinger Exit Temp (≤68°F) | Cond. Temp (≤--°F) | CPM Filter Temp (--±--°F) | Meter Inlet Temp ($t_{mi}$) | Meter Outlet Temp ($t_{mo}$) | Pump Vacuum | Square Root ΔP ($\Delta p^{1/2}$) | Local Stack Velocity ($v_s$)$_l$ | Cumul. Meter Volume ($V_m$)$_{std}$ | Cumul. Percent IsoKinetic (I) | Est-Run Meter Volume ($V_m$)$_{std}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 64.634 | 0.005 | 1.700 | 1.70 | 1459 | 240 | | 47 | | | 51 | 51 | 2.5 | 0.07 | 7.34 | 4.669 | | 93.390 |
| A-2 | 3.0 | 00:03:00 | 69.450 | 0.025 | 1.700 | 1.70 | 1497 | 240 | | 44 | | | 55 | 51 | 2.5 | 0.16 | 16.57 | 6.973 | | 69.729 |
| A-3 | 6.0 | 00:06:00 | 71.835 | 0.030 | 1.700 | 1.70 | 1517 | 240 | | 45 | | | 56 | 51 | 2.5 | 0.17 | 18.25 | 9.231 | | 61.538 |
| A-4 | 9.0 | 00:09:00 | 74.175 | 0.030 | 1.700 | 1.70 | 1523 | 240 | | 46 | | | 57 | 51 | 2.5 | 0.17 | 18.28 | 11.501 | | 57.504 |
| A-5 | 12.0 | 00:12:00 | 76.530 | 0.010 | 1.700 | 1.70 | 1498 | 240 | | 48 | | | 58 | 51 | 2.5 | 0.10 | 10.49 | 13.783 | | 55.132 |
| A-6 | 15.0 | 00:15:00 | 78.900 | 0.010 | 1.700 | 1.70 | 1464 | 240 | | 47 | | | 58 | 51 | 2.5 | 0.10 | 10.39 | 16.094 | | 53.647 |
| A-7 | 18.0 | 00:18:00 | 81.300 | 0.040 | 1.700 | 1.70 | 1616 | 240 | | 49 | | | 59 | 52 | 2.5 | 0.20 | 21.59 | 18.353 | | 52.436 |
| A-8 | 21.0 | 00:21:00 | 83.650 | 0.040 | 1.700 | 1.70 | 1608 | 240 | | 49 | | | 59 | 52 | 2.5 | 0.20 | 21.55 | 20.655 | | 51.637 |
| A-9 | 24.0 | 00:24:00 | 86.045 | 0.030 | 1.700 | 1.70 | 1565 | 240 | | 51 | | | 59 | 52 | 2.5 | 0.17 | 18.47 | 22.956 | | 51.014 |
| A-10 | 27.0 | 00:27:00 | 88.440 | 0.010 | 1.700 | 1.70 | 1446 | 240 | | 51 | | | 59 | 53 | 2.5 | 0.10 | 10.35 | 25.281 | | 50.562 |
| B-1 | 30.0 | 00:30:00 | 90.861 | 0.030 | 1.700 | 1.70 | 1608 | 240 | | 51 | | | 57 | 53 | 2.5 | 0.17 | 18.66 | 27.558 | | 50.106 |
| B-2 | 33.0 | 00:33:00 | 93.228 | 0.030 | 1.700 | 1.70 | 1601 | 240 | | 51 | | | 59 | 53 | 2.5 | 0.17 | 18.63 | 29.821 | | 49.702 |
| B-3 | 36.0 | 00:36:00 | 95.585 | 0.025 | 1.700 | 1.70 | 1516 | 240 | | 51 | | | 60 | 53 | 2.5 | 0.16 | 16.65 | 32.100 | | 49.384 |
| B-4 | 39.0 | 00:39:00 | 97.960 | 0.010 | 1.700 | 1.70 | 1435 | 240 | | 51 | | | 60 | 54 | 2.5 | 0.10 | 10.32 | 34.390 | | 49.129 |
| B-5 | 42.0 | 00:42:00 | 100.350 | 0.035 | 1.700 | 1.70 | 1560 | 240 | | 52 | | | 61 | 54 | 2.5 | 0.19 | 19.92 | 36.645 | | 48.860 |
| B-6 | 45.0 | 00:45:00 | 102.705 | 0.040 | 1.700 | 1.70 | 1552 | 240 | | 53 | | | 61 | 54 | 2.5 | 0.20 | 21.26 | 38.914 | | 48.642 |
| B-7 | 48.0 | 00:48:00 | 105.075 | 0.045 | 1.700 | 1.70 | 1636 | 240 | | 55 | | | 61 | 54 | 2.5 | 0.21 | 23.01 | 41.188 | | 48.456 |
| B-8 | 51.0 | 00:51:00 | 107.450 | 0.040 | 1.700 | 1.70 | 1639 | 240 | | 55 | | | 61 | 55 | 2.5 | 0.20 | 21.71 | 43.531 | | 48.368 |
| B-9 | 54.0 | 00:54:00 | 109.900 | 0.040 | 1.700 | 1.70 | 1395 | 240 | | 55 | | | 61 | 55 | 2.5 | 0.20 | 20.41 | 45.970 | | 48.389 |
| B-10 | 57.0 | 00:57:00 | 112.450 | 0.010 | 1.700 | 1.70 | 1325 | 240 | | 57 | | | 62 | 55 | 2.5 | 0.10 | 10.01 | 48.056 | | 48.056 |
| Last Pt | 60.0 | 01:00:00 | 114.633 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 114.633 | | | | | | | | | | | **Max Vac** | 2.5 | **Final Values** | | 48.056 | | |
| **Average Values** | | | | 0.03 | | 1.70 | 1523 | 240 | | 50 | | | 59 | 53 | | 0.16 | 16.69 | | | |
| | | | | | | | | | | | | | 56 | | | | | | | |

**METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA**

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/12/14 |
| **Operator** | TP |
| **Run Number** | 30-70-30%-6 |

| **Ideal Nozzle Diameter and IsoKinetic Factor Setup** | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1553.1 | °F |
| **Average Meter Temp** | ($t_m$) | 61.3 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.17 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 5.43 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.47 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.80 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| **Leak Checks** | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.03 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.04 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.04 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.02 | in $H_2O$ for | 15.0 | sec |

| **Sampling Equipment** | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4680 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | SAMP-BC-0012 | | |
| **Impinger Case Number** | SAMP-BC-0012 | | |

| **Pressures** | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.26 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.26 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.39 | in Hg |

| **Nozzle Measurements** | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| **Run Time** | | | |
|---|---|---|---|
| **Start** | 11:22 | **End** | 12:25 |

| **Weights** | **Imp 1** | **Imp 2** | **Imp 3** | **Imp 4** | **Imp 5** | **Imp 6** | **Imp 7** | **Imp 8** |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 773.6 | 700.1 | 592.6 | 804.4 | | | | |
| **Post** | 809.0 | 709.4 | 595.0 | 812.3 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| **Traverse Point #** | **Sampling Time (Θ)** | **Timer Time** | **Dry Gas Meter Reading ($V_m$)** | **Velocity Head (Δp)** | **Desired Orifice ΔH ($\Delta H_d$)** | **Actual Orifice ΔH ($\Delta H_a$)** | **Stack Temp ($t_s$)** | **Snorkel Temp (248±25°F)** | **Filter Temp (248±25°F)** | **Impinger Exit Temp (≤68°F)** | **Cond. Temp (≤--°F)** | **CPM Filter Temp (--±--°F)** | **Meter Inlet Temp ($t_{mi}$)** | **Meter Outlet Temp ($t_{mo}$)** | **Pump Vacuum** | **Square Root ΔP ($\Delta p^{1/2}$)** | **Local Stack Velocity ($v_s$)$_l$** | **Cumul. Meter Volume ($V_m$)$_{std}$** | **Cumul. Percent IsoKinetic (I)** | **Est-Run Meter Volume ($V_m$)$_{std}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 114.870 | 0.005 | 1.700 | 1.70 | 1451 | 240 | | 52 | | | 59 | 55 | 3.5 | 0.07 | 7.33 | 2.252 | | 45.041 |
| A-2 | 3.0 | 00:03:00 | 117.220 | 0.025 | 1.700 | 1.70 | 1567 | 240 | | 51 | | | 64 | 55 | 3.5 | 0.16 | 16.88 | 4.503 | | 45.028 |
| A-3 | 6.0 | 00:06:00 | 119.580 | 0.035 | 1.700 | 1.70 | 1591 | 240 | | 52 | | | 64 | 56 | 3.5 | 0.19 | 20.09 | 6.732 | | 44.882 |
| A-4 | 9.0 | 00:09:00 | 121.920 | 0.035 | 1.700 | 1.70 | 1588 | 240 | | 52 | | | 64 | 56 | 3.5 | 0.19 | 20.07 | 8.995 | | 44.976 |
| A-5 | 12.0 | 00:12:00 | 124.295 | 0.040 | 1.700 | 1.70 | 1582 | 240 | | 53 | | | 64 | 56 | 3.5 | 0.20 | 21.43 | 11.231 | | 44.926 |
| A-6 | 15.0 | 00:15:00 | 126.642 | 0.015 | 1.700 | 1.70 | 1464 | 240 | | 54 | | | 65 | 56 | 3.5 | 0.12 | 12.74 | 13.495 | | 44.984 |
| A-7 | 18.0 | 00:18:00 | 129.020 | 0.035 | 1.700 | 1.70 | 1622 | 240 | | 54 | | | 65 | 57 | 3.5 | 0.19 | 20.24 | 15.756 | | 45.016 |
| A-8 | 21.0 | 00:21:00 | 131.397 | 0.040 | 1.700 | 1.70 | 1628 | 240 | | 55 | | | 65 | 57 | 3.5 | 0.20 | 21.67 | 18.041 | | 45.102 |
| A-9 | 24.0 | 00:24:00 | 133.800 | 0.040 | 1.700 | 1.70 | 1618 | 240 | | 55 | | | 65 | 57 | 3.5 | 0.20 | 21.62 | 20.271 | | 45.046 |
| A-10 | 27.0 | 00:27:00 | 136.145 | 0.040 | 1.700 | 1.70 | 1609 | 240 | | 55 | | | 65 | 58 | 3.5 | 0.20 | 21.57 | 22.545 | | 45.090 |
| B-1 | 30.0 | 00:30:00 | 138.539 | 0.005 | 1.700 | 1.70 | 1449 | 240 | | 55 | | | 63 | 58 | 3.5 | 0.07 | 7.33 | 24.793 | | 45.077 |
| B-2 | 33.0 | 00:33:00 | 140.900 | 0.035 | 1.700 | 1.70 | 1610 | 240 | | 55 | | | 65 | 58 | 3.5 | 0.19 | 20.18 | 27.030 | | 45.050 |
| B-3 | 36.0 | 00:36:00 | 143.255 | 0.040 | 1.700 | 1.70 | 1622 | 240 | | 56 | | | 66 | 58 | 3.5 | 0.20 | 21.64 | 29.303 | | 45.082 |
| B-4 | 39.0 | 00:39:00 | 145.650 | 0.040 | 1.700 | 1.70 | 1647 | 240 | | 56 | | | 66 | 58 | 3.5 | 0.20 | 21.77 | 31.496 | | 44.994 |
| B-5 | 42.0 | 00:42:00 | 147.960 | 0.015 | 1.700 | 1.70 | 1487 | 240 | | 57 | | | 66 | 58 | 3.5 | 0.12 | 12.81 | 33.764 | | 45.019 |
| B-6 | 45.0 | 00:45:00 | 150.350 | 0.010 | 1.700 | 1.70 | 1392 | 240 | | 58 | | | 66 | 59 | 3.5 | 0.10 | 10.20 | 36.045 | | 45.056 |
| B-7 | 48.0 | 00:48:00 | 152.755 | 0.045 | 1.700 | 1.70 | 1565 | 240 | | 58 | | | 67 | 59 | 3.5 | 0.21 | 22.63 | 38.332 | | 45.097 |
| B-8 | 51.0 | 00:51:00 | 155.170 | 0.040 | 1.700 | 1.70 | 1605 | 240 | | 58 | | | 67 | 60 | 3.5 | 0.20 | 21.55 | 40.613 | | 45.126 |
| B-9 | 54.0 | 00:54:00 | 157.580 | 0.045 | 1.700 | 1.70 | 1591 | 240 | | 58 | | | 67 | 60 | 3.5 | 0.21 | 22.78 | 43.046 | | 45.311 |
| B-10 | 57.0 | 00:57:00 | 160.150 | 0.010 | 1.700 | 1.70 | 1373 | 240 | | 60 | | | 67 | 60 | 3.5 | 0.10 | 10.15 | 45.201 | | 45.201 |
| Last Pt | 60.0 | 01:00:00 | 162.427 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 162.427 | | | | | | | | | | | **Max Vac** | 3.5 | **Final Values** | | 45.201 | | |
| **Average Values** | | | | 0.03 | | 1.70 | 1553 | 240 | | 55 | | | 65 | 58 | | 0.17 | 17.73 | | | |
| | | | | | | | | | | | | | 61 | | | | | | | |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 178,215 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.21 | in. Hg |
| Relative Humidity | 40 | % |
| Ambient Temperature | 53 | $^{o}$F |
| Specific Humidity | 0.003355 | lb $H_2O$ / lb air |

30-70-30 Load, Run - 4.0X30PF R4

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/12/14 08:40:00 | 5370 | 12.83 | 0.27 | 0.16 | 6.00 | 28.79 | 62.22 | 1,292.26 |
| | 03/12/14 08:40:30 | 5400 | 13.39 | 0.21 | 0.14 | 5.71 | 28.79 | 62.22 | 1,286.42 |
| | 03/12/14 08:41:00 | 5430 | 12.92 | 0.37 | 0.12 | 5.76 | 28.23 | 61.77 | 1,300.31 |
| | 03/12/14 08:41:30 | 5460 | 12.43 | 0.05 | 0.13 | 6.38 | 77.23 | 61.77 | 2,301.30 |
| | 03/12/14 08:42:00 | 5490 | 12.41 | 0.10 | 0.13 | 6.35 | 146.43 | 63.57 | 3,020.25 |
| | 03/12/14 08:42:30 | 5520 | 12.97 | 0.01 | 0.14 | 6.17 | 153.07 | 64.13 | 3,088.47 |
| | 03/12/14 08:43:00 | 5550 | 13.40 | 0.21 | 0.10 | 5.74 | 154.18 | 65.03 | 3,096.78 |
| | 03/12/14 08:43:30 | 5580 | 12.84 | 0.26 | 0.10 | 5.85 | 151.41 | 65.48 | 3,109.53 |
| | 03/12/14 08:44:00 | 5610 | 13.04 | 0.10 | 0.13 | 5.83 | 152.52 | 65.48 | 3,086.93 |
| | 03/12/14 08:44:30 | 5640 | 12.64 | 0.16 | 0.11 | 6.15 | 149.75 | 66.49 | 3,100.30 |
| | 03/12/14 08:45:00 | 5670 | 13.03 | 0.20 | 0.11 | 5.88 | 150.30 | 66.49 | 3,096.84 |
| | 03/12/14 08:45:30 | 5700 | 13.25 | 0.28 | 0.11 | 5.78 | 150.86 | 66.49 | 3,110.72 |
| | 03/12/14 08:46:00 | 5730 | 12.81 | 0.16 | 0.11 | 6.00 | 151.96 | 66.49 | 3,102.27 |
| | 03/12/14 08:46:30 | 5760 | 12.86 | 0.06 | 0.10 | 5.99 | 150.30 | 66.94 | 3,079.31 |
| | 03/12/14 08:47:00 | 5790 | 13.72 | 0.12 | 0.12 | 5.55 | 148.64 | 67.39 | 3,072.89 |
| | 03/12/14 08:47:30 | 5820 | 13.69 | 0.28 | 0.12 | 5.37 | 147.53 | 67.39 | 3,059.28 |
| | 03/12/14 08:48:00 | 5850 | 13.28 | 0.38 | 0.12 | 5.66 | 149.75 | 67.39 | 3,075.95 |
| | 03/12/14 08:48:30 | 5880 | 7.55 | 0.02 | 0.05 | 10.10 | 149.75 | 67.83 | 3,086.22 |
| | 03/12/14 08:49:00 | 5910 | 10.15 | -0.16 | 0.06 | 8.12 | 151.41 | 68.28 | 3,097.41 |
| | 03/12/14 08:49:30 | 5940 | 10.41 | -0.16 | 0.07 | 7.83 | 149.75 | 67.83 | 3,089.82 |
| | 03/12/14 08:50:00 | 5970 | 10.47 | -0.14 | 0.08 | 7.69 | 148.64 | 68.28 | 3,070.69 |
| | 03/12/14 08:50:30 | 6000 | 14.53 | 0.70 | 0.09 | 4.84 | 146.98 | 68.28 | 3,055.78 |
| | 03/12/14 08:51:00 | 6030 | 14.30 | 3.12 | 0.10 | 4.97 | 150.30 | 68.73 | 3,076.26 |
| | 03/12/14 08:51:30 | 6060 | 13.68 | 4.65 | 0.10 | 5.18 | 150.30 | 68.73 | 3,089.66 |
| | 03/12/14 08:52:00 | 6090 | 13.34 | 2.79 | 0.10 | 5.68 | 45.40 | 68.28 | 1,672.65 |
| | 03/12/14 08:52:30 | 6120 | 13.53 | 2.63 | 0.09 | 5.53 | 28.79 | 67.39 | 1,303.30 |
| | 03/12/14 08:53:00 | 6150 | 13.12 | 2.97 | 0.08 | 5.82 | 28.79 | 66.49 | 1,305.63 |
| | 03/12/14 08:53:30 | 6180 | 13.33 | 2.91 | 0.09 | 5.60 | 28.79 | 65.93 | 1,310.12 |
| | 03/12/14 08:54:00 | 6210 | 13.29 | 2.59 | 0.10 | 5.72 | 28.79 | 65.48 | 1,308.11 |
| | 03/12/14 08:54:30 | 6240 | 13.23 | 2.95 | 0.09 | 5.76 | 28.79 | 64.58 | 1,300.42 |
| | 03/12/14 08:55:00 | 6270 | 13.28 | 3.07 | 0.08 | 5.74 | 28.23 | 64.13 | 1,294.93 |
| | 03/12/14 08:55:30 | 6300 | 13.34 | 3.67 | 0.11 | 5.89 | 27.68 | 63.57 | 1,294.68 |
| | 03/12/14 08:56:00 | 6330 | 12.97 | 5.69 | 0.09 | 5.81 | 27.68 | 62.67 | 1,294.68 |
| | 03/12/14 08:56:30 | 6360 | 12.68 | 1.37 | 0.08 | 6.09 | 28.23 | 62.22 | 1,294.29 |
| | 03/12/14 08:57:00 | 6390 | 12.63 | 1.01 | 0.08 | 6.30 | 27.68 | 61.77 | 1,295.25 |
| | 03/12/14 08:57:30 | 6420 | 12.61 | 0.68 | 0.10 | 6.30 | 28.23 | 61.77 | 1,298.98 |
| | 03/12/14 08:58:00 | 6450 | 12.29 | 0.34 | 0.09 | 6.59 | 27.68 | 61.77 | 1,296.17 |
| | 03/12/14 08:58:30 | 6480 | 12.59 | 0.66 | 0.09 | 6.23 | 28.23 | 61.32 | 1,293.83 |
| | 03/12/14 08:59:00 | 6510 | 12.55 | 0.38 | 0.06 | 6.25 | 69.75 | 61.32 | 2,170.80 |
| | 03/12/14 08:59:30 | 6540 | 12.34 | 0.60 | 0.07 | 6.38 | 142.27 | 62.22 | 3,028.09 |
| | 03/12/14 09:00:00 | 6570 | 12.66 | 0.42 | 0.08 | 6.20 | 148.09 | 63.57 | 3,068.44 |
| A2 | 03/12/14 09:00:30 | 6600 | 12.92 | 0.62 | 0.09 | 6.02 | 148.09 | 64.58 | 3,078.10 |
| | 03/12/14 09:01:00 | 6630 | 12.82 | 0.84 | 0.07 | 6.00 | 150.30 | 64.58 | 3,099.81 |
| | 03/12/14 09:01:30 | 6660 | 12.79 | 0.84 | 0.08 | 6.11 | 148.64 | 65.03 | 3,118.81 |
| | 03/12/14 09:02:00 | 6690 | 12.27 | 0.48 | 0.05 | 6.49 | 149.19 | 65.48 | 3,087.98 |
| | 03/12/14 09:02:30 | 6720 | 12.73 | 0.27 | 0.05 | 6.10 | 148.64 | 65.48 | 3,097.88 |
| | 03/12/14 09:03:00 | 6750 | 12.81 | 0.51 | 0.05 | 6.08 | 147.53 | 65.93 | 3,090.22 |
| | 03/12/14 09:03:30 | 6780 | 11.00 | 0.60 | 0.03 | 6.78 | 146.98 | 66.49 | 3,055.78 |
| | 03/12/14 09:04:00 | 6810 | 11.11 | -0.06 | 0.03 | 7.38 | 144.49 | 66.49 | 3,040.57 |
| | 03/12/14 09:04:30 | 6840 | 11.43 | -0.12 | 0.03 | 7.11 | 142.83 | 66.94 | 3,037.19 |
| | 03/12/14 09:05:00 | 6870 | 11.53 | -0.14 | 0.03 | 6.92 | 146.98 | 67.39 | 3,075.60 |
| | 03/12/14 09:05:30 | 6900 | 11.61 | -0.12 | 0.03 | 6.93 | 147.53 | 67.39 | 3,092.36 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 178,215 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.21 | in. Hg |
| Relative Humidity | 40 | % |
| Ambient Temperature | 53 | $^{o}$F |
| Specific Humidity | 0.003355 | lb $H_2O$ / lb air |

30-70-30 Load, Run - 4.0X30PF R4

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/12/14 09:06:00 | 6930 | 12.60 | 0.08 | 0.05 | 6.26 | 148.09 | 67.39 | 3,097.95 |
| | 03/12/14 09:06:30 | 6960 | 12.80 | 0.62 | 0.05 | 6.10 | 148.09 | 67.83 | 3,093.28 |
| | 03/12/14 09:07:00 | 6990 | 12.60 | 0.79 | 0.04 | 6.27 | 82.21 | 67.83 | 2,260.27 |
| | 03/12/14 09:07:30 | 7020 | 12.65 | 0.79 | 0.04 | 6.23 | 28.23 | 66.94 | 1,322.26 |
| | 03/12/14 09:08:00 | 7050 | 12.78 | 0.70 | 0.05 | 6.19 | 27.68 | 65.93 | 1,307.10 |
| | 03/12/14 09:08:30 | 7080 | 13.21 | 3.02 | 0.06 | 5.60 | 27.68 | 65.03 | 1,305.92 |
| | 03/12/14 09:09:00 | 7110 | 12.40 | 2.15 | 0.05 | 6.37 | 27.68 | 64.58 | 1,297.15 |
| | 03/12/14 09:09:30 | 7140 | 12.76 | 0.90 | 0.05 | 6.13 | 27.68 | 64.58 | 1,298.20 |
| | 03/12/14 09:10:00 | 7170 | 12.64 | 0.71 | 0.04 | 6.26 | 27.68 | 63.57 | 1,304.22 |
| | 03/12/14 09:10:30 | 7200 | 12.81 | 0.65 | 0.05 | 6.11 | 27.68 | 63.57 | 1,307.72 |
| | 03/12/14 09:11:00 | 7230 | 13.02 | 0.87 | 0.05 | 6.00 | 28.23 | 62.67 | 1,303.59 |
| | 03/12/14 09:11:30 | 7260 | 12.60 | 0.76 | 0.05 | 6.36 | 27.68 | 61.77 | 1,305.28 |
| | 03/12/14 09:12:00 | 7290 | 12.52 | 0.69 | 0.05 | 6.32 | 138.95 | 62.67 | 3,017.24 |
| | 03/12/14 09:12:30 | 7320 | 12.23 | 0.38 | 0.05 | 6.58 | 149.19 | 64.58 | 3,081.77 |
| | 03/12/14 09:13:00 | 7350 | 12.83 | 0.48 | 0.05 | 6.08 | 147.53 | 65.03 | 3,088.60 |
| | 03/12/14 09:13:30 | 7380 | 13.06 | 0.71 | 0.04 | 5.92 | 148.64 | 65.48 | 3,102.52 |
| | 03/12/14 09:14:00 | 7410 | 12.55 | 0.68 | 0.03 | 6.36 | 147.53 | 65.48 | 3,097.28 |
| | 03/12/14 09:14:30 | 7440 | 13.05 | 0.78 | 0.03 | 5.94 | 147.53 | 65.93 | 3,098.27 |
| | 03/12/14 09:15:00 | 7470 | 12.65 | 1.00 | 0.04 | 6.18 | 148.64 | 66.49 | 3,103.77 |
| | 03/12/14 09:15:30 | 7500 | 12.95 | 0.81 | 0.04 | 5.96 | 149.19 | 66.49 | 3,111.26 |
| | 03/12/14 09:16:00 | 7530 | 13.01 | 0.93 | 0.04 | 5.97 | 146.98 | 66.49 | 3,084.98 |
| | 03/12/14 09:16:30 | 7560 | 12.68 | 1.12 | 0.04 | 6.08 | 145.60 | 65.93 | 3,081.48 |
| | 03/12/14 09:17:00 | 7590 | 12.80 | 1.05 | 0.04 | 6.11 | 145.60 | 66.49 | 3,064.39 |
| | 03/12/14 09:17:30 | 7620 | 12.91 | 1.13 | 0.04 | 5.98 | 144.49 | 66.49 | 3,070.74 |
| | 03/12/14 09:18:00 | 7650 | 11.12 | 1.31 | 0.02 | 7.63 | 146.43 | 66.49 | 3,088.86 |
| | 03/12/14 09:18:30 | 7680 | 11.98 | 0.20 | 0.02 | 6.74 | 147.53 | 66.94 | 3,099.43 |
| | 03/12/14 09:19:00 | 7710 | 12.55 | 0.21 | 0.03 | 6.42 | 146.98 | 67.39 | 3,095.56 |
| | 03/12/14 09:19:30 | 7740 | 12.77 | 0.34 | 0.04 | 6.18 | 145.60 | 67.39 | 3,077.95 |
| | 03/12/14 09:20:00 | 7770 | 12.80 | 0.52 | 0.04 | 6.15 | 145.04 | 67.83 | 3,062.45 |
| A3 | 03/12/14 09:20:30 | 7800 | 12.85 | 0.77 | 0.02 | 6.20 | 145.04 | 67.83 | 3,065.36 |
| | 03/12/14 09:21:00 | 7830 | 13.05 | 0.85 | 0.03 | 5.98 | 150.30 | 67.83 | 3,108.38 |
| | 03/12/14 09:21:30 | 7860 | 12.89 | 1.44 | 0.04 | 6.04 | 29.06 | 67.39 | 1,374.25 |
| | 03/12/14 09:22:00 | 7890 | 13.09 | 1.74 | 0.01 | 6.00 | 27.68 | 65.93 | 1,312.72 |
| | 03/12/14 09:22:30 | 7920 | 13.26 | 1.74 | 0.09 | 5.98 | 27.68 | 65.48 | 1,309.90 |
| | 03/12/14 09:23:00 | 7950 | 13.11 | 6.52 | 0.04 | 5.79 | 27.68 | 64.58 | 1,311.25 |
| | 03/12/14 09:23:30 | 7980 | 12.35 | 1.51 | 0.03 | 6.49 | 27.13 | 64.13 | 1,311.13 |
| | 03/12/14 09:24:00 | 8010 | 12.37 | 0.99 | 0.04 | 6.44 | 27.13 | 64.13 | 1,302.45 |
| | 03/12/14 09:24:30 | 8040 | 12.07 | 0.81 | 0.03 | 6.81 | 27.13 | 63.57 | 1,293.56 |
| | 03/12/14 09:25:00 | 8070 | 12.66 | 1.05 | 0.02 | 6.29 | 26.57 | 63.12 | 1,290.37 |
| | 03/12/14 09:25:30 | 8100 | 12.49 | 1.12 | 0.03 | 6.36 | 26.57 | 62.67 | 1,285.21 |
| | 03/12/14 09:26:00 | 8130 | 12.62 | 1.14 | 0.03 | 6.21 | 58.96 | 62.22 | 2,125.23 |
| | 03/12/14 09:26:30 | 8160 | 12.64 | 1.46 | 0.03 | 6.24 | 142.27 | 63.57 | 3,021.88 |
| | 03/12/14 09:27:00 | 8190 | 12.47 | 1.01 | 0.03 | 6.35 | 145.87 | 64.58 | 3,071.22 |
| | 03/12/14 09:27:30 | 8220 | 12.61 | 1.22 | 0.04 | 6.18 | 149.75 | 65.03 | 3,089.16 |
| | 03/12/14 09:28:00 | 8250 | 12.80 | 1.29 | 0.03 | 6.13 | 145.60 | 65.03 | 3,074.47 |
| | 03/12/14 09:28:30 | 8280 | 12.33 | 1.39 | 0.02 | 6.34 | 146.98 | 65.48 | 3,076.88 |
| | 03/12/14 09:29:00 | 8310 | 12.65 | 1.06 | 0.02 | 6.19 | 145.04 | 65.48 | 3,069.51 |
| | 03/12/14 09:29:30 | 8340 | 12.45 | 1.24 | 0.01 | 6.33 | 145.60 | 65.93 | 3,069.89 |
| | 03/12/14 09:30:00 | 8370 | 12.74 | 1.23 | 0.02 | 6.14 | 145.87 | 66.49 | 3,078.88 |
| | 03/12/14 09:30:30 | 8400 | 12.38 | 1.26 | 0.01 | 6.38 | 147.53 | 66.49 | 3,085.74 |
| | 03/12/14 09:31:00 | 8430 | 12.41 | 0.89 | 0.02 | 6.32 | 148.09 | 66.94 | 3,095.76 |
| | 03/12/14 09:31:30 | 8460 | 12.41 | 0.93 | 0.02 | 6.43 | 148.09 | 66.94 | 3,083.54 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 178,215 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.21 | in. Hg |
| Relative Humidity | 40 | % |
| Ambient Temperature | 53 | $^{o}$F |
| Specific Humidity | 0.003355 | lb $H_2O$ / lb air |

30-70-30 Load, Run - 4.0X30PF R4

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/12/14 09:32:00 | 8490 | 12.96 | 1.20 | 0.03 | 6.12 | 145.04 | 67.39 | 3,058.15 |
| 03/12/14 09:32:30 | 8520 | 12.14 | 2.35 | 0.00 | 6.78 | 144.49 | 67.39 | 3,058.11 |
| 03/12/14 09:33:00 | 8550 | 12.88 | 0.33 | 0.00 | 5.96 | 146.98 | 67.39 | 3,084.19 |
| 03/12/14 09:33:30 | 8580 | 12.97 | 0.49 | 0.00 | 6.10 | 149.75 | 67.39 | 3,107.47 |
| 03/12/14 09:34:00 | 8610 | 12.84 | 0.89 | 0.02 | 6.10 | 150.30 | 67.39 | 3,112.70 |
| 03/12/14 09:34:30 | 8640 | 12.93 | 0.85 | 0.01 | 6.04 | 151.41 | 67.39 | 3,113.28 |
| 03/12/14 09:35:00 | 8670 | 12.73 | 1.15 | 0.01 | 6.28 | 148.64 | 67.39 | 3,087.70 |
| 03/12/14 09:35:30 | 8700 | 14.42 | 1.37 | 2.03 | 5.86 | 146.43 | 67.83 | 3,067.40 |
| 03/12/14 09:36:00 | 8730 | 20.59 | 0.53 | 3.07 | 0.12 | 28.79 | 67.39 | 1,357.44 |
| 03/12/14 09:36:30 | 8760 | 20.63 | 0.19 | 3.10 | 0.10 | 26.57 | 66.49 | 1,307.75 |
| 03/12/14 09:37:00 | 8790 | 8.37 | 0.65 | 0.13 | 0.30 | 27.68 | 65.48 | 1,322.69 |
| 03/12/14 09:37:30 | 8820 | 0.17 | 8.08 | -0.11 | 0.04 | 28.79 | 65.48 | 1,336.69 |
| 03/12/14 09:38:00 | 8850 | 0.13 | 9.04 | -0.11 | 0.02 | 28.23 | 65.03 | 1,344.32 |
| 03/12/14 09:38:30 | 8880 | 12.29 | 8.06 | 0.63 | 4.15 | 28.79 | 64.58 | 1,346.98 |
| 03/12/14 09:39:00 | 8910 | 11.62 | 14.23 | -0.03 | 6.60 | 28.23 | 64.13 | 1,344.11 |
| 03/12/14 09:39:30 | 8940 | 12.03 | 0.83 | -0.03 | 9.37 | 28.23 | 63.57 | 1,337.08 |
| **RAW AVERAGE** | | **12.52** | **1.30** | **0.13** | **6.00** | **101.90** | **65.51** | **2,411.60** |

| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F8_PRF1 | F8_TE5 | |
| | | | | | | **(in. $H_2O$)** | **($^{o}$F)** | **(SCFH)** |
| | **Initial Zero** | 0.12 | 0.18 | -0.03 | 0.01 | F-13 LINE 2-3- | F-13 Line 1-3 | F-13 Line Orifi |
| | **Final Zero** | 0.12 | 0.10 | -0.03 | 0.04 | | | |
| | **Avg. Zero** | 0.12 | 0.14 | -0.03 | 0.03 | | | |
| **Bias** | | | | | | | | |
| | **Initial UpScale** | 12.01 | 9.00 | 3.02 | 9.33 | | | |
| | **Final UpScale** | 12.02 | 9.03 | 3.07 | 9.38 | | | |
| | **Avg. UpScale** | 12.02 | 9.02 | 3.05 | 9.36 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| **EMISSIONS DATA** | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.51 | 1.17 | 0.15 | 6.03 |
| **Corrected Raw Average (ppm/% wet basis)** | 11.84 | 1.10 | 0.15 | 5.71 |
| **Emission Rate (lb/hr)** | N/A | 0.02 | 0.00 | N/A |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.4 | % |
| Stack Exhaust Flow (M2) | 192,325 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 33 | % |
| Ambient Temperature | 60 | $^{o}$F |
| Specific Humidity | 0.003560 | lb $H_2O$ / lb air |

30-70-30 Load, Run - 4.0X30PF R5

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/12/14 10:00:00 | 10170 | 12.70 | 7.10 | 0.04 | 6.41 | 27.68 | 54.47 | 1,298.51 |
| | 03/12/14 10:00:30 | 10200 | 12.78 | 4.66 | 0.05 | 6.43 | 27.68 | 54.91 | 1,292.60 |
| | 03/12/14 10:01:00 | 10230 | 12.79 | 3.15 | 0.06 | 6.39 | 28.23 | 54.91 | 1,295.13 |
| | 03/12/14 10:01:30 | 10260 | 12.56 | 2.12 | 0.04 | 6.58 | 28.23 | 54.91 | 1,299.05 |
| | 03/12/14 10:02:00 | 10290 | 12.58 | 1.42 | 0.04 | 6.58 | 28.23 | 54.91 | 1,295.88 |
| | 03/12/14 10:02:30 | 10320 | 12.67 | 0.97 | 0.04 | 6.46 | 28.23 | 54.91 | 1,295.46 |
| | 03/12/14 10:03:00 | 10350 | 12.81 | 0.72 | 0.07 | 6.30 | 28.79 | 54.91 | 1,297.88 |
| | 03/12/14 10:03:30 | 10380 | 12.60 | 0.69 | 0.14 | 6.61 | 133.14 | 55.81 | 2,910.58 |
| | 03/12/14 10:04:00 | 10410 | 13.94 | 2.07 | 0.12 | 5.69 | 153.07 | 57.16 | 3,080.92 |
| | 03/12/14 10:04:30 | 10440 | 13.46 | 1.98 | 0.12 | 5.97 | 151.96 | 58.17 | 3,081.72 |
| | 03/12/14 10:05:00 | 10470 | 13.44 | 1.21 | 0.11 | 6.06 | 153.07 | 59.07 | 3,093.78 |
| | 03/12/14 10:05:30 | 10500 | 13.70 | 1.00 | 0.10 | 5.83 | 152.52 | 59.52 | 3,085.65 |
| | 03/12/14 10:06:00 | 10530 | 13.22 | 0.70 | 0.11 | 6.17 | 149.19 | 59.97 | 3,064.90 |
| | 03/12/14 10:06:30 | 10560 | 13.60 | 0.52 | 0.12 | 5.98 | 149.75 | 60.87 | 3,075.06 |
| | 03/12/14 10:07:00 | 10590 | 14.18 | 0.61 | 0.10 | 5.38 | 149.75 | 61.77 | 3,070.84 |
| | 03/12/14 10:07:30 | 10620 | 13.63 | 0.65 | 0.09 | 5.79 | 154.18 | 62.22 | 3,105.58 |
| | 03/12/14 10:08:00 | 10650 | 13.63 | 0.49 | 0.11 | 5.87 | 153.07 | 63.12 | 3,090.96 |
| | 03/12/14 10:08:30 | 10680 | 13.66 | 0.50 | 0.11 | 5.86 | 151.41 | 63.57 | 3,086.68 |
| | 03/12/14 10:09:00 | 10710 | 13.63 | 0.41 | 0.10 | 5.71 | 147.53 | 64.13 | 3,049.33 |
| | 03/12/14 10:09:30 | 10740 | 13.17 | 0.34 | 0.09 | 6.11 | 145.87 | 64.13 | 3,048.66 |
| | 03/12/14 10:10:00 | 10770 | 13.48 | 0.26 | 0.10 | 6.01 | 146.98 | 65.03 | 3,042.75 |
| | 03/12/14 10:10:30 | 10800 | 13.67 | 0.39 | 0.11 | 5.82 | 147.53 | 65.03 | 3,054.23 |
| | 03/12/14 10:11:00 | 10830 | 13.81 | 0.41 | 0.10 | 5.68 | 150.30 | 65.48 | 3,084.83 |
| | 03/12/14 10:11:30 | 10860 | 13.41 | 0.37 | 0.09 | 5.95 | 153.62 | 65.48 | 3,097.30 |
| | 03/12/14 10:12:00 | 10890 | 13.20 | 0.25 | 0.09 | 6.16 | 151.41 | 65.93 | 3,076.39 |
| | 03/12/14 10:12:30 | 10920 | 13.19 | 0.19 | 0.09 | 6.23 | 148.64 | 66.49 | 3,058.32 |
| | 03/12/14 10:13:00 | 10950 | 13.59 | 0.29 | 0.08 | 5.88 | 147.53 | 66.94 | 3,049.38 |
| | 03/12/14 10:13:30 | 10980 | 13.03 | 0.28 | 0.06 | 6.18 | 148.64 | 66.94 | 3,053.30 |
| | 03/12/14 10:14:00 | 11010 | 13.06 | 0.27 | 0.07 | 6.11 | 28.79 | 66.94 | 1,331.51 |
| | 03/12/14 10:14:30 | 11040 | 12.61 | 0.27 | 0.08 | 6.38 | 28.79 | 65.93 | 1,313.96 |
| | 03/12/14 10:15:00 | 11070 | 13.20 | 0.35 | 0.06 | 5.97 | 28.79 | 65.48 | 1,310.87 |
| | 03/12/14 10:15:30 | 11100 | 13.14 | 0.37 | 0.05 | 5.95 | 28.79 | 65.03 | 1,317.28 |
| | 03/12/14 10:16:00 | 11130 | 12.94 | 0.25 | 0.06 | 6.12 | 28.79 | 64.58 | 1,311.92 |
| | 03/12/14 10:16:30 | 11160 | 12.72 | 0.23 | 0.06 | 6.23 | 28.79 | 64.58 | 1,316.23 |
| | 03/12/14 10:17:00 | 11190 | 12.67 | 0.37 | 0.06 | 6.25 | 28.79 | 64.58 | 1,311.88 |
| | 03/12/14 10:17:30 | 11220 | 12.84 | 0.68 | 0.05 | 6.13 | 28.23 | 64.13 | 1,301.32 |
| | 03/12/14 10:18:00 | 11250 | 12.93 | 0.74 | 0.06 | 6.04 | 28.23 | 64.13 | 1,298.43 |
| | 03/12/14 10:18:30 | 11280 | 12.87 | 0.41 | 0.06 | 6.10 | 28.23 | 63.57 | 1,290.22 |
| | 03/12/14 10:19:00 | 11310 | 13.06 | 0.44 | 0.05 | 5.93 | 27.68 | 63.12 | 1,294.62 |
| | 03/12/14 10:19:30 | 11340 | 12.95 | 0.58 | 0.04 | 5.96 | 96.33 | 63.12 | 2,230.99 |
| | 03/12/14 10:20:00 | 11370 | 13.48 | 1.50 | 0.06 | 5.58 | 153.62 | 64.13 | 3,086.58 |
| A2 | 03/12/14 10:20:30 | 11400 | 12.71 | 1.85 | 0.08 | 6.16 | 148.64 | 65.03 | 3,067.77 |
| | 03/12/14 10:21:00 | 11430 | 12.61 | 0.33 | 0.05 | 6.21 | 151.41 | 65.48 | 3,078.23 |
| | 03/12/14 10:21:30 | 11460 | 12.84 | 0.11 | 0.05 | 6.13 | 151.41 | 66.49 | 3,093.06 |
| | 03/12/14 10:22:00 | 11490 | 13.04 | 0.13 | 0.06 | 5.99 | 153.07 | 66.94 | 3,112.58 |
| | 03/12/14 10:22:30 | 11520 | 13.11 | 0.34 | 0.06 | 5.88 | 150.86 | 66.94 | 3,084.54 |
| | 03/12/14 10:23:00 | 11550 | 13.42 | 0.27 | 0.06 | 5.78 | 146.98 | 67.39 | 3,061.17 |
| | 03/12/14 10:23:30 | 11580 | 12.92 | 0.44 | 0.05 | 5.96 | 146.98 | 67.83 | 3,039.96 |
| | 03/12/14 10:24:00 | 11610 | 12.80 | 0.53 | 0.06 | 6.07 | 146.98 | 67.83 | 3,038.49 |
| | 03/12/14 10:24:30 | 11640 | 12.72 | 0.50 | 0.05 | 6.15 | 146.43 | 67.83 | 3,044.69 |
| | 03/12/14 10:25:00 | 11670 | 12.73 | 0.59 | 0.06 | 6.14 | 146.98 | 67.83 | 3,048.88 |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.4 | % |
| Stack Exhaust Flow (M2) | 192,325 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 33 | % |
| Ambient Temperature | 60 | $^{o}$F |
| Specific Humidity | 0.003560 | lb $H_2O$ / lb air |

30-70-30 Load, Run - 4.0X30PF R5

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/12/14 10:25:30 | 11700 | 12.82 | 0.69 | 0.05 | 6.11 | 150.30 | 68.28 | 3,078.48 |
| | 03/12/14 10:26:00 | 11730 | 12.53 | 0.66 | 0.05 | 6.29 | 153.07 | 68.28 | 3,088.57 |
| | 03/12/14 10:26:30 | 11760 | 12.47 | 0.35 | 0.05 | 6.37 | 149.75 | 68.28 | 3,076.08 |
| | 03/12/14 10:27:00 | 11790 | 12.51 | 0.20 | 0.04 | 6.39 | 146.98 | 68.73 | 3,037.14 |
| | 03/12/14 10:27:30 | 11820 | 12.88 | 0.45 | 0.04 | 6.10 | 149.19 | 69.18 | 3,072.19 |
| | 03/12/14 10:28:00 | 11850 | 12.64 | 0.67 | 0.04 | 6.05 | 149.75 | 68.73 | 3,086.99 |
| | 03/12/14 10:28:30 | 11880 | 12.80 | 0.35 | 0.04 | 6.03 | 30.72 | 68.73 | 1,472.88 |
| | 03/12/14 10:29:00 | 11910 | 11.42 | 0.37 | 0.03 | 6.95 | 28.79 | 67.83 | 1,348.30 |
| | 03/12/14 10:29:30 | 11940 | 12.78 | 0.28 | 0.03 | 6.03 | 28.79 | 66.94 | 1,307.31 |
| | 03/12/14 10:30:00 | 11970 | 12.88 | 1.13 | 0.04 | 5.94 | 28.23 | 65.93 | 1,309.81 |
| | 03/12/14 10:30:30 | 12000 | 12.93 | 1.41 | 0.05 | 5.87 | 27.68 | 65.48 | 1,310.02 |
| | 03/12/14 10:31:00 | 12030 | 13.00 | 1.63 | 0.04 | 5.83 | 28.23 | 65.03 | 1,299.56 |
| | 03/12/14 10:31:30 | 12060 | 12.88 | 2.03 | 0.03 | 5.93 | 28.23 | 65.03 | 1,296.38 |
| | 03/12/14 10:32:00 | 12090 | 13.10 | 1.78 | 0.02 | 5.78 | 27.68 | 64.58 | 1,289.22 |
| | 03/12/14 10:32:30 | 12120 | 12.94 | 2.14 | 0.02 | 5.92 | 27.68 | 64.13 | 1,291.59 |
| | 03/12/14 10:33:00 | 12150 | 12.96 | 1.79 | 0.02 | 5.95 | 27.68 | 64.13 | 1,289.30 |
| | 03/12/14 10:33:30 | 12180 | 13.17 | 1.83 | 0.02 | 5.84 | 28.79 | 63.57 | 1,289.63 |
| | 03/12/14 10:34:00 | 12210 | 13.30 | 2.74 | 0.03 | 5.76 | 133.69 | 64.13 | 2,907.30 |
| | 03/12/14 10:34:30 | 12240 | 13.14 | 4.09 | 0.04 | 5.70 | 150.30 | 65.03 | 3,072.82 |
| | 03/12/14 10:35:00 | 12270 | 12.66 | 1.81 | 0.04 | 6.15 | 153.62 | 65.48 | 3,098.13 |
| | 03/12/14 10:35:30 | 12300 | 12.52 | 0.89 | 0.03 | 6.25 | 149.75 | 65.93 | 3,085.89 |
| | 03/12/14 10:36:00 | 12330 | 12.29 | 0.49 | 0.04 | 6.45 | 150.30 | 66.49 | 3,094.23 |
| | 03/12/14 10:36:30 | 12360 | 12.27 | 0.33 | 0.04 | 6.47 | 153.07 | 66.49 | 3,108.66 |
| | 03/12/14 10:37:00 | 12390 | 12.45 | 0.26 | 0.02 | 6.39 | 151.41 | 66.49 | 3,108.05 |
| | 03/12/14 10:37:30 | 12420 | 12.66 | 0.43 | 0.02 | 6.23 | 150.86 | 66.94 | 3,092.07 |
| | 03/12/14 10:38:00 | 12450 | 12.55 | 0.41 | 0.02 | 6.31 | 149.75 | 67.39 | 3,079.72 |
| | 03/12/14 10:38:30 | 12480 | 12.79 | 0.51 | 0.03 | 6.19 | 149.75 | 67.39 | 3,072.03 |
| | 03/12/14 10:39:00 | 12510 | 12.82 | 0.62 | 0.01 | 6.11 | 148.64 | 67.83 | 3,084.84 |
| | 03/12/14 10:39:30 | 12540 | 12.71 | 0.58 | 0.01 | 6.18 | 149.75 | 67.83 | 3,088.29 |
| | 03/12/14 10:40:00 | 12570 | 12.85 | 0.65 | 0.03 | 6.08 | 153.62 | 68.28 | 3,117.13 |
| A3 | 03/12/14 10:40:30 | 12600 | 12.55 | 0.64 | 0.03 | 6.24 | 155.28 | 68.73 | 3,120.97 |
| | 03/12/14 10:41:00 | 12630 | 12.18 | 0.58 | 0.02 | 6.51 | 153.07 | 68.28 | 3,102.02 |
| | 03/12/14 10:41:30 | 12660 | 12.28 | 0.45 | 0.02 | 6.49 | 148.64 | 68.73 | 3,078.46 |
| | 03/12/14 10:42:00 | 12690 | 12.50 | 0.59 | 0.03 | 6.31 | 149.75 | 68.28 | 3,072.79 |
| | 03/12/14 10:42:30 | 12720 | 12.65 | 0.58 | 0.03 | 6.21 | 149.75 | 68.28 | 3,072.36 |
| | 03/12/14 10:43:00 | 12750 | 12.54 | 0.72 | 0.02 | 6.27 | 149.75 | 68.28 | 3,079.77 |
| | 03/12/14 10:43:30 | 12780 | 11.69 | 0.82 | 0.01 | 6.83 | 28.23 | 67.83 | 1,315.88 |
| | 03/12/14 10:44:00 | 12810 | 13.00 | 0.32 | 0.00 | 6.04 | 28.23 | 66.94 | 1,317.76 |
| | 03/12/14 10:44:30 | 12840 | 13.05 | 0.58 | 0.01 | 5.83 | 28.23 | 66.49 | 1,315.12 |
| | 03/12/14 10:45:00 | 12870 | 13.30 | 0.93 | 0.01 | 5.72 | 28.23 | 66.49 | 1,307.96 |
| | 03/12/14 10:45:30 | 12900 | 13.26 | 1.40 | 0.01 | 5.67 | 28.79 | 65.93 | 1,307.40 |
| | 03/12/14 10:46:00 | 12930 | 13.33 | 1.64 | 0.02 | 5.64 | 28.23 | 65.93 | 1,298.34 |
| | 03/12/14 10:46:30 | 12960 | 13.30 | 2.96 | 0.02 | 5.65 | 27.68 | 65.93 | 1,300.41 |
| | 03/12/14 10:47:00 | 12990 | 13.43 | 2.77 | 0.02 | 5.57 | 27.68 | 65.93 | 1,299.27 |
| | 03/12/14 10:47:30 | 13020 | 13.47 | 2.73 | 0.01 | 5.53 | 27.68 | 65.93 | 1,294.42 |
| | 03/12/14 10:48:00 | 13050 | 13.51 | 2.98 | 0.02 | 5.51 | 26.57 | 65.93 | 1,289.68 |
| | 03/12/14 10:48:30 | 13080 | 13.58 | 3.01 | 0.03 | 5.48 | 110.44 | 65.93 | 2,740.00 |
| | 03/12/14 10:49:00 | 13110 | 13.99 | 6.68 | 0.11 | 5.07 | 148.64 | 66.94 | 3,079.14 |
| | 03/12/14 10:49:30 | 13140 | 12.61 | 5.59 | 0.02 | 6.12 | 149.75 | 67.39 | 3,090.56 |
| | 03/12/14 10:50:00 | 13170 | 12.42 | 1.38 | 0.01 | 6.31 | 149.75 | 67.83 | 3,088.73 |
| | 03/12/14 10:50:30 | 13200 | 12.40 | 0.98 | 0.01 | 6.36 | 150.86 | 68.28 | 3,086.69 |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.4 | % |
| Stack Exhaust Flow (M2) | 192,325 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 33 | % |
| Ambient Temperature | 60 | $^{o}$F |
| Specific Humidity | 0.003560 | lb $H_2O$ / lb air |

30-70-30 Load, Run - 4.0X30PF R5

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/12/14 10:51:00 | 13230 | 12.61 | 1.01 | 0.01 | 6.18 | 154.18 | 68.73 | 3,121.09 |
| 03/12/14 10:51:30 | 13260 | 12.45 | 1.15 | 0.01 | 6.30 | 149.75 | 68.73 | 3,088.55 |
| 03/12/14 10:52:00 | 13290 | 12.61 | 0.96 | 0.01 | 6.24 | 147.53 | 69.18 | 3,058.14 |
| 03/12/14 10:52:30 | 13320 | 12.66 | 1.31 | 0.01 | 6.19 | 148.64 | 69.63 | 3,073.83 |
| 03/12/14 10:53:00 | 13350 | 12.71 | 1.17 | 0.01 | 6.13 | 150.30 | 70.08 | 3,077.73 |
| 03/12/14 10:53:30 | 13380 | 12.62 | 1.26 | 0.01 | 6.20 | 149.19 | 70.08 | 3,080.58 |
| 03/12/14 10:54:00 | 13410 | 12.79 | 1.62 | 0.01 | 6.08 | 149.19 | 70.53 | 3,080.44 |
| 03/12/14 10:54:30 | 13440 | 12.58 | 1.25 | 0.00 | 6.22 | 151.41 | 70.08 | 3,106.57 |
| 03/12/14 10:55:00 | 13470 | 12.38 | 0.80 | 0.00 | 6.42 | 153.62 | 70.08 | 3,124.78 |
| 03/12/14 10:55:30 | 13500 | 12.60 | 0.69 | 0.01 | 6.27 | 154.73 | 70.53 | 3,117.94 |
| 03/12/14 10:56:00 | 13530 | 12.65 | 0.83 | 0.01 | 6.20 | 151.41 | 70.53 | 3,086.09 |
| 03/12/14 10:56:30 | 13560 | 12.43 | 0.85 | 0.00 | 6.37 | 150.86 | 70.53 | 3,074.48 |
| 03/12/14 10:57:00 | 13590 | 12.59 | 0.88 | 0.01 | 6.25 | 149.75 | 70.53 | 3,083.78 |
| 03/12/14 10:57:30 | 13620 | 12.55 | 0.89 | 0.01 | 6.25 | 150.86 | 70.53 | 3,078.17 |
| 03/12/14 10:58:00 | 13650 | 12.68 | 1.07 | 0.00 | 6.15 | 152.52 | 70.53 | 3,114.43 |
| 03/12/14 10:58:30 | 13680 | 12.47 | 0.64 | 0.01 | 6.30 | 25.47 | 70.08 | 1,264.54 |
| 03/12/14 10:59:30 | 13740 | 13.64 | 2.34 | -0.01 | 5.38 | 28.23 | 68.28 | 1,307.04 |
| 03/12/14 11:00:00 | 13770 | 13.51 | 2.47 | 0.00 | 5.57 | 27.68 | 68.28 | 1,301.23 |
| **RAW AVERAGE** | | **12.92** | **1.13** | **0.04** | **6.08** | **105.90** | **65.66** | **2,437.87** |

| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | **(%)** | **(ppmvd)** | **(ppmvw)** | **(%)** | **(in. $H_2O$)** | **($^{o}$F)** | **(SCFH)** |
| **Bias** | **Initial Zero** | 0.12 | 0.10 | -0.03 | 0.04 | | | |
| | **Final Zero** | 0.10 | 0.16 | -0.02 | 0.05 | | | |
| | **Avg. Zero** | 0.11 | 0.13 | -0.03 | 0.05 | | | |
| | **Initial UpScale** | 12.02 | 9.03 | 3.07 | 9.38 | | | |
| | **Final UpScale** | 12.00 | 8.98 | 3.06 | 9.34 | | | |
| | **Avg. UpScale** | 12.01 | 9.01 | 3.07 | 9.36 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| **EMISSIONS DATA** | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.92 | 1.01 | 0.07 | 6.10 |
| **Corrected Raw Average (ppm/% wet basis)** | 12.21 | 0.95 | 0.07 | 5.76 |
| **Emission Rate (lb/hr)** | N/A | 0.01 | 0.00 | N/A |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.4 | % |
| Stack Exhaust Flow (M2) | 201,263 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 25 | % |
| Ambient Temperature | 66 | $^{o}$F |
| Specific Humidity | 0.003330 | lb $H_2O$ / lb air |

30-70-30 Load, Run - 4.0X30PF R6

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/12/14 11:23:00 | 15150 | 11.23 | 6.02 | 0.01 | 7.19 | 28.79 | 61.32 | 1,306.17 |
| | 03/12/14 11:23:30 | 15180 | 11.28 | 1.82 | 0.01 | 7.17 | 28.79 | 61.32 | 1,300.24 |
| | 03/12/14 11:24:00 | 15210 | 12.65 | 1.22 | 0.01 | 6.29 | 28.23 | 61.77 | 1,305.78 |
| | 03/12/14 11:24:30 | 15240 | 13.02 | 1.55 | 0.02 | 5.89 | 28.79 | 61.77 | 1,305.15 |
| | 03/12/14 11:25:00 | 15270 | 12.92 | 1.64 | 0.03 | 5.93 | 28.23 | 61.77 | 1,299.84 |
| | 03/12/14 11:25:30 | 15300 | 12.80 | 1.17 | 0.03 | 6.05 | 28.23 | 61.77 | 1,301.44 |
| | 03/12/14 11:26:00 | 15330 | 12.99 | 1.22 | 0.03 | 5.99 | 112.38 | 62.22 | 2,749.40 |
| | 03/12/14 11:26:30 | 15360 | 14.27 | 3.67 | 0.04 | 4.93 | 154.18 | 63.57 | 3,079.82 |
| | 03/12/14 11:27:00 | 15390 | 13.35 | 3.07 | 0.06 | 5.59 | 153.07 | 65.03 | 3,077.64 |
| | 03/12/14 11:27:30 | 15420 | 13.40 | 1.79 | 0.05 | 5.68 | 154.18 | 65.48 | 3,091.85 |
| | 03/12/14 11:28:00 | 15450 | 13.43 | 1.72 | 0.04 | 5.56 | 154.18 | 66.49 | 3,086.38 |
| | 03/12/14 11:28:30 | 15480 | 12.87 | 1.22 | 0.04 | 6.00 | 155.28 | 66.94 | 3,112.37 |
| | 03/12/14 11:29:00 | 15510 | 12.83 | 0.79 | 0.04 | 6.05 | 158.88 | 67.39 | 3,144.12 |
| | 03/12/14 11:29:30 | 15540 | 12.94 | 0.73 | 0.05 | 6.05 | 154.73 | 67.83 | 3,122.11 |
| | 03/12/14 11:30:00 | 15570 | 13.33 | 0.61 | 0.05 | 5.65 | 154.18 | 68.73 | 3,094.42 |
| | 03/12/14 11:30:30 | 15600 | 12.79 | 0.49 | 0.04 | 6.10 | 151.96 | 68.73 | 3,083.26 |
| | 03/12/14 11:31:00 | 15630 | 12.74 | 0.47 | 0.04 | 6.17 | 151.96 | 69.63 | 3,077.58 |
| | 03/12/14 11:31:30 | 15660 | 13.27 | 0.52 | 0.04 | 5.76 | 151.96 | 70.08 | 3,082.65 |
| | 03/12/14 11:32:00 | 15690 | 13.09 | 0.53 | 0.03 | 5.89 | 151.41 | 70.08 | 3,074.27 |
| | 03/12/14 11:32:30 | 15720 | 13.00 | 0.41 | 0.03 | 5.95 | 153.07 | 70.53 | 3,096.96 |
| | 03/12/14 11:33:00 | 15750 | 13.16 | 0.35 | 0.03 | 5.82 | 155.28 | 71.43 | 3,092.32 |
| | 03/12/14 11:33:30 | 15780 | 13.15 | 0.34 | 0.03 | 5.85 | 153.62 | 72.78 | 3,096.66 |
| | 03/12/14 11:34:00 | 15810 | 13.42 | 0.31 | 0.03 | 5.62 | 151.96 | 72.78 | 3,083.70 |
| | 03/12/14 11:34:30 | 15840 | 13.21 | 0.36 | 0.03 | 5.76 | 153.07 | 73.23 | 3,072.40 |
| | 03/12/14 11:35:00 | 15870 | 13.25 | 0.34 | 0.04 | 5.82 | 151.96 | 73.23 | 3,077.54 |
| | 03/12/14 11:35:30 | 15900 | 13.53 | 0.31 | 0.04 | 5.54 | 151.96 | 74.13 | 3,077.53 |
| | 03/12/14 11:36:00 | 15930 | 13.35 | 0.34 | 0.02 | 5.67 | 156.39 | 74.58 | 3,091.46 |
| | 03/12/14 11:36:30 | 15960 | 13.08 | 0.26 | 0.02 | 5.82 | 153.07 | 74.58 | 3,072.14 |
| | 03/12/14 11:37:00 | 15990 | 12.81 | 0.11 | 0.02 | 6.06 | 70.31 | 74.58 | 1,972.28 |
| | 03/12/14 11:37:30 | 16020 | 11.75 | 0.08 | 0.01 | 6.76 | 27.68 | 74.13 | 1,308.33 |
| | 03/12/14 11:38:00 | 16050 | 13.24 | 0.32 | 0.02 | 5.76 | 29.06 | 74.13 | 1,313.18 |
| | 03/12/14 11:38:30 | 16080 | 12.96 | 1.31 | 0.02 | 5.87 | 28.79 | 73.23 | 1,310.40 |
| | 03/12/14 11:39:00 | 16110 | 13.11 | 1.41 | 0.02 | 5.85 | 29.06 | 72.78 | 1,306.76 |
| | 03/12/14 11:39:30 | 16140 | 13.13 | 1.77 | 0.02 | 5.81 | 28.79 | 72.33 | 1,307.94 |
| | 03/12/14 11:40:00 | 16170 | 13.10 | 1.76 | 0.02 | 5.84 | 28.79 | 72.78 | 1,306.45 |
| | 03/12/14 11:40:30 | 16200 | 13.24 | 1.86 | 0.01 | 5.75 | 28.79 | 72.78 | 1,309.64 |
| | 03/12/14 11:41:00 | 16230 | 13.48 | 2.25 | 0.01 | 5.69 | 117.92 | 72.78 | 2,806.82 |
| | 03/12/14 11:41:30 | 16260 | 13.83 | 3.49 | 0.01 | 5.15 | 156.95 | 73.68 | 3,101.64 |
| | 03/12/14 11:42:00 | 16290 | 13.19 | 1.61 | 0.01 | 5.61 | 153.62 | 74.13 | 3,067.23 |
| | 03/12/14 11:42:30 | 16320 | 12.86 | 0.56 | 0.01 | 6.05 | 154.18 | 74.13 | 3,080.16 |
| | 03/12/14 11:43:00 | 16350 | 13.09 | 0.39 | 0.02 | 5.80 | 154.73 | 74.58 | 3,092.79 |
| A2 | 03/12/14 11:43:30 | 16380 | 13.28 | 0.32 | 0.02 | 5.84 | 155.28 | 75.03 | 3,088.49 |
| | 03/12/14 11:44:00 | 16410 | 13.05 | 0.53 | 0.02 | 5.81 | 153.07 | 75.03 | 3,078.69 |
| | 03/12/14 11:44:30 | 16440 | 12.85 | 0.67 | 0.03 | 6.06 | 152.52 | 75.47 | 3,073.09 |
| | 03/12/14 11:45:00 | 16470 | 12.82 | 0.66 | 0.04 | 6.07 | 152.52 | 75.47 | 3,073.78 |
| | 03/12/14 11:45:30 | 16500 | 12.86 | 0.66 | 0.03 | 6.06 | 151.96 | 75.47 | 3,074.61 |
| | 03/12/14 11:46:00 | 16530 | 12.97 | 0.84 | 0.04 | 5.94 | 152.52 | 75.47 | 3,077.32 |
| | 03/12/14 11:46:30 | 16560 | 12.89 | 0.76 | 0.04 | 6.04 | 154.73 | 76.04 | 3,094.61 |
| | 03/12/14 11:47:00 | 16590 | 12.75 | 0.71 | 0.03 | 6.12 | 154.18 | 76.04 | 3,095.25 |
| | 03/12/14 11:47:30 | 16620 | 12.83 | 0.56 | 0.03 | 6.09 | 151.41 | 76.04 | 3,088.58 |
| | 03/12/14 11:48:00 | 16650 | 12.87 | 0.82 | 0.03 | 6.03 | 151.96 | 76.49 | 3,064.59 |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.4 | % |
| Stack Exhaust Flow (M2) | 201,263 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 25 | % |
| Ambient Temperature | 66 | $^{o}$F |
| Specific Humidity | 0.003330 | lb $H_2O$ / lb air |

30-70-30 Load, Run - 4.0X30PF R6

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/12/14 11:48:30 | 16680 | 12.82 | 0.84 | 0.03 | 6.06 | 152.52 | 76.49 | 3,077.67 |
| | 03/12/14 11:49:00 | 16710 | 12.57 | 0.58 | 0.03 | 6.27 | 151.96 | 76.04 | 3,070.97 |
| | 03/12/14 11:49:30 | 16740 | 12.90 | 0.59 | 0.02 | 6.05 | 154.18 | 76.49 | 3,083.18 |
| | 03/12/14 11:50:00 | 16770 | 12.94 | 0.75 | 0.03 | 6.00 | 154.18 | 76.49 | 3,093.04 |
| | 03/12/14 11:50:30 | 16800 | 12.68 | 0.58 | 0.03 | 6.20 | 153.62 | 76.94 | 3,076.35 |
| | 03/12/14 11:51:00 | 16830 | 12.77 | 0.45 | 0.01 | 6.18 | 152.52 | 76.94 | 3,078.03 |
| | 03/12/14 11:51:30 | 16860 | 13.06 | 0.68 | 0.01 | 5.98 | 28.23 | 76.49 | 1,310.86 |
| | 03/12/14 11:52:00 | 16890 | 13.42 | 1.87 | 0.01 | 5.66 | 28.79 | 76.04 | 1,314.77 |
| | 03/12/14 11:52:30 | 16920 | 13.28 | 2.58 | 0.02 | 5.75 | 28.79 | 75.03 | 1,311.50 |
| | 03/12/14 11:53:00 | 16950 | 13.52 | 2.89 | 0.02 | 5.57 | 28.79 | 74.58 | 1,317.88 |
| | 03/12/14 11:53:30 | 16980 | 13.36 | 3.49 | 0.02 | 5.69 | 28.79 | 73.68 | 1,317.02 |
| | 03/12/14 11:54:00 | 17010 | 12.91 | 2.77 | 0.01 | 5.95 | 27.68 | 73.23 | 1,314.88 |
| | 03/12/14 11:54:30 | 17040 | 12.49 | 1.58 | 0.00 | 6.34 | 28.23 | 73.23 | 1,300.35 |
| | 03/12/14 11:55:00 | 17070 | 12.73 | 1.22 | 0.00 | 6.18 | 28.23 | 72.78 | 1,296.98 |
| | 03/12/14 11:55:30 | 17100 | 13.18 | 1.50 | 0.00 | 5.93 | 27.68 | 72.33 | 1,297.32 |
| | 03/12/14 11:56:00 | 17130 | 13.21 | 1.44 | 0.02 | 6.00 | 123.18 | 72.33 | 2,821.14 |
| | 03/12/14 11:56:30 | 17160 | 13.41 | 4.16 | 0.01 | 5.61 | 154.73 | 73.68 | 3,098.60 |
| | 03/12/14 11:57:00 | 17190 | 12.67 | 1.96 | 0.00 | 6.24 | 153.07 | 74.13 | 3,081.00 |
| | 03/12/14 11:57:30 | 17220 | 12.37 | 0.65 | -0.01 | 6.46 | 152.52 | 74.13 | 3,096.16 |
| | 03/12/14 11:58:00 | 17250 | 12.65 | 0.46 | 0.01 | 6.26 | 154.18 | 74.58 | 3,088.41 |
| | 03/12/14 11:58:30 | 17280 | 12.47 | 0.49 | 0.01 | 6.36 | 151.96 | 74.58 | 3,087.49 |
| | 03/12/14 11:59:00 | 17310 | 12.72 | 0.50 | -0.01 | 6.18 | 150.30 | 75.03 | 3,078.64 |
| | 03/12/14 11:59:30 | 17340 | 12.20 | 0.43 | -0.01 | 6.51 | 151.41 | 74.58 | 3,078.26 |
| | 03/12/14 12:00:00 | 17370 | 12.70 | 0.14 | 0.01 | 6.25 | 153.62 | 75.03 | 3,084.27 |
| | 03/12/14 12:00:30 | 17400 | 12.69 | 0.48 | 0.00 | 6.20 | 151.41 | 75.47 | 3,089.97 |
| | 03/12/14 12:01:00 | 17430 | 12.89 | 0.53 | 0.00 | 6.09 | 154.73 | 76.04 | 3,103.11 |
| | 03/12/14 12:01:30 | 17460 | 12.91 | 0.60 | 0.00 | 6.05 | 152.52 | 76.49 | 3,093.01 |
| | 03/12/14 12:02:00 | 17490 | 12.86 | 0.59 | 0.01 | 6.12 | 151.41 | 76.49 | 3,079.02 |
| | 03/12/14 12:02:30 | 17520 | 12.72 | 0.70 | 0.00 | 6.17 | 149.75 | 76.04 | 3,074.41 |
| | 03/12/14 12:03:00 | 17550 | 12.94 | 0.64 | 0.00 | 6.10 | 150.30 | 76.49 | 3,072.29 |
| A3 | 03/12/14 12:03:30 | 17580 | 12.74 | 0.89 | 0.00 | 6.09 | 151.41 | 76.49 | 3,070.18 |
| | 03/12/14 12:04:00 | 17610 | 12.62 | 0.40 | 0.00 | 6.33 | 151.96 | 76.49 | 3,075.67 |
| | 03/12/14 12:04:30 | 17640 | 12.68 | 0.54 | 0.00 | 6.18 | 153.62 | 76.49 | 3,087.42 |
| | 03/12/14 12:05:00 | 17670 | 12.38 | 0.40 | -0.01 | 6.43 | 153.62 | 76.94 | 3,076.92 |
| | 03/12/14 12:05:30 | 17700 | 12.44 | 0.52 | -0.01 | 6.42 | 151.41 | 76.94 | 3,068.13 |
| | 03/12/14 12:06:00 | 17730 | 12.54 | 0.44 | 0.00 | 6.37 | 151.41 | 76.94 | 3,073.95 |
| | 03/12/14 12:06:30 | 17760 | 12.67 | 0.83 | 0.00 | 6.23 | 59.51 | 77.38 | 1,711.97 |
| | 03/12/14 12:07:00 | 17790 | 12.30 | 0.74 | 0.01 | 6.52 | 27.68 | 76.49 | 1,304.41 |
| | 03/12/14 12:07:30 | 17820 | 13.17 | 0.43 | 0.00 | 5.90 | 27.68 | 76.04 | 1,310.67 |
| | 03/12/14 12:08:00 | 17850 | 13.31 | 1.31 | 0.01 | 5.72 | 28.79 | 75.47 | 1,316.86 |
| | 03/12/14 12:08:30 | 17880 | 13.60 | 1.84 | 0.02 | 5.58 | 28.79 | 75.03 | 1,314.81 |
| | 03/12/14 12:09:00 | 17910 | 13.48 | 2.47 | -0.01 | 5.60 | 28.79 | 74.58 | 1,313.28 |
| | 03/12/14 12:09:30 | 17940 | 13.29 | 2.54 | -0.02 | 5.79 | 28.79 | 74.58 | 1,312.22 |
| | 03/12/14 12:10:00 | 17970 | 13.62 | 2.57 | 0.01 | 5.54 | 28.23 | 74.58 | 1,311.42 |
| | 03/12/14 12:10:30 | 18000 | 14.12 | 2.98 | 0.03 | 5.16 | 66.43 | 74.13 | 2,171.20 |
| | 03/12/14 12:11:00 | 18030 | 14.00 | 4.75 | 0.10 | 5.17 | 154.18 | 75.03 | 3,094.79 |
| | 03/12/14 12:11:30 | 18060 | 12.87 | 4.51 | 0.00 | 6.03 | 153.62 | 76.04 | 3,086.17 |
| | 03/12/14 12:12:00 | 18090 | 12.79 | 1.62 | 0.00 | 6.18 | 151.41 | 76.04 | 3,072.57 |
| | 03/12/14 12:12:30 | 18120 | 13.09 | 1.79 | 0.00 | 5.94 | 150.86 | 76.49 | 3,068.19 |
| | 03/12/14 12:13:00 | 18150 | 12.72 | 1.42 | -0.01 | 6.16 | 151.96 | 76.49 | 3,076.77 |
| | 03/12/14 12:13:30 | 18180 | 12.59 | 1.33 | -0.01 | 6.28 | 153.07 | 77.38 | 3,095.58 |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.4 | % |
| Stack Exhaust Flow (M2) | 201,263 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 25 | % |
| Ambient Temperature | 66 | $^{o}$F |
| Specific Humidity | 0.003330 | lb $H_2O$ / lb air |

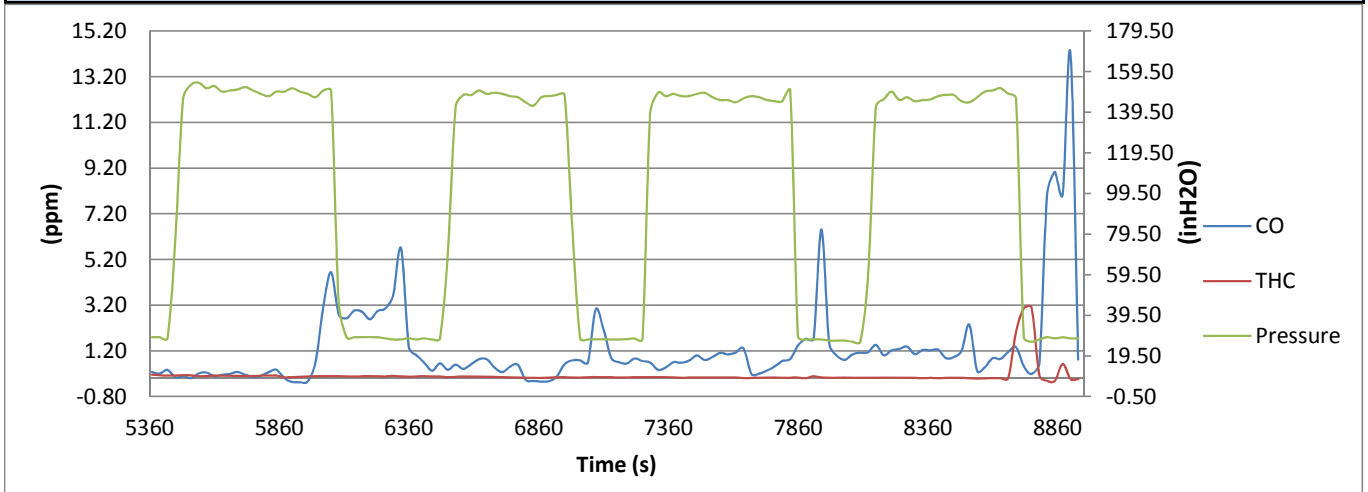
30-70-30 Load, Run - 4.0X30PF R6

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/12/14 12:14:00 | 18210 | 13.03 | 1.18 | 0.00 | 6.00 | 151.96 | 78.28 | 3,089.81 |
| 03/12/14 12:14:30 | 18240 | 12.82 | 1.14 | 0.00 | 6.11 | 150.86 | 78.28 | 3,082.60 |
| 03/12/14 12:15:00 | 18270 | 12.68 | 1.23 | 0.00 | 6.22 | 151.41 | 78.73 | 3,071.27 |
| 03/12/14 12:15:30 | 18300 | 13.00 | 1.55 | 0.00 | 5.95 | 150.86 | 78.28 | 3,085.60 |
| 03/12/14 12:16:00 | 18330 | 12.69 | 1.54 | -0.02 | 6.19 | 151.96 | 78.28 | 3,097.04 |
| 03/12/14 12:16:30 | 18360 | 12.43 | 0.86 | -0.02 | 6.36 | 154.18 | 78.28 | 3,105.09 |
| 03/12/14 12:17:00 | 18390 | 12.49 | 0.63 | 0.00 | 6.33 | 152.52 | 77.83 | 3,096.95 |
| 03/12/14 12:17:30 | 18420 | 12.36 | 0.75 | 0.00 | 6.42 | 151.96 | 77.83 | 3,081.92 |
| 03/12/14 12:18:00 | 18450 | 12.70 | 0.75 | -0.02 | 6.19 | 150.30 | 77.83 | 3,083.05 |
| 03/12/14 12:18:30 | 18480 | 12.57 | 1.06 | -0.02 | 6.27 | 150.86 | 78.28 | 3,079.57 |
| 03/12/14 12:19:00 | 18510 | 12.54 | 0.88 | -0.01 | 6.31 | 150.30 | 78.73 | 3,073.42 |
| 03/12/14 12:19:30 | 18540 | 12.70 | 0.95 | -0.01 | 6.15 | 152.52 | 78.73 | 3,092.08 |
| 03/12/14 12:20:00 | 18570 | 12.65 | 0.98 | -0.02 | 6.21 | 151.96 | 78.73 | 3,091.89 |
| 03/12/14 12:20:30 | 18600 | 12.71 | 1.10 | -0.01 | 6.17 | 153.07 | 78.73 | 3,084.57 |
| 03/12/14 12:21:00 | 18630 | 12.30 | 1.10 | 0.00 | 6.47 | 27.68 | 78.28 | 1,306.95 |
| 03/12/14 12:21:30 | 18660 | 13.67 | 1.90 | -0.01 | 5.58 | 27.68 | 76.49 | 1,311.49 |
| 03/12/14 12:22:00 | 18690 | 13.72 | 3.55 | -0.01 | 5.40 | 28.23 | 76.49 | 1,311.99 |
| 03/12/14 12:22:30 | 18720 | 13.85 | 4.08 | -0.01 | 5.33 | 28.23 | 76.04 | 1,305.72 |
| 03/12/14 12:23:00 | 18750 | 13.71 | 4.64 | 0.00 | 5.41 | 28.23 | 76.04 | 1,305.86 |
| **RAW AVERAGE** | | **12.95** | **1.30** | **0.01** | **5.99** | **114.84** | **73.88** | **2,550.45** |

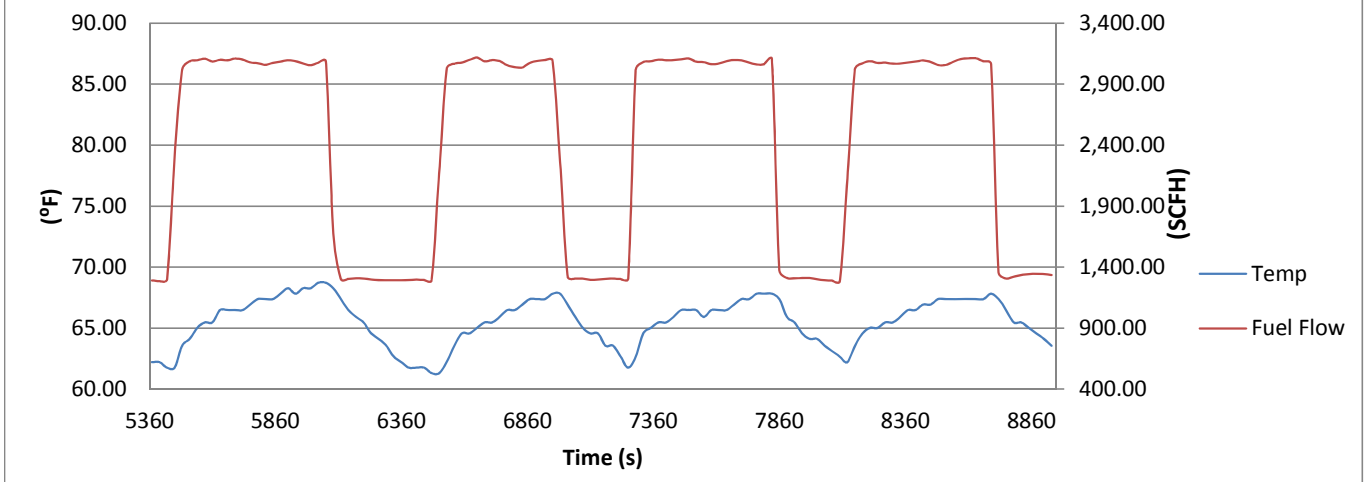
| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | **(%)** | **(ppmvd)** | **(ppmvw)** | **(%)** | **(in. $H_2O$)** | **($^{o}$F)** | **(SCFH)** |
| **Bias** | **Initial Zero** | 0.10 | 0.16 | -0.02 | 0.05 | | | |
| | **Final Zero** | 0.09 | 0.08 | -0.07 | 0.06 | | | |
| | **Avg. Zero** | 0.10 | 0.12 | -0.05 | 0.06 | | | |
| | **Initial UpScale** | 12.00 | 8.98 | 3.06 | 9.34 | | | |
| | **Final UpScale** | 11.99 | 8.94 | 3.03 | 9.44 | | | |
| | **Avg. UpScale** | 12.00 | 8.96 | 3.05 | 9.39 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| **EMISSIONS DATA** | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.96 | 1.20 | 0.06 | 5.99 |
| **Corrected Raw Average (ppm/% wet basis)** | 12.25 | 1.12 | 0.06 | 5.66 |
| **Emission Rate (lb/hr)** | N/A | 0.02 | 0.00 | N/A |

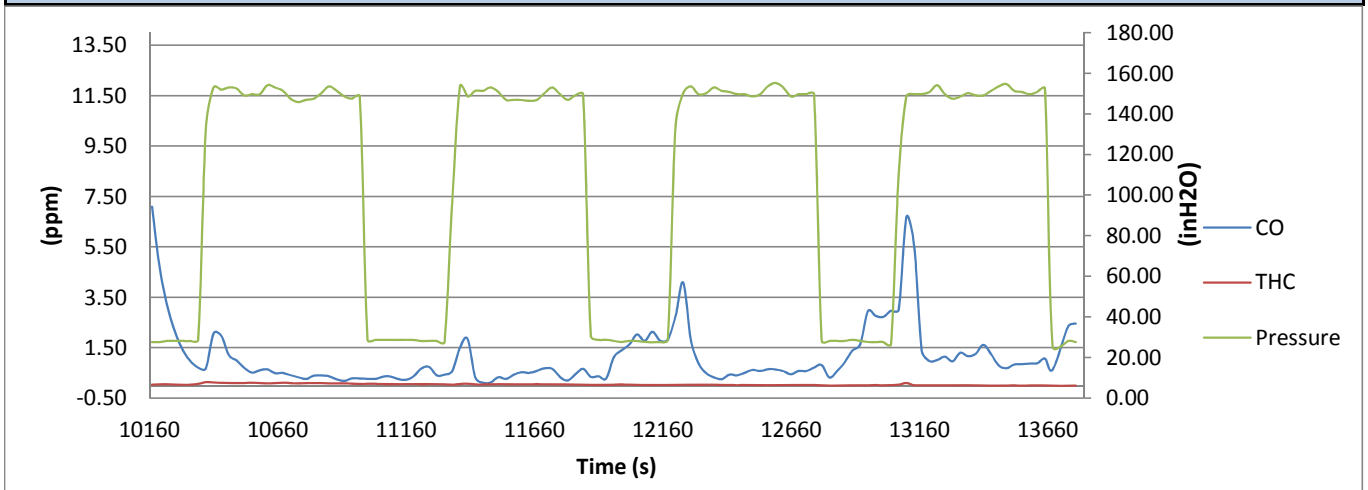
## 4.0X30PF R4



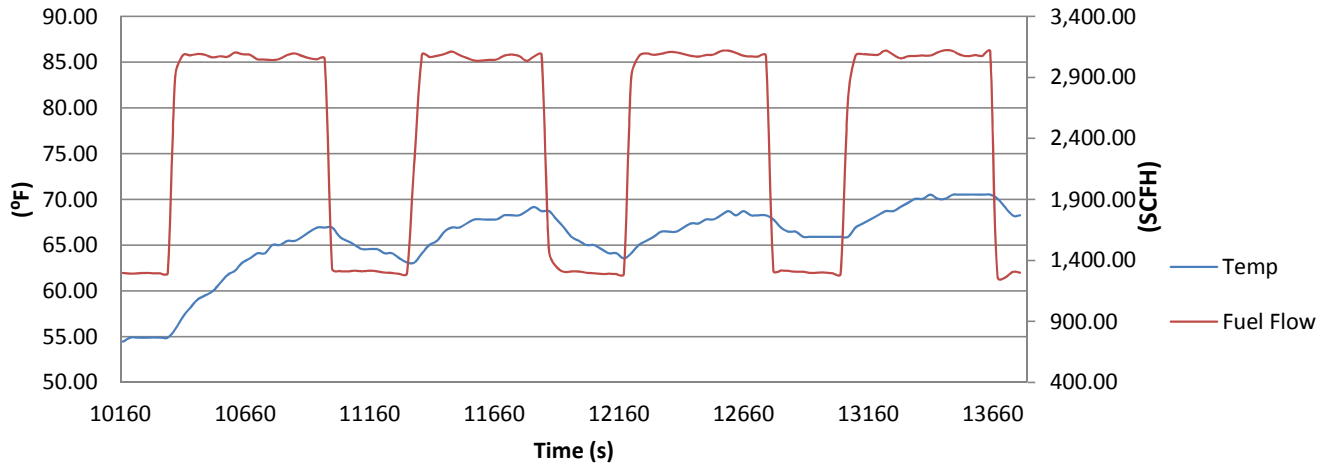

## 4.0X30PF R4



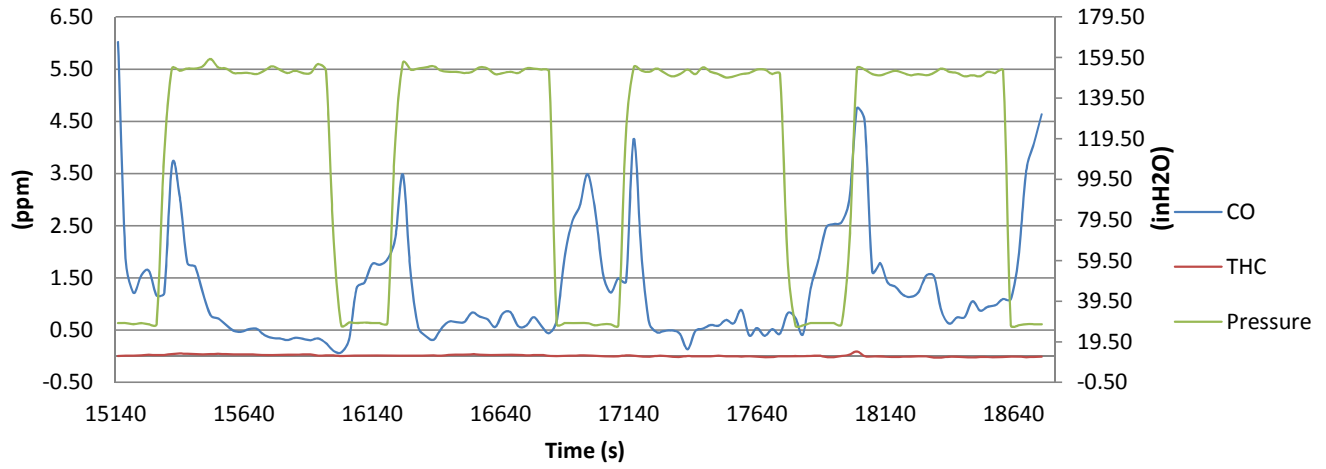

## 4.0X30PF R5



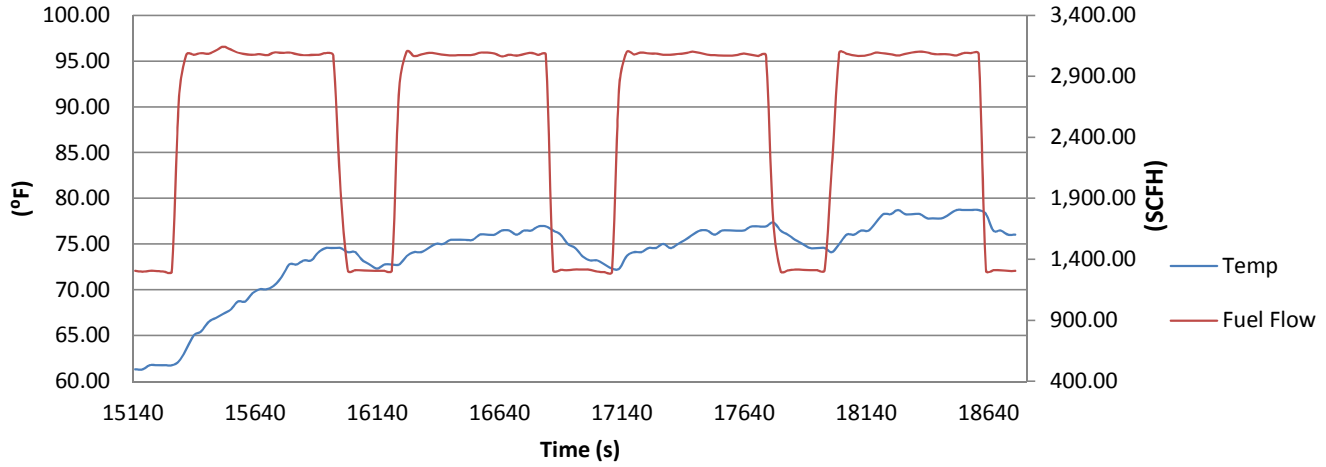
## 4.0X30PF R5

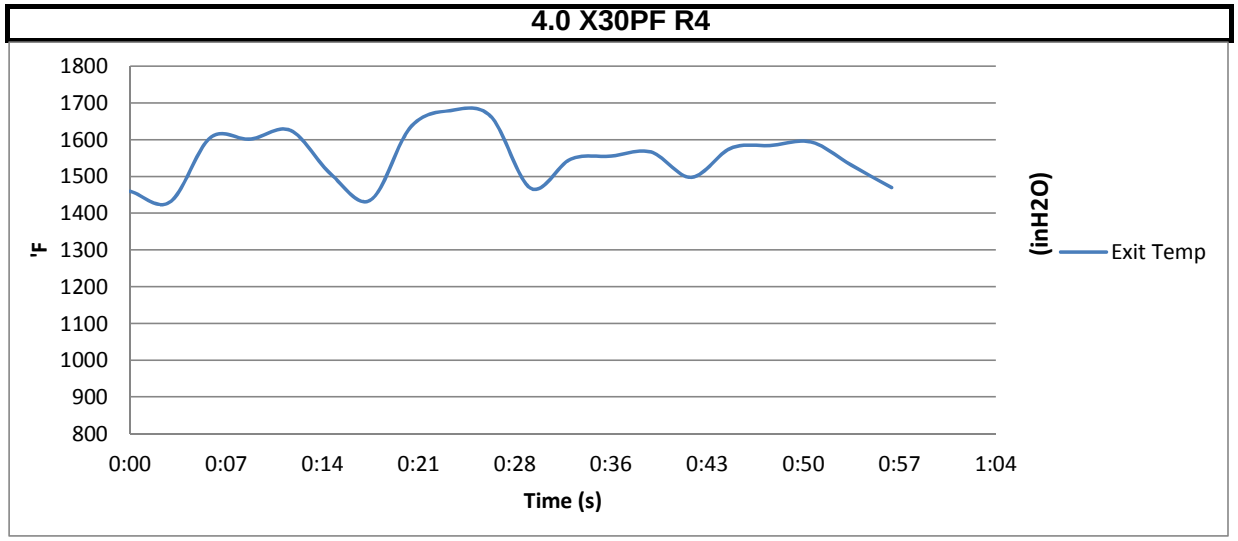


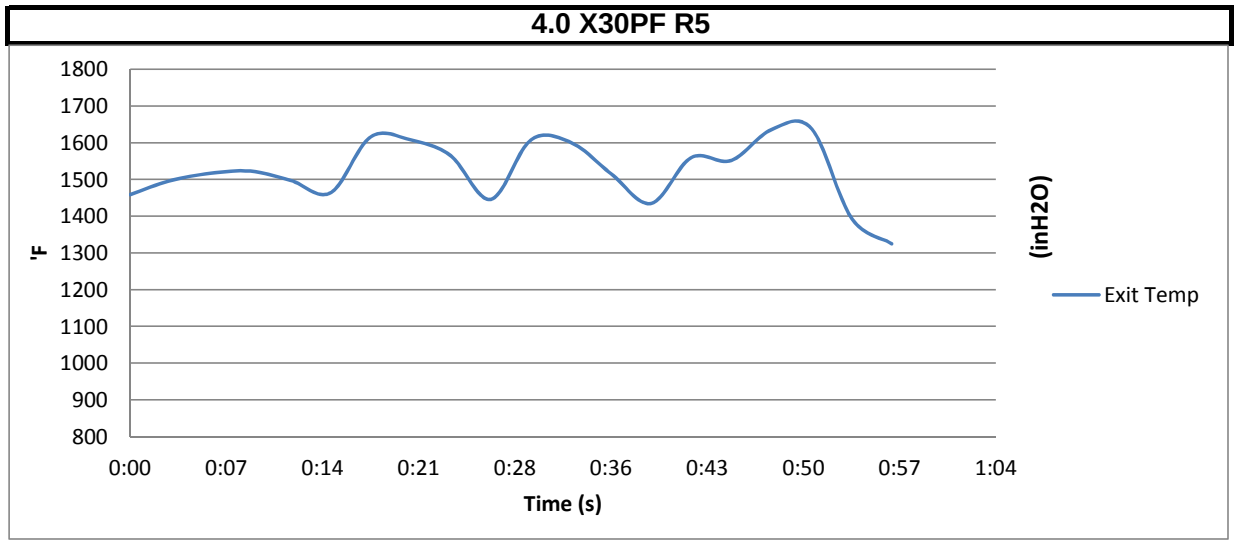

## 4.0X30PF R6

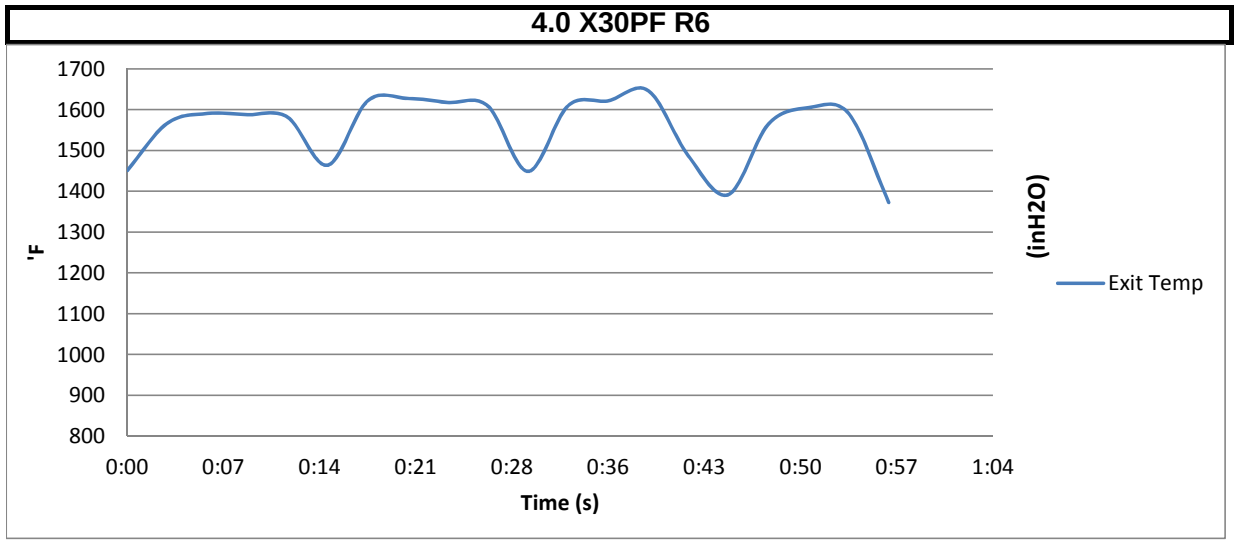



## 4.0X30PF R6




4.0 X30PF R4
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp


4.0 X30PF R5
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp


4.0 X30PF R6
1700
1600
1500
1400
1300
1200
1100
1000
900
800
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp

# EMISSION DATA RECORDS

## 70-100-70% Ramp-up, Ramp-down Unit Operations Data

| METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE |
|---|

| Source Information | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Fuel Type** | Gas, Propene |

| Test Information | | | |
|---|---|---|---|
| **Project #** | | jz-14-tulsa.ok-comp#1 | |
| **Operator** | | TP | |
| **Date for Preliminary Run** | (mm/dd/yy) | 03/11/14 | |
| **Standard Temperature** | | 68 | °F |
| **Standard Pressure** | | 29.92 | in Hg |
| **Required Sample Vol.** | RM4, 8.1.1.2 | 21 | scf |
| **Run Duration** | ≤0.75 cfm | 60 | minutes |
| **Unit Number** | | 1 | |
| **Base Run Number** | | 70-100-70% | |
| **Number of Ports Available** | | 2 | |
| **Number of Ports Used** | | 2 | |
| **Port Inside Diameter** | | 4.00 | in |
| **Stack Shape** | | Circular | |

| Test Equipment Information | | | | | |
|---|---|---|---|---|---|
| **Run** | | **7** | **8** | **9** | |
| **Test Date** | (mm/dd/yy) | 03/12/14 | 03/12/14 | 03/13/14 | |
| **Load** | % or w/DB | 70-100-70 | 70-100-70 | 70-100-70 | |
| **Meter Box Number** | from ACS | samp-cp-0008 | samp-cp-0008 | samp-cp-0008 | |
| **Meter Calibration Factor** | (Y) | 0.924 | 0.924 | 0.924 | |
| **Orifice Meter Coefficient** | ($\Delta H_@$) | 1.700 | 1.700 | 1.700 | in $H_2O$ |
| **Pitot Identification** | from ACS | A4174 | A4174 | A4174 | |
| **Pitot Tube Coefficient** | ($C_p$) | 0.819 | 0.819 | 0.819 | |
| **Probe Number** | from ACS | samp-hp-0003 | samp-hp-0003 | samp-hp-0003 | |
| **Probe Length** | | 60.0 | 60.0 | 60.0 | in |
| **(SS, Glass …. ) Liner Material** | from list | inconel | inconel | inconel | |
| **Impinger Case Number** | from ACS | samp-bh-0016 | samp-bh-0016 | samp-bh-0016 | |

| Testing Company Information | |
|---|---|
| **Company Name** | Air Hygiene International, Inc. (Tulsa, Oklahoma) |
| **Address** | 1600 W Tacoma Street |
| **City, State Zip** | Broken Arrow, Oklahoma 74012 |
| **Project Manager** | Min Sum Lee |
| **Phone Number** | (918) 307-8865 |
| **Fax Number** | (918) 307-9131 |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] - RESULTS

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| **Historical Data** | 70-100-70%-7 | 70-100-70%-8 | 70-100-70%-9 | **Average** | **Units** |
|---|---|---|---|---|---|
| Run Start Time | 13:19 | 16:30 | 08:40 | | hh:mm |
| Run Stop Time | 14:22 | 17:33 | 09:43 | | hh:mm |
| Test Date | 03/12/14 | 03/12/14 | 03/13/14 | | mm/dd/yy |
| Meter Calibration Factor | 0.924 | 0.924 | 0.924 | | |
| Pitot Tube Coefficient | 0.819 | 0.819 | 0.819 | | |
| **Stack Test Data** | 70-100-70%-7 | 70-100-70%-8 | 70-100-70%-9 | **Average** | **Units** |
| Initial Meter Volume | 162.614 | 232.300 | 279.325 | | $ft^3$ |
| Final Meter Volume | 210.177 | 279.680 | 329.761 | | $ft^3$ |
| Total Meter Volume | 47.563 | 47.380 | 50.436 | 48.460 | $ft^3$ |
| Total Sampling Time | 60.00 | 60.00 | 60.00 | 60.00 | min |
| Average Meter Temperature | 65.88 | 71.38 | 58.10 | 65.12 | °F |
| Average Stack Temperature | 1444.90 | 1656.35 | 1594.95 | 1565.40 | °F |
| Barometric Pressure | 30.26 | 30.19 | 30.19 | 30.21 | in Hg |
| Stack Static Pressure | 0.00 | 0.00 | 0.00 | 0.00 | in $H_2O$ |
| Absolute Stack Pressure | 30.26 | 30.19 | 30.19 | 30.21 | in Hg |
| Average Orifice Pressure Drop | 1.70 | 1.70 | 1.70 | 1.70 | in $H_2O$ |
| Absolute Meter Pressure | 30.39 | 30.32 | 30.32 | 30.34 | in Hg |
| Avg Square Root Pitot Pressure | 0.25 | 0.24 | 0.24 | 0.24 | √(in $H_2O$) |
| **Moisture Content Data** | 70-100-70%-7 | 70-100-70%-8 | 70-100-70%-9 | **Average** | **Units** |
| Impinger Water Weight Gain | 53.70 | 50.20 | 45.00 | 49.63 | g |
| Silica Gel Weight Gain | 11.00 | 9.40 | 11.60 | 10.67 | g |
| Total Water Volume Collected | 64.82 | 59.71 | 56.70 | 60.41 | ml |
| Standard Water Vapor Volume | 3.05 | 2.81 | 2.67 | 2.84 | scf |
| Standard Meter Volume | 44.8 | 44.1 | 48.1 | 45.7 | dscf |
| Calculated Stack Moisture | 6.37 | 5.99 | 5.25 | 5.87 | % |
| Saturated Stack Moisture | 100.00 | 100.00 | 100.00 | 100.00 | % |
| Reported Stack Moisture Content | 6.37 | 5.99 | 5.25 | 5.87 | % |
| **Gas Analysis Data** | 70-100-70%-7 | 70-100-70%-8 | 70-100-70%-9 | **Average** | **Units** |
| Carbon Dioxide Content | 5.3 | 5.5 | 5.7 | 5.5 | % |
| Oxygen Content | 15.4 | 14.7 | 14.3 | 14.8 | % |
| Nitrogen Content | 79.3 | 79.8 | 79.9 | 79.7 | % |
| Stack Dry Molecular Weight | 29.44 | 29.47 | 29.47 | 29.46 | lb/lb-mole |
| Stack Wet Molecular Weight | 28.71 | 28.78 | 28.87 | 28.79 | lb/lb-mole |
| Percent Excess Air | 278.2 | 230.9 | 210.5 | 239.9 | % |
| **Volumetric Flow Rate Data** | 70-100-70%-7 | 70-100-70%-8 | 70-100-70%-9 | **Average** | **Units** |
| Average Stack Gas Velocity | 25.86 | 26.20 | 25.57 | 25.88 | ft/sec |
| Stack Cross-Sectional Area | 12.57 | 12.57 | 12.57 | 12.57 | $ft^2$ |
| Actual Stack Flow Rate | 19,499 | 19,753 | 19,279 | 19,510 | acfm |
| Wet Standard Stack Flow Rate | 328 | 298 | 300 | 309 | wkscfh |
| Dry Standard Stack Flow Rate | 307,067 | 280,468 | 284,135 | 290,557 | dscfh |

## METHOD 3C - DETERMINATION OF DRY MOLECULAR WEIGHT BY ANALYZER

| | | | | | |
|---|---|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Preliminary Date** | 03/11/14 | | |
| **Sampling Location** | 4.0X30PF | **Operator** | TP | | |
| **Project #** | jz-14-tulsa.ok-comp#1 | **# of Ports Used** | 2 | | |
| **Fuel Type** | Gas, Propene | **Min. Fuel Factor** | N/A | **Max. Fuel Factor** | N/A |

| Gas Analysis Data | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 70-100-70%-7 | | **Date** | 03/12/14 | **Run Start Time** | 13:19 | | **Run Stop Time** | 14:22 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:03 | 5.3 | 15.4 | 0.0 | 79.3 | 29.44 | 1.048 | | 278.2 | N/A |

| Gas Analysis Data | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 70-100-70%-8 | | **Date** | 03/12/14 | **Run Start Time** | 16:30 | | **Run Stop Time** | 17:33 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:03 | 5.5 | 14.7 | 0.0 | 79.8 | 29.47 | 1.127 | | 230.9 | N/A |

| Gas Analysis Data | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | 70-100-70%-9 | | **Date** | 03/13/14 | **Run Start Time** | 08:40 | | **Run Stop Time** | 09:43 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | | % | |
| 01:03 | 5.7 | 14.3 | 0.0 | 79.9 | 29.47 | 1.152 | | 210.5 | N/A |

## METHOD 4 - DETERMINATION OF MOISTURE CONTENT IN STACK GASES

| | | | |
|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Preliminary Date** | 03/11/14 |
| **Sampling Location** | 4.0X30PF | **Operator** | TP |
| **Project #** | jz-14-tulsa.ok-comp#1 | **Ports Used** | 2 |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 70-100-70%-7 | | **Date** | 03/12/14 | **Start Time** | 13:19 | **Stop Time** | 14:22 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 47.563 | dcf | | **Barometric Pressure** | ($P_b$) | 30.26 | in Hg |
| **Average Stack Temp** | | $(t_s)_{avg}$ | 1445 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | $(t_m)_{avg}$ | 66 | °F | | **Avg Orifice Pressure** | $(\Delta H)_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 835.00 | 758.70 | 581.60 | 918.40 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 794.60 | 748.10 | 578.90 | 907.40 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 40.4 | 10.6 | 2.7 | 11.0 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 64.70 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 3.051 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 44.812 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 6.37 | % | | **Final Moisture Content** | ($B_{ws}$) | 6.37 | % |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 70-100-70%-8 | | **Date** | 03/12/14 | **Start Time** | 16:30 | **Stop Time** | 17:33 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 47.380 | dcf | | **Barometric Pressure** | ($P_b$) | 30.19 | in Hg |
| **Average Stack Temp** | | $(t_s)_{avg}$ | 1656 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | $(t_m)_{avg}$ | 71 | °F | | **Avg Orifice Pressure** | $(\Delta H)_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 875.30 | 767.30 | 582.90 | 927.80 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 835.00 | 758.70 | 581.60 | 918.40 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 40.3 | 8.6 | 1.3 | 9.4 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 59.60 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.810 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 44.075 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 5.99 | % | | **Final Moisture Content** | ($B_{ws}$) | 5.99 | % |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 70-100-70%-9 | | **Date** | 03/13/14 | **Start Time** | 08:40 | **Stop Time** | 09:43 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 50.436 | dcf | | **Barometric Pressure** | ($P_b$) | 30.19 | in Hg |
| **Average Stack Temp** | | $(t_s)_{avg}$ | 1595 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | $(t_m)_{avg}$ | 58 | °F | | **Avg Orifice Pressure** | $(\Delta H)_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 732.40 | 758.30 | 579.00 | 886.60 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 707.30 | 742.00 | 575.40 | 875.00 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 25.1 | 16.3 | 3.6 | 11.6 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 56.60 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.669 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 48.120 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 5.25 | % | | **Final Moisture Content** | ($B_{ws}$) | 5.25 | % |

**METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA**

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/12/14 |
| **Operator** | TP |
| **Run Number** | 70-100-70%-7 |

| **Ideal Nozzle Diameter and IsoKinetic Factor Setup** | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1444.9 | °F |
| **Average Meter Temp** | ($t_m$) | 65.9 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.25 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 6.37 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.44 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.75 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| **Leak Checks** | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.025 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.025 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.035 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.015 | in $H_2O$ for | 15.0 | sec |

| **Sampling Equipment** | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4013 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | samp-bh-0016 | | |

| **Pressures** | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.26 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.26 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.39 | in Hg |

| **Nozzle Measurements** | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| **Run Time** | | | |
|---|---|---|---|
| **Start** | 13:19 | **End** | 14:22 |

| **Weights** | **Imp 1** | **Imp 2** | **Imp 3** | **Imp 4** | **Imp 5** | **Imp 6** | **Imp 7** | **Imp 8** |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 794.6 | 748.1 | 578.9 | 907.4 | | | | |
| **Post** | 835.0 | 758.7 | 581.6 | 918.4 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| **Traverse Point #** | **Sampling Time (Θ)** | **Timer Time** | **Dry Gas Meter Reading ($V_m$)** | **Velocity Head (Δp)** | **Desired Orifice ΔH ($\Delta H_d$)** | **Actual Orifice ΔH ($\Delta H_a$)** | **Stack Temp ($t_s$)** | **Snorkel Temp (248±25°F)** | **Filter Temp (248±25°F)** | **Impinger Exit Temp (≤68°F)** | **Cond. Temp (≤--°F)** | **CPM Filter Temp (--±--°F)** | **Meter Inlet Temp ($t_{mi}$)** | **Meter Outlet Temp ($t_{mo}$)** | **Pump Vacuum** | **Square Root ΔP ($\Delta p^{1/2}$)** | **Local Stack Velocity ($v_s$)$_l$** | **Cumul. Meter Volume ($V_m$)$_{std}$** | **Cumul. Percent IsoKinetic (I)** | **Est-Run Meter Volume ($V_m$)$_{std}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 162.614 | 0.030 | 1.700 | 1.70 | 1401 | 240 | | 67 | | | 60 | 60 | 2.5 | 0.17 | 17.76 | 1.907 | | 38.131 |
| A-2 | 3.0 | 00:03:00 | 164.615 | 0.045 | 1.700 | 1.70 | 1426 | 240 | | 66 | | | 62 | 60 | 2.5 | 0.21 | 21.89 | 4.236 | | 42.364 |
| A-3 | 6.0 | 00:06:00 | 167.065 | 0.050 | 1.700 | 1.70 | 1423 | 240 | | 65 | | | 64 | 60 | 2.5 | 0.22 | 23.06 | 6.419 | | 42.796 |
| A-4 | 9.0 | 00:09:00 | 169.365 | 0.075 | 1.700 | 1.70 | 1635 | 240 | | 65 | | | 66 | 60 | 2.5 | 0.27 | 29.79 | 8.797 | | 43.986 |
| A-5 | 12.0 | 00:12:00 | 171.875 | 0.050 | 1.700 | 1.70 | 1580 | 240 | | 65 | | | 67 | 60 | 2.5 | 0.22 | 24.00 | 10.974 | | 43.896 |
| A-6 | 15.0 | 00:15:00 | 174.175 | 0.045 | 1.700 | 1.70 | 1435 | 240 | | 66 | | | 68 | 61 | 2.5 | 0.21 | 21.95 | 13.218 | | 44.058 |
| A-7 | 18.0 | 00:18:00 | 176.550 | 0.070 | 1.700 | 1.70 | 1473 | 240 | | 67 | | | 68 | 61 | 2.5 | 0.26 | 27.64 | 15.503 | | 44.296 |
| A-8 | 21.0 | 00:21:00 | 178.970 | 0.080 | 1.700 | 1.70 | 1463 | 240 | | 68 | | | 69 | 61 | 2.5 | 0.28 | 29.48 | 17.797 | | 44.492 |
| A-9 | 24.0 | 00:24:00 | 181.400 | 0.075 | 1.700 | 1.70 | 1445 | 240 | | 66 | | | 71 | 62 | 2.5 | 0.27 | 28.41 | 20.083 | | 44.630 |
| A-10 | 27.0 | 00:27:00 | 183.830 | 0.060 | 1.700 | 1.70 | 1386 | 240 | | 64 | | | 71 | 63 | 2.5 | 0.24 | 25.01 | 22.374 | | 44.747 |
| B-1 | 30.0 | 00:30:00 | 186.266 | 0.070 | 1.700 | 1.70 | 1424 | 240 | | 63 | | | 68 | 63 | 2.5 | 0.26 | 27.29 | 24.631 | | 44.783 |
| B-2 | 33.0 | 00:33:00 | 188.660 | 0.075 | 1.700 | 1.70 | 1593 | 240 | | 61 | | | 71 | 63 | 2.5 | 0.27 | 29.49 | 26.864 | | 44.773 |
| B-3 | 36.0 | 00:36:00 | 191.035 | 0.080 | 1.700 | 1.70 | 1510 | 240 | | 58 | | | 71 | 64 | 2.5 | 0.28 | 29.83 | 29.094 | | 44.760 |
| B-4 | 39.0 | 00:39:00 | 193.410 | 0.075 | 1.700 | 1.70 | 1492 | 240 | | 59 | | | 72 | 64 | 2.5 | 0.27 | 28.75 | 31.337 | | 44.767 |
| B-5 | 42.0 | 00:42:00 | 195.800 | 0.055 | 1.700 | 1.70 | 1336 | 240 | | 59 | | | 72 | 65 | 2.5 | 0.23 | 23.62 | 33.578 | | 44.770 |
| B-6 | 45.0 | 00:45:00 | 198.190 | 0.050 | 1.700 | 1.70 | 1336 | 240 | | 59 | | | 72 | 65 | 2.5 | 0.22 | 22.52 | 35.809 | | 44.761 |
| B-7 | 48.0 | 00:48:00 | 200.570 | 0.075 | 1.700 | 1.70 | 1411 | 240 | | 58 | | | 72 | 65 | 2.5 | 0.27 | 28.15 | 38.040 | | 44.753 |
| B-8 | 51.0 | 00:51:00 | 202.950 | 0.080 | 1.700 | 1.70 | 1404 | 240 | | 58 | | | 72 | 65 | 2.5 | 0.28 | 29.02 | 40.290 | | 44.767 |
| B-9 | 54.0 | 00:54:00 | 205.350 | 0.070 | 1.700 | 1.70 | 1393 | 240 | | 59 | | | 72 | 65 | 2.5 | 0.26 | 27.07 | 42.610 | | 44.853 |
| B-10 | 57.0 | 00:57:00 | 207.825 | 0.050 | 1.700 | 1.70 | 1332 | 240 | | 58 | | | 74 | 66 | 2.5 | 0.22 | 22.50 | 44.809 | | 44.809 |
| Last Pt | 60.0 | 01:00:00 | 210.177 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 210.177 | | | | | | | | | | | **Max Vac** | 2.5 | **Final Values** | | 44.809 | | |
| **Average Values** | | | | 0.06 | | 1.70 | 1445 | 240 | | 63 | | | 69 | 63 | | 0.25 | 25.86 | | | |
| | | | | | | | | | | | | | 66 | | | | | | | |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/12/14 |
| **Operator** | TP |
| **Run Number** | 70-100-70%-8 |

| Ideal Nozzle Diameter and IsoKinetic Factor Setup | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1656.4 | °F |
| **Average Meter Temp** | ($t_m$) | 71.4 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.24 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 5.99 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.47 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.75 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| Leak Checks | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.04 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.06 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.05 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.04 | in $H_2O$ for | 15.0 | sec |

| Sampling Equipment | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4131 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | samp-bh-0016 | | |

| Pressures | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.19 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.19 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.32 | in Hg |

| Nozzle Measurements | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| Run Time | | | |
|---|---|---|---|
| **Start** | 16:30 | **End** | 17:33 |

| Weights | Imp 1 | Imp 2 | Imp 3 | Imp 4 | Imp 5 | Imp 6 | Imp 7 | Imp 8 |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 835.0 | 758.7 | 581.6 | 918.4 | | | | |
| **Post** | 875.3 | 767.3 | 582.9 | 927.8 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| Traverse Point # | Sampling Time (Θ) | Timer Time | Dry Gas Meter Reading ($V_m$) | Velocity Head (Δp) | Desired Orifice ΔH ($\Delta H_d$) | Actual Orifice ΔH ($\Delta H_a$) | Stack Temp ($t_s$) | Snorkel Temp (248±25°F) | Filter Temp (248±25°F) | Impinger Exit Temp (≤68°F) | Cond. Temp (≤--°F) | CPM Filter Temp (--±--°F) | Meter Inlet Temp ($t_{mi}$) | Meter Outlet Temp ($t_{mo}$) | Pump Vacuum | Square Root ΔP ($\Delta p^{1/2}$) | Local Stack Velocity ($v_s$)$_l$ | Cumul. Meter Volume ($V_m$)$_{std}$ | Cumul. Percent IsoKinetic (I) | Est-Run Meter Volume ($V_m$)$_{std}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 232.300 | 0.035 | 1.700 | 1.70 | 1546 | 240 | | 45 | | | 66 | 66 | 2.5 | 0.19 | 19.91 | 2.396 | | 47.928 |
| A-2 | 3.0 | 00:03:00 | 234.850 | 0.055 | 1.700 | 1.70 | 1707 | 240 | | 42 | | | 68 | 66 | 2.5 | 0.23 | 25.94 | 4.582 | | 45.819 |
| A-3 | 6.0 | 00:06:00 | 237.180 | 0.060 | 1.700 | 1.70 | 1736 | 240 | | 43 | | | 70 | 66 | 2.5 | 0.24 | 27.28 | 6.754 | | 45.026 |
| A-4 | 9.0 | 00:09:00 | 239.500 | 0.060 | 1.700 | 1.70 | 1736 | 240 | | 44 | | | 71 | 66 | 2.5 | 0.24 | 27.28 | 8.952 | | 44.759 |
| A-5 | 12.0 | 00:12:00 | 241.850 | 0.045 | 1.700 | 1.70 | 1658 | 240 | | 44 | | | 72 | 66 | 2.5 | 0.21 | 23.20 | 11.208 | | 44.834 |
| A-6 | 15.0 | 00:15:00 | 244.265 | 0.035 | 1.700 | 1.70 | 1611 | 240 | | 45 | | | 73 | 66 | 2.5 | 0.19 | 20.23 | 13.108 | | 43.694 |
| A-7 | 18.0 | 00:18:00 | 246.300 | 0.080 | 1.700 | 1.70 | 1767 | 240 | | 46 | | | 73 | 67 | 2.5 | 0.28 | 31.72 | 15.300 | | 43.714 |
| A-8 | 21.0 | 00:21:00 | 248.650 | 0.075 | 1.700 | 1.70 | 1800 | 240 | | 47 | | | 74 | 67 | 2.5 | 0.27 | 30.94 | 17.485 | | 43.713 |
| A-9 | 24.0 | 00:24:00 | 250.995 | 0.065 | 1.700 | 1.70 | 1744 | 240 | | 47 | | | 74 | 67 | 2.5 | 0.25 | 28.44 | 19.735 | | 43.856 |
| A-10 | 27.0 | 00:27:00 | 253.410 | 0.040 | 1.700 | 1.70 | 1622 | 240 | | 49 | | | 75 | 68 | 2.5 | 0.20 | 21.69 | 21.999 | | 43.998 |
| B-1 | 30.0 | 00:30:00 | 255.844 | 0.070 | 1.700 | 1.70 | 1598 | 240 | | 51 | | | 75 | 68 | 2.5 | 0.26 | 28.52 | 24.190 | | 43.982 |
| B-2 | 33.0 | 00:33:00 | 258.200 | 0.080 | 1.700 | 1.70 | 1599 | 240 | | 51 | | | 77 | 68 | 2.5 | 0.28 | 30.50 | 26.418 | | 44.030 |
| B-3 | 36.0 | 00:36:00 | 260.600 | 0.080 | 1.700 | 1.70 | 1600 | 240 | | 51 | | | 78 | 69 | 2.5 | 0.28 | 30.51 | 28.595 | | 43.993 |
| B-4 | 39.0 | 00:39:00 | 262.950 | 0.045 | 1.700 | 1.70 | 1490 | 240 | | 52 | | | 79 | 69 | 2.5 | 0.21 | 22.26 | 30.803 | | 44.005 |
| B-5 | 42.0 | 00:42:00 | 265.335 | 0.050 | 1.700 | 1.70 | 1574 | 240 | | 52 | | | 80 | 69 | 2.5 | 0.22 | 23.97 | 33.018 | | 44.024 |
| B-6 | 45.0 | 00:45:00 | 267.730 | 0.050 | 1.700 | 1.70 | 1587 | 240 | | 52 | | | 79 | 70 | 2.5 | 0.22 | 24.04 | 35.252 | | 44.064 |
| B-7 | 48.0 | 00:48:00 | 270.145 | 0.075 | 1.700 | 1.70 | 1781 | 240 | | 53 | | | 77 | 70 | 2.5 | 0.27 | 30.81 | 37.480 | | 44.094 |
| B-8 | 51.0 | 00:51:00 | 272.550 | 0.070 | 1.700 | 1.70 | 1775 | 240 | | 52 | | | 78 | 70 | 2.5 | 0.26 | 29.72 | 39.637 | | 44.041 |
| B-9 | 54.0 | 00:54:00 | 274.880 | 0.050 | 1.700 | 1.70 | 1634 | 240 | | 53 | | | 79 | 70 | 2.5 | 0.22 | 24.32 | 41.838 | | 44.040 |
| B-10 | 57.0 | 00:57:00 | 277.260 | 0.045 | 1.700 | 1.70 | 1562 | 240 | | 53 | | | 79 | 70 | 2.5 | 0.21 | 22.67 | 44.076 | | 44.076 |
| Last Pt | 60.0 | 01:00:00 | 279.680 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 279.680 | | | | | | | | | | | **Max Vac** | 2.5 | **Final Values** | | 44.076 | | |
| **Average Values** | | | | 0.06 | | 1.70 | 1656 | 240 | | 49 | | | 75 | 68 | | 0.24 | 26.20 | | | |
| | | | | | | | | | | | | | 71 | | | | | | | |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/13/14 |
| **Operator** | TP |
| **Run Number** | 70-100-70%-9 |

| Ideal Nozzle Diameter and IsoKinetic Factor Setup | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1595.0 | °F |
| **Average Meter Temp** | ($t_m$) | 58.1 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.24 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 5.25 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.47 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.73 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| Leak Checks | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.015 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.040 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.035 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.015 | in $H_2O$ for | 15.0 | sec |

| Sampling Equipment | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4131 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | samp-bh-0016 | | |

| Pressures | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.19 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.19 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.32 | in Hg |

| Nozzle Measurements | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| Run Time | | | |
|---|---|---|---|
| **Start** | 08:40 | **End** | 09:43 |

| Weights | Imp 1 | Imp 2 | Imp 3 | Imp 4 | Imp 5 | Imp 6 | Imp 7 | Imp 8 |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 707.3 | 742.0 | 575.4 | 875.0 | | | | |
| **Post** | 732.4 | 758.3 | 579.0 | 886.6 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| Traverse Point # | Sampling Time (Θ) | Timer Time | Dry Gas Meter Reading ($V_m$) | Velocity Head (Δp) | Desired Orifice ΔH ($\Delta H_d$) | Actual Orifice ΔH ($\Delta H_a$) | Stack Temp ($t_s$) | Snorkel Temp (248±25°F) | Filter Temp (248±25°F) | Impinger Exit Temp (≤68°F) | Cond. Temp (≤--°F) | CPM Filter Temp (--±--°F) | Meter Inlet Temp ($t_{mi}$) | Meter Outlet Temp ($t_{mo}$) | Pump Vacuum | Square Root ΔP ($\Delta p^{1/2}$) | Local Stack Velocity ($v_s$)$_l$ | Cumul. Meter Volume ($V_m$)$_{std}$ | Cumul. Percent IsoKinetic (I) | Est-Run Meter Volume ($V_m$)$_{std}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 279.325 | 0.040 | 1.700 | 1.70 | 1494 | 240 | | 41 | | | 57 | 46 | 2.5 | 0.20 | 20.98 | 2.769 | | 55.375 |
| A-2 | 3.0 | 00:03:00 | 282.190 | 0.055 | 1.700 | 1.70 | 1552 | 240 | | 41 | | | 62 | 47 | 2.5 | 0.23 | 24.96 | 5.214 | | 52.139 |
| A-3 | 6.0 | 00:06:00 | 284.735 | 0.060 | 1.700 | 1.70 | 1659 | 240 | | 41 | | | 61 | 47 | 2.5 | 0.24 | 26.76 | 7.488 | | 49.922 |
| A-4 | 9.0 | 00:09:00 | 287.100 | 0.060 | 1.700 | 1.70 | 1654 | 240 | | 43 | | | 61 | 47 | 2.5 | 0.24 | 26.72 | 9.782 | | 48.910 |
| A-5 | 12.0 | 00:12:00 | 289.485 | 0.050 | 1.700 | 1.70 | 1515 | 240 | | 43 | | | 61 | 48 | 2.5 | 0.22 | 23.58 | 12.198 | | 48.793 |
| A-6 | 15.0 | 00:15:00 | 292.000 | 0.055 | 1.700 | 1.70 | 1505 | 240 | | 46 | | | 61 | 49 | 2.5 | 0.23 | 24.67 | 14.406 | | 48.020 |
| A-7 | 18.0 | 00:18:00 | 294.300 | 0.055 | 1.700 | 1.70 | 1519 | 240 | | 47 | | | 62 | 50 | 2.5 | 0.23 | 24.76 | 16.767 | | 47.906 |
| A-8 | 21.0 | 00:21:00 | 296.765 | 0.070 | 1.700 | 1.70 | 1693 | 240 | | 50 | | | 63 | 51 | 2.5 | 0.26 | 29.13 | 19.048 | | 47.619 |
| A-9 | 24.0 | 00:24:00 | 299.150 | 0.070 | 1.700 | 1.70 | 1702 | 240 | | 51 | | | 64 | 51 | 2.5 | 0.26 | 29.19 | 21.436 | | 47.635 |
| A-10 | 27.0 | 00:27:00 | 301.650 | 0.035 | 1.700 | 1.70 | 1550 | 240 | | 52 | | | 63 | 52 | 2.5 | 0.19 | 19.90 | 23.739 | | 47.477 |
| B-1 | 30.0 | 00:30:00 | 304.061 | 0.045 | 1.700 | 1.70 | 1440 | 240 | | 52 | | | 60 | 52 | 2.5 | 0.21 | 21.94 | 27.392 | | 49.804 |
| B-2 | 33.0 | 00:33:00 | 307.875 | 0.055 | 1.700 | 1.70 | 1663 | 240 | | 55 | | | 64 | 54 | 2.5 | 0.23 | 25.64 | 29.664 | | 49.440 |
| B-3 | 36.0 | 00:36:00 | 310.260 | 0.070 | 1.700 | 1.70 | 1695 | 240 | | 56 | | | 65 | 54 | 2.5 | 0.26 | 29.14 | 31.938 | | 49.135 |
| B-4 | 39.0 | 00:39:00 | 312.650 | 0.050 | 1.700 | 1.70 | 1570 | 240 | | 58 | | | 66 | 54 | 2.5 | 0.22 | 23.91 | 34.267 | | 48.953 |
| B-5 | 42.0 | 00:42:00 | 315.100 | 0.050 | 1.700 | 1.70 | 1555 | 240 | | 59 | | | 66 | 55 | 2.5 | 0.22 | 23.82 | 36.594 | | 48.792 |
| B-6 | 45.0 | 00:45:00 | 317.550 | 0.075 | 1.700 | 1.70 | 1661 | 240 | | 60 | | | 67 | 55 | 2.5 | 0.27 | 29.93 | 38.861 | | 48.577 |
| B-7 | 48.0 | 00:48:00 | 319.940 | 0.080 | 1.700 | 1.70 | 1717 | 240 | | 61 | | | 68 | 56 | 2.5 | 0.28 | 31.32 | 41.233 | | 48.510 |
| B-8 | 51.0 | 00:51:00 | 322.445 | 0.075 | 1.700 | 1.70 | 1712 | 240 | | 64 | | | 71 | 57 | 2.5 | 0.27 | 30.29 | 43.474 | | 48.304 |
| B-9 | 54.0 | 00:54:00 | 324.820 | 0.050 | 1.700 | 1.70 | 1537 | 240 | | 65 | | | 71 | 57 | 2.5 | 0.22 | 23.71 | 45.813 | | 48.225 |
| B-10 | 57.0 | 00:57:00 | 327.300 | 0.040 | 1.700 | 1.70 | 1506 | 240 | | 66 | | | 71 | 58 | 2.5 | 0.20 | 21.04 | 48.133 | | 48.133 |
| Last Pt | 60.0 | 01:00:00 | 329.761 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 329.761 | | | | | | | | | | | **Max Vac** | 2.5 | **Final Values** | | 48.133 | | |
| **Average Values** | | | | 0.06 | | 1.70 | 1595 | 240 | | 53 | | | 64 | 52 | | 0.24 | 25.57 | | | |
| | | | | | | | | | | | | | 58 | | | | | | | |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 307,067 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 58 | $^{o}$F |
| Specific Humidity | 0.002809 | lb $H_2O$ / lb air |

70-100-70 Load, Run - 4.0X30PF R7

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/12/14 13:19:00 | 22110 | 12.87 | 0.05 | 0.03 | 6.65 | 152.52 | 85.47 | 3,075.24 |
| | 03/12/14 13:19:30 | 22140 | 13.98 | 0.13 | 0.04 | 5.63 | 151.41 | 85.47 | 3,063.58 |
| | 03/12/14 13:20:00 | 22170 | 13.50 | 0.23 | 0.04 | 5.93 | 149.75 | 85.02 | 3,054.88 |
| | 03/12/14 13:20:30 | 22200 | 13.60 | 0.28 | 0.03 | 5.92 | 150.86 | 85.47 | 3,041.11 |
| | 03/12/14 13:21:00 | 22230 | 14.61 | 0.36 | 0.04 | 5.04 | 151.41 | 85.92 | 3,039.76 |
| | 03/12/14 13:21:30 | 22260 | 14.81 | 0.42 | 0.04 | 4.78 | 155.28 | 85.92 | 3,081.55 |
| | 03/12/14 13:22:00 | 22290 | 14.24 | 0.50 | 0.04 | 5.44 | 156.39 | 86.37 | 3,095.40 |
| | 03/12/14 13:22:30 | 22320 | 15.14 | 0.59 | 0.04 | 4.54 | 159.44 | 86.82 | 3,293.21 |
| | 03/12/14 13:23:00 | 22350 | 14.97 | 0.34 | 0.04 | 4.57 | 268.22 | 86.82 | 4,104.93 |
| | 03/12/14 13:23:30 | 22380 | 13.74 | 0.34 | 0.03 | 5.85 | 306.14 | 87.72 | 4,374.63 |
| | 03/12/14 13:24:00 | 22410 | 14.26 | 0.11 | 0.03 | 5.42 | 305.59 | 88.17 | 4,352.06 |
| | 03/12/14 13:24:30 | 22440 | 14.26 | 0.00 | 0.03 | 5.27 | 314.72 | 88.17 | 4,435.68 |
| | 03/12/14 13:25:00 | 22470 | 13.26 | 0.04 | 0.04 | 6.09 | 314.17 | 88.17 | 4,416.83 |
| | 03/12/14 13:25:30 | 22500 | 13.79 | 0.44 | 0.04 | 5.74 | 311.95 | 88.62 | 4,399.03 |
| | 03/12/14 13:26:00 | 22530 | 13.68 | 0.85 | 0.04 | 5.92 | 306.14 | 89.07 | 4,375.50 |
| | 03/12/14 13:26:30 | 22560 | 14.26 | 0.78 | 0.04 | 5.20 | 305.59 | 89.07 | 4,359.29 |
| | 03/12/14 13:27:00 | 22590 | 14.50 | 0.55 | 0.03 | 5.24 | 309.74 | 89.07 | 4,410.47 |
| | 03/12/14 13:27:30 | 22620 | 13.83 | 0.20 | 0.02 | 5.82 | 313.06 | 89.52 | 4,429.15 |
| | 03/12/14 13:28:00 | 22650 | 14.81 | -0.06 | 0.05 | 4.71 | 319.15 | 89.97 | 4,449.14 |
| | 03/12/14 13:28:30 | 22680 | 15.05 | -0.15 | 0.04 | 4.53 | 317.49 | 89.97 | 4,428.63 |
| | 03/12/14 13:29:00 | 22710 | 13.31 | -0.18 | 0.03 | 6.04 | 309.18 | 89.97 | 4,416.69 |
| | 03/12/14 13:29:30 | 22740 | 13.22 | -0.24 | 0.04 | 6.17 | 309.74 | 89.97 | 4,401.16 |
| | 03/12/14 13:30:00 | 22770 | 14.35 | -0.22 | 0.05 | 5.33 | 313.06 | 90.42 | 4,416.40 |
| | 03/12/14 13:30:30 | 22800 | 13.44 | -0.21 | 0.04 | 6.02 | 317.49 | 90.87 | 4,433.92 |
| | 03/12/14 13:31:00 | 22830 | 14.92 | -0.23 | 0.04 | 4.90 | 311.40 | 91.32 | 4,392.08 |
| | 03/12/14 13:31:30 | 22860 | 14.58 | -0.20 | 0.04 | 4.90 | 309.74 | 90.87 | 4,398.48 |
| | 03/12/14 13:32:00 | 22890 | 13.23 | -0.22 | 0.03 | 6.03 | 307.25 | 90.42 | 4,373.22 |
| | 03/12/14 13:32:30 | 22920 | 12.59 | -0.26 | 0.02 | 6.81 | 182.69 | 89.97 | 3,356.97 |
| | 03/12/14 13:33:00 | 22950 | 13.72 | -0.23 | 0.05 | 5.77 | 146.98 | 89.52 | 3,037.46 |
| | 03/12/14 13:33:30 | 22980 | 13.41 | -0.20 | 0.03 | 6.00 | 157.78 | 89.07 | 3,101.39 |
| | 03/12/14 13:34:00 | 23010 | 13.11 | -0.20 | 0.03 | 6.24 | 157.78 | 89.07 | 3,086.61 |
| | 03/12/14 13:34:30 | 23040 | 12.82 | -0.17 | 0.02 | 6.49 | 154.18 | 89.07 | 3,073.21 |
| | 03/12/14 13:35:00 | 23070 | 13.19 | -0.14 | 0.02 | 6.27 | 154.73 | 89.07 | 3,066.08 |
| | 03/12/14 13:35:30 | 23100 | 13.67 | -0.05 | 0.03 | 5.91 | 154.18 | 89.07 | 3,066.81 |
| | 03/12/14 13:36:00 | 23130 | 13.23 | -0.02 | 0.02 | 6.12 | 152.52 | 88.62 | 3,064.71 |
| | 03/12/14 13:36:30 | 23160 | 13.00 | -0.13 | 0.02 | 6.41 | 156.95 | 88.62 | 3,092.56 |
| | 03/12/14 13:37:00 | 23190 | 13.28 | -0.12 | 0.02 | 6.24 | 157.78 | 88.17 | 3,105.08 |
| | 03/12/14 13:37:30 | 23220 | 13.56 | -0.06 | 0.02 | 5.94 | 217.29 | 87.72 | 3,707.73 |
| | 03/12/14 13:38:00 | 23250 | 13.06 | -0.12 | 0.03 | 6.38 | 281.78 | 88.62 | 4,256.34 |
| | 03/12/14 13:38:30 | 23280 | 13.52 | -0.14 | 0.03 | 6.12 | 318.60 | 89.07 | 4,429.86 |
| | 03/12/14 13:39:00 | 23310 | 13.50 | -0.15 | 0.02 | 6.01 | 311.40 | 89.07 | 4,401.63 |
| A2 | 03/12/14 13:39:30 | 23340 | 12.82 | -0.20 | 0.02 | 6.43 | 314.17 | 89.52 | 4,446.70 |
| | 03/12/14 13:40:00 | 23370 | 12.73 | -0.25 | 0.02 | 6.58 | 319.70 | 89.52 | 4,456.40 |
| | 03/12/14 13:40:30 | 23400 | 12.79 | -0.27 | 0.02 | 6.61 | 320.53 | 89.52 | 4,440.90 |
| | 03/12/14 13:41:00 | 23430 | 12.62 | -0.26 | 0.01 | 6.64 | 314.72 | 90.42 | 4,409.38 |
| | 03/12/14 13:41:30 | 23460 | 13.52 | -0.25 | 0.02 | 5.89 | 311.40 | 90.87 | 4,410.59 |
| | 03/12/14 13:42:00 | 23490 | 13.19 | -0.25 | 0.03 | 6.19 | 309.74 | 91.32 | 4,410.06 |
| | 03/12/14 13:42:30 | 23520 | 13.95 | -0.25 | 0.03 | 5.64 | 315.83 | 91.77 | 4,429.14 |
| | 03/12/14 13:43:00 | 23550 | 13.73 | -0.22 | 0.03 | 5.59 | 309.74 | 91.77 | 4,411.94 |
| | 03/12/14 13:43:30 | 23580 | 13.81 | -0.21 | 0.03 | 5.78 | 306.69 | 92.21 | 4,383.04 |
| | 03/12/14 13:44:00 | 23610 | 13.86 | -0.04 | 0.03 | 5.44 | 307.80 | 92.21 | 4,382.48 |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 307,067 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 58 | $^{o}$F |
| Specific Humidity | 0.002809 | lb $H_2O$ / lb air |

70-100-70 Load, Run - 4.0X30PF R7

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/12/14 13:44:30 | 23640 | 12.30 | -0.05 | 0.03 | 6.39 | 309.74 | 92.66 | 4,388.41 |
| | 03/12/14 13:45:00 | 23670 | 12.12 | -0.24 | 0.03 | 6.56 | 316.38 | 93.11 | 4,409.76 |
| | 03/12/14 13:45:30 | 23700 | 12.12 | -0.24 | 0.03 | 6.58 | 317.49 | 93.56 | 4,426.40 |
| | 03/12/14 13:46:00 | 23730 | 12.24 | -0.26 | 0.02 | 6.53 | 310.29 | 93.11 | 4,415.08 |
| | 03/12/14 13:46:30 | 23760 | 11.86 | -0.22 | 0.02 | 6.74 | 309.18 | 93.11 | 4,388.39 |
| | 03/12/14 13:47:00 | 23790 | 12.30 | -0.26 | 0.01 | 6.51 | 306.69 | 93.56 | 4,373.54 |
| | 03/12/14 13:47:30 | 23820 | 12.11 | -0.23 | 0.00 | 6.57 | 156.39 | 93.11 | 3,107.83 |
| | 03/12/14 13:48:00 | 23850 | 12.77 | -0.17 | 0.01 | 6.13 | 156.39 | 93.11 | 3,073.68 |
| | 03/12/14 13:48:30 | 23880 | 12.20 | -0.14 | 0.00 | 6.53 | 157.78 | 91.77 | 3,083.36 |
| | 03/12/14 13:49:00 | 23910 | 12.25 | -0.15 | 0.01 | 6.45 | 155.84 | 90.87 | 3,079.60 |
| | 03/12/14 13:49:30 | 23940 | 12.40 | -0.16 | 0.01 | 6.43 | 154.73 | 90.87 | 3,064.41 |
| | 03/12/14 13:50:00 | 23970 | 12.64 | -0.05 | 0.00 | 6.19 | 156.95 | 90.42 | 3,069.25 |
| | 03/12/14 13:50:30 | 24000 | 12.49 | -0.06 | 0.00 | 6.37 | 158.33 | 89.97 | 3,083.95 |
| | 03/12/14 13:51:00 | 24030 | 12.48 | 0.02 | 0.01 | 6.38 | 155.84 | 89.97 | 3,070.80 |
| | 03/12/14 13:51:30 | 24060 | 13.00 | 0.13 | 0.01 | 5.94 | 157.22 | 89.97 | 3,077.94 |
| | 03/12/14 13:52:00 | 24090 | 12.72 | 0.14 | 0.01 | 6.21 | 263.24 | 90.42 | 4,114.88 |
| | 03/12/14 13:52:30 | 24120 | 13.17 | 0.33 | 0.00 | 5.83 | 316.93 | 91.77 | 4,421.29 |
| | 03/12/14 13:53:00 | 24150 | 12.19 | 0.21 | 0.00 | 6.52 | 313.61 | 92.21 | 4,399.97 |
| | 03/12/14 13:53:30 | 24180 | 12.11 | -0.15 | 0.00 | 6.61 | 308.91 | 92.66 | 4,388.83 |
| | 03/12/14 13:54:00 | 24210 | 12.07 | -0.21 | 0.00 | 6.61 | 318.04 | 92.21 | 4,422.03 |
| | 03/12/14 13:54:30 | 24240 | 11.79 | -0.21 | 0.00 | 6.81 | 310.29 | 92.21 | 4,397.52 |
| | 03/12/14 13:55:00 | 24270 | 11.67 | -0.26 | 0.00 | 6.93 | 310.29 | 92.21 | 4,399.15 |
| | 03/12/14 13:55:30 | 24300 | 12.08 | -0.26 | 0.01 | 6.65 | 306.69 | 92.21 | 4,367.23 |
| | 03/12/14 13:56:00 | 24330 | 11.93 | -0.26 | 0.01 | 6.72 | 307.80 | 92.21 | 4,366.04 |
| | 03/12/14 13:56:30 | 24360 | 11.88 | -0.26 | 0.00 | 6.74 | 305.03 | 92.66 | 4,350.21 |
| | 03/12/14 13:57:00 | 24390 | 12.31 | -0.25 | 0.01 | 6.47 | 306.14 | 93.11 | 4,371.99 |
| | 03/12/14 13:57:30 | 24420 | 12.17 | -0.23 | 0.00 | 6.51 | 312.51 | 93.56 | 4,392.89 |
| | 03/12/14 13:58:00 | 24450 | 12.01 | -0.26 | 0.01 | 6.63 | 300.60 | 94.01 | 4,273.33 |
| | 03/12/14 13:58:30 | 24480 | 12.16 | -0.25 | 0.01 | 6.56 | 291.47 | 94.46 | 4,260.98 |
| | 03/12/14 13:59:00 | 24510 | 12.32 | -0.24 | 0.00 | 6.42 | 301.16 | 94.46 | 4,318.68 |
| A3 | 03/12/14 13:59:30 | 24540 | 12.14 | -0.23 | -0.01 | 6.56 | 297.28 | 94.46 | 4,292.64 |
| | 03/12/14 14:00:00 | 24570 | 11.96 | -0.22 | -0.01 | 6.67 | 300.60 | 94.01 | 4,336.00 |
| | 03/12/14 14:00:30 | 24600 | 11.91 | -0.24 | 0.00 | 6.71 | 304.48 | 94.46 | 4,339.84 |
| | 03/12/14 14:01:00 | 24630 | 12.00 | -0.25 | 0.01 | 6.68 | 284.55 | 94.46 | 4,225.65 |
| | 03/12/14 14:01:30 | 24660 | 11.99 | -0.24 | 0.01 | 6.69 | 280.12 | 94.46 | 4,193.73 |
| | 03/12/14 14:02:00 | 24690 | 11.93 | -0.21 | -0.01 | 6.74 | 174.66 | 94.01 | 3,350.10 |
| | 03/12/14 14:02:30 | 24720 | 12.06 | -0.15 | 0.00 | 6.76 | 149.75 | 93.56 | 3,027.00 |
| | 03/12/14 14:03:00 | 24750 | 13.13 | 0.53 | 0.00 | 5.87 | 155.84 | 93.11 | 3,092.65 |
| | 03/12/14 14:03:30 | 24780 | 12.66 | 0.72 | 0.00 | 6.23 | 155.84 | 93.11 | 3,080.97 |
| | 03/12/14 14:04:00 | 24810 | 12.82 | 0.74 | 0.01 | 6.14 | 154.73 | 93.11 | 3,064.95 |
| | 03/12/14 14:04:30 | 24840 | 13.05 | 0.84 | 0.00 | 5.99 | 154.73 | 93.11 | 3,052.84 |
| | 03/12/14 14:05:00 | 24870 | 13.05 | 1.16 | 0.01 | 5.96 | 152.52 | 92.21 | 3,054.64 |
| | 03/12/14 14:05:30 | 24900 | 13.10 | 0.88 | 0.01 | 5.94 | 154.18 | 91.77 | 3,049.94 |
| | 03/12/14 14:06:00 | 24930 | 13.22 | 0.87 | 0.01 | 5.87 | 154.18 | 91.77 | 3,057.94 |
| | 03/12/14 14:06:30 | 24960 | 13.18 | 1.29 | 0.01 | 5.87 | 156.39 | 91.77 | 3,072.34 |
| | 03/12/14 14:07:00 | 24990 | 12.98 | 0.97 | -0.01 | 6.01 | 155.84 | 91.32 | 3,087.40 |
| | 03/12/14 14:07:30 | 25020 | 13.03 | 0.85 | -0.01 | 5.96 | 154.73 | 91.32 | 3,083.03 |
| | 03/12/14 14:08:00 | 25050 | 13.05 | 0.98 | -0.01 | 5.95 | 249.40 | 91.77 | 3,964.20 |
| | 03/12/14 14:08:30 | 25080 | 12.64 | 0.70 | -0.01 | 6.20 | 269.33 | 91.77 | 4,104.64 |
| | 03/12/14 14:09:00 | 25110 | 11.98 | 0.24 | 0.00 | 6.67 | 270.43 | 91.32 | 4,109.96 |
| | 03/12/14 14:09:30 | 25140 | 11.94 | 0.11 | 0.01 | 6.74 | 273.20 | 91.32 | 4,128.62 |

**John Zink Co, LLC**
**March 12, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 307,067 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.26 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 58 | $^{o}$F |
| Specific Humidity | 0.002809 | lb $H_2O$ / lb air |

70-100-70 Load, Run - 4.0X30PF R7

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/12/14 14:10:00 | 25170 | 12.02 | 0.06 | -0.02 | 6.69 | 267.66 | 91.32 | 4,098.62 |
| 03/12/14 14:10:30 | 25200 | 12.03 | 0.06 | -0.02 | 6.66 | 270.43 | 91.32 | 4,087.29 |
| 03/12/14 14:11:00 | 25230 | 12.64 | 0.16 | 0.00 | 6.33 | 267.11 | 91.77 | 4,077.26 |
| 03/12/14 14:11:30 | 25260 | 12.93 | 0.34 | 0.00 | 6.03 | 270.43 | 92.21 | 4,097.22 |
| 03/12/14 14:12:00 | 25290 | 12.88 | 0.49 | 0.00 | 6.05 | 268.77 | 92.21 | 4,108.05 |
| 03/12/14 14:12:30 | 25320 | 13.18 | 0.47 | 0.00 | 5.83 | 272.09 | 92.21 | 4,134.34 |
| 03/12/14 14:13:00 | 25350 | 12.78 | 0.54 | 0.00 | 6.08 | 269.88 | 92.66 | 4,087.50 |
| 03/12/14 14:13:30 | 25380 | 12.74 | 0.46 | 0.00 | 6.16 | 270.43 | 92.66 | 4,099.23 |
| 03/12/14 14:14:00 | 25410 | 13.21 | 0.55 | 0.00 | 5.86 | 270.43 | 92.66 | 4,098.39 |
| 03/12/14 14:14:30 | 25440 | 12.34 | 0.61 | -0.01 | 6.28 | 270.99 | 92.66 | 4,085.69 |
| 03/12/14 14:15:00 | 25470 | 12.04 | 0.15 | -0.01 | 6.68 | 269.33 | 92.21 | 4,117.17 |
| 03/12/14 14:15:30 | 25500 | 12.25 | 0.11 | -0.01 | 6.51 | 273.20 | 92.21 | 4,102.68 |
| 03/12/14 14:16:00 | 25530 | 11.98 | 0.20 | -0.01 | 6.67 | 268.77 | 92.21 | 4,101.73 |
| 03/12/14 14:16:30 | 25560 | 12.04 | 0.11 | -0.01 | 6.63 | 161.65 | 91.77 | 3,110.23 |
| 03/12/14 14:17:00 | 25590 | 12.18 | 0.08 | 0.00 | 6.59 | 155.84 | 91.32 | 3,082.29 |
| 03/12/14 14:17:30 | 25620 | 12.53 | 0.31 | 0.00 | 6.30 | 157.22 | 91.32 | 3,080.99 |
| 03/12/14 14:18:00 | 25650 | 12.54 | 0.37 | -0.01 | 6.32 | 158.33 | 91.32 | 3,110.89 |
| 03/12/14 14:18:30 | 25680 | 13.10 | 0.58 | -0.01 | 5.88 | 154.73 | 91.77 | 3,067.13 |
| 03/12/14 14:19:00 | 25710 | 12.84 | 0.93 | -0.01 | 6.08 | 155.28 | 90.87 | 3,072.05 |
| **RAW AVERAGE** | | **12.97** | **0.10** | **0.01** | **6.13** | **244.95** | **90.93** | **3,851.94** |

| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | (%) | (ppmvd) | (ppmvw) | (%) | (in. $H_2O$) | ($^{o}$F) | (SCFH) |
| **Bias** | **Initial Zero** | 0.09 | 0.08 | -0.07 | 0.06 | | | |
| | **Final Zero** | 0.09 | 0.06 | -0.03 | 0.05 | | | |
| | **Avg. Zero** | 0.09 | 0.07 | -0.05 | 0.06 | | | |
| | **Initial UpScale** | 11.99 | 8.94 | 3.03 | 9.44 | | | |
| | **Final UpScale** | 11.97 | 8.94 | 3.00 | 9.37 | | | |
| | **Avg. UpScale** | 11.98 | 8.94 | 3.02 | 9.41 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| EMISSIONS DATA | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.99 | 0.03 | 0.06 | 6.12 |
| **Corrected Raw Average (ppm/% wet basis)** | 12.16 | 0.02 | 0.06 | 5.73 |
| **Emission Rate (lb/hr)** | N/A | 0.00 | 0.00 | N/A |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.0 | % |
| Stack Exhaust Flow (M2) | 280,468 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.20 | in. Hg |
| Relative Humidity | 21 | % |
| Ambient Temperature | 72 | $^{o}$F |
| Specific Humidity | 0.003443 | lb $H_2O$ / lb air |

70-100-70 Load, Run - 4.0X30PF R8

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/12/14 16:30:00 | 33570 | 13.52 | 0.80 | -0.01 | 5.52 | 153.62 | 87.27 | 3,082.68 |
| | 03/12/14 16:30:30 | 33600 | 13.39 | 1.05 | 0.00 | 5.62 | 150.30 | 87.72 | 3,071.22 |
| | 03/12/14 16:31:00 | 33630 | 13.59 | 0.64 | 0.00 | 5.47 | 150.86 | 88.17 | 3,069.17 |
| | 03/12/14 16:31:30 | 33660 | 13.79 | 1.16 | -0.01 | 5.29 | 150.86 | 88.62 | 3,068.57 |
| | 03/12/14 16:32:00 | 33690 | 13.43 | 1.01 | -0.02 | 5.55 | 150.86 | 89.07 | 3,069.00 |
| | 03/12/14 16:32:30 | 33720 | 13.16 | 0.45 | -0.01 | 5.77 | 154.18 | 89.52 | 3,081.36 |
| | 03/12/14 16:33:00 | 33750 | 13.08 | 0.48 | -0.01 | 5.87 | 154.18 | 89.97 | 3,087.87 |
| | 03/12/14 16:33:30 | 33780 | 13.40 | 0.61 | -0.01 | 5.61 | 267.66 | 90.42 | 4,090.77 |
| | 03/12/14 16:34:00 | 33810 | 12.56 | 0.52 | -0.01 | 6.16 | 309.74 | 91.77 | 4,364.97 |
| | 03/12/14 16:34:30 | 33840 | 12.56 | -0.04 | -0.01 | 6.22 | 311.95 | 92.66 | 4,371.67 |
| | 03/12/14 16:35:00 | 33870 | 11.87 | -0.13 | 0.00 | 6.71 | 310.29 | 92.21 | 4,401.23 |
| | 03/12/14 16:35:30 | 33900 | 12.03 | -0.21 | 0.00 | 6.61 | 313.06 | 92.66 | 4,395.10 |
| | 03/12/14 16:36:00 | 33930 | 12.41 | -0.21 | -0.01 | 6.33 | 309.74 | 93.56 | 4,385.68 |
| | 03/12/14 16:36:30 | 33960 | 12.28 | -0.20 | -0.02 | 6.42 | 301.71 | 94.46 | 4,314.02 |
| | 03/12/14 16:37:00 | 33990 | 12.82 | -0.21 | -0.03 | 6.01 | 304.48 | 94.91 | 4,332.19 |
| | 03/12/14 16:37:30 | 34020 | 12.70 | -0.19 | -0.01 | 6.14 | 301.16 | 95.47 | 4,338.07 |
| | 03/12/14 16:38:00 | 34050 | 12.91 | -0.18 | -0.01 | 5.94 | 307.25 | 95.47 | 4,365.88 |
| | 03/12/14 16:38:30 | 34080 | 12.10 | -0.21 | -0.01 | 6.50 | 307.25 | 95.47 | 4,371.14 |
| | 03/12/14 16:39:00 | 34110 | 12.65 | -0.23 | -0.01 | 6.17 | 307.80 | 95.47 | 4,344.08 |
| | 03/12/14 16:39:30 | 34140 | 12.87 | -0.20 | -0.01 | 5.98 | 301.71 | 95.81 | 4,316.94 |
| | 03/12/14 16:40:00 | 34170 | 12.46 | -0.21 | -0.01 | 6.31 | 305.03 | 96.71 | 4,319.82 |
| | 03/12/14 16:40:30 | 34200 | 12.60 | -0.19 | -0.01 | 6.18 | 307.25 | 96.26 | 4,331.10 |
| | 03/12/14 16:41:00 | 34230 | 12.62 | -0.21 | -0.01 | 6.17 | 309.18 | 97.16 | 4,354.53 |
| | 03/12/14 16:41:30 | 34260 | 12.97 | -0.19 | 0.00 | 5.91 | 309.74 | 97.16 | 4,353.42 |
| | 03/12/14 16:42:00 | 34290 | 13.02 | -0.20 | 0.00 | 5.86 | 303.93 | 96.71 | 4,343.62 |
| | 03/12/14 16:42:30 | 34320 | 12.72 | -0.20 | 0.00 | 6.09 | 300.60 | 96.71 | 4,317.25 |
| | 03/12/14 16:43:00 | 34350 | 13.12 | -0.21 | 0.00 | 5.84 | 228.08 | 97.16 | 3,469.09 |
| | 03/12/14 16:43:30 | 34380 | 13.61 | -0.14 | 0.00 | 5.42 | 155.28 | 96.71 | 3,093.18 |
| | 03/12/14 16:44:00 | 34410 | 13.74 | 0.05 | -0.01 | 5.29 | 154.73 | 96.71 | 3,081.71 |
| | 03/12/14 16:44:30 | 34440 | 12.94 | 0.05 | 0.00 | 5.93 | 153.07 | 96.26 | 3,067.06 |
| | 03/12/14 16:45:00 | 34470 | 12.94 | -0.01 | -0.01 | 5.92 | 152.52 | 95.81 | 3,063.32 |
| | 03/12/14 16:45:30 | 34500 | 13.37 | 0.13 | 0.00 | 5.61 | 151.41 | 95.81 | 3,063.43 |
| | 03/12/14 16:46:00 | 34530 | 13.57 | 0.36 | -0.01 | 5.47 | 155.84 | 95.47 | 3,086.96 |
| | 03/12/14 16:46:30 | 34560 | 12.96 | 0.29 | -0.02 | 5.94 | 154.73 | 95.47 | 3,083.91 |
| | 03/12/14 16:47:00 | 34590 | 13.21 | 0.22 | 0.00 | 5.71 | 153.62 | 95.47 | 3,079.60 |
| | 03/12/14 16:47:30 | 34620 | 13.00 | 0.12 | 0.00 | 5.92 | 156.95 | 95.47 | 3,083.18 |
| | 03/12/14 16:48:00 | 34650 | 13.27 | 0.18 | -0.01 | 5.70 | 155.28 | 95.47 | 3,094.54 |
| | 03/12/14 16:48:30 | 34680 | 13.45 | 0.20 | -0.02 | 5.55 | 154.73 | 94.91 | 3,079.35 |
| | 03/12/14 16:49:00 | 34710 | 13.44 | 0.15 | -0.01 | 5.58 | 284.55 | 95.47 | 4,179.05 |
| | 03/12/14 16:49:30 | 34740 | 13.35 | 0.19 | -0.01 | 5.65 | 309.18 | 96.26 | 4,342.46 |
| | 03/12/14 16:50:00 | 34770 | 13.44 | 0.07 | 0.00 | 5.53 | 315.27 | 96.71 | 4,392.31 |
| A2 | 03/12/14 16:50:30 | 34800 | 12.57 | -0.11 | 0.00 | 6.22 | 323.85 | 96.71 | 4,432.74 |
| | 03/12/14 16:51:00 | 34830 | 12.90 | -0.19 | 0.00 | 6.00 | 302.82 | 96.71 | 4,339.17 |
| | 03/12/14 16:51:30 | 34860 | 13.19 | -0.18 | -0.01 | 5.78 | 305.03 | 97.16 | 4,348.83 |
| | 03/12/14 16:52:00 | 34890 | 13.03 | -0.18 | -0.01 | 5.90 | 308.35 | 97.16 | 4,348.15 |
| | 03/12/14 16:52:30 | 34920 | 13.09 | -0.18 | -0.01 | 5.86 | 313.06 | 97.61 | 4,366.48 |
| | 03/12/14 16:53:00 | 34950 | 12.87 | -0.18 | -0.02 | 5.99 | 314.72 | 97.61 | 4,380.10 |
| | 03/12/14 16:53:30 | 34980 | 12.52 | -0.21 | -0.02 | 6.26 | 315.27 | 97.61 | 4,395.84 |
| | 03/12/14 16:54:00 | 35010 | 12.48 | -0.21 | -0.01 | 6.28 | 308.91 | 97.16 | 4,356.97 |
| | 03/12/14 16:54:30 | 35040 | 12.63 | -0.22 | 0.00 | 6.20 | 306.14 | 97.61 | 4,341.52 |
| | 03/12/14 16:55:00 | 35070 | 12.70 | -0.20 | 0.00 | 6.12 | 305.59 | 97.61 | 4,332.30 |
| | 03/12/14 16:55:30 | 35100 | 13.07 | -0.22 | -0.01 | 5.90 | 303.93 | 98.06 | 4,328.45 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.0 | % |
| Stack Exhaust Flow (M2) | 280,468 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.20 | in. Hg |
| Relative Humidity | 21 | % |
| Ambient Temperature | 72 | $^{o}$F |
| Specific Humidity | 0.003443 | lb $H_2O$ / lb air |

70-100-70 Load, Run - 4.0X30PF R8

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/12/14 16:56:00 | 35130 | 13.41 | -0.16 | 0.00 | 5.61 | 307.25 | 98.06 | 4,357.45 |
| | 03/12/14 16:56:30 | 35160 | 13.12 | -0.18 | 0.00 | 5.88 | 309.74 | 98.51 | 4,378.03 |
| | 03/12/14 16:57:00 | 35190 | 13.27 | -0.15 | -0.01 | 5.72 | 308.91 | 98.96 | 4,371.69 |
| | 03/12/14 16:57:30 | 35220 | 13.19 | -0.18 | -0.01 | 5.78 | 156.39 | 98.96 | 3,044.53 |
| | 03/12/14 16:58:00 | 35250 | 13.16 | -0.15 | -0.01 | 5.85 | 151.96 | 98.06 | 3,068.18 |
| | 03/12/14 16:58:30 | 35280 | 13.72 | 0.08 | -0.01 | 5.31 | 153.62 | 98.06 | 3,068.68 |
| | 03/12/14 16:59:00 | 35310 | 13.45 | 0.22 | -0.01 | 5.63 | 155.28 | 97.61 | 3,084.48 |
| | 03/12/14 16:59:30 | 35340 | 13.65 | 0.40 | -0.01 | 5.40 | 154.73 | 96.71 | 3,082.30 |
| | 03/12/14 17:00:00 | 35370 | 12.88 | 0.21 | 0.00 | 6.00 | 155.28 | 96.71 | 3,076.77 |
| | 03/12/14 17:00:30 | 35400 | 13.00 | 0.30 | -0.01 | 5.89 | 153.62 | 96.26 | 3,070.57 |
| | 03/12/14 17:01:00 | 35430 | 12.58 | 0.18 | -0.02 | 6.22 | 153.62 | 96.26 | 3,073.88 |
| | 03/12/14 17:01:30 | 35460 | 12.68 | 0.16 | -0.02 | 6.14 | 153.07 | 96.26 | 3,058.58 |
| | 03/12/14 17:02:00 | 35490 | 12.74 | 0.16 | 0.00 | 6.11 | 154.18 | 96.26 | 3,092.52 |
| | 03/12/14 17:02:30 | 35520 | 12.80 | 0.36 | -0.01 | 6.06 | 155.28 | 95.81 | 3,101.62 |
| | 03/12/14 17:03:00 | 35550 | 12.80 | 0.25 | -0.01 | 6.06 | 153.62 | 95.81 | 3,074.06 |
| | 03/12/14 17:03:30 | 35580 | 12.90 | 0.29 | -0.01 | 5.98 | 280.12 | 96.71 | 4,083.32 |
| | 03/12/14 17:04:00 | 35610 | 12.79 | 0.44 | -0.01 | 6.05 | 321.64 | 98.06 | 4,423.17 |
| | 03/12/14 17:04:30 | 35640 | 12.13 | 0.10 | -0.01 | 6.53 | 315.27 | 98.06 | 4,391.94 |
| | 03/12/14 17:05:00 | 35670 | 12.11 | -0.09 | -0.01 | 6.54 | 316.93 | 98.51 | 4,419.03 |
| | 03/12/14 17:05:30 | 35700 | 12.27 | -0.13 | 0.00 | 6.42 | 315.27 | 98.96 | 4,368.36 |
| | 03/12/14 17:06:00 | 35730 | 12.17 | -0.15 | -0.01 | 6.50 | 312.51 | 98.96 | 4,357.82 |
| | 03/12/14 17:06:30 | 35760 | 12.21 | -0.18 | -0.02 | 6.47 | 311.40 | 99.40 | 4,370.12 |
| | 03/12/14 17:07:00 | 35790 | 12.10 | -0.20 | -0.01 | 6.54 | 310.29 | 99.85 | 4,363.58 |
| | 03/12/14 17:07:30 | 35820 | 12.07 | -0.20 | -0.01 | 6.57 | 313.61 | 99.85 | 4,380.54 |
| | 03/12/14 17:08:00 | 35850 | 11.89 | -0.20 | -0.01 | 6.68 | 316.38 | 99.85 | 4,410.87 |
| | 03/12/14 17:08:30 | 35880 | 11.58 | -0.22 | -0.01 | 6.90 | 316.93 | 99.85 | 4,395.77 |
| | 03/12/14 17:09:00 | 35910 | 11.68 | -0.23 | -0.01 | 6.80 | 318.60 | 100.30 | 4,384.03 |
| | 03/12/14 17:09:30 | 35940 | 11.77 | -0.23 | 0.00 | 6.77 | 309.74 | 100.30 | 4,353.79 |
| | 03/12/14 17:10:00 | 35970 | 11.87 | -0.24 | -0.01 | 6.69 | 311.40 | 100.75 | 4,364.37 |
| A3 | 03/12/14 17:10:30 | 36000 | 11.86 | -0.23 | 0.00 | 6.69 | 315.27 | 101.20 | 4,361.13 |
| | 03/12/14 17:11:00 | 36030 | 11.94 | -0.24 | -0.01 | 6.65 | 309.18 | 101.65 | 4,344.88 |
| | 03/12/14 17:11:30 | 36060 | 12.16 | -0.21 | -0.01 | 6.51 | 192.10 | 101.20 | 3,309.18 |
| | 03/12/14 17:12:00 | 36090 | 12.83 | -0.11 | 0.00 | 6.02 | 150.86 | 100.30 | 3,070.18 |
| | 03/12/14 17:12:30 | 36120 | 12.93 | 0.18 | -0.01 | 5.91 | 149.75 | 99.40 | 3,058.82 |
| | 03/12/14 17:13:00 | 36150 | 12.27 | 0.07 | 0.00 | 6.45 | 150.30 | 98.51 | 3,048.70 |
| | 03/12/14 17:13:30 | 36180 | 12.03 | 0.02 | -0.01 | 6.57 | 153.07 | 98.06 | 3,080.16 |
| | 03/12/14 17:14:00 | 36210 | 12.04 | 0.20 | -0.02 | 6.51 | 155.28 | 98.06 | 3,093.15 |
| | 03/12/14 17:14:30 | 36240 | 11.97 | 0.35 | -0.02 | 6.59 | 154.73 | 97.61 | 3,086.66 |
| | 03/12/14 17:15:00 | 36270 | 11.99 | 0.42 | -0.01 | 6.57 | 153.07 | 97.61 | 3,072.22 |
| | 03/12/14 17:15:30 | 36300 | 12.20 | 0.64 | -0.01 | 6.43 | 153.07 | 98.06 | 3,063.57 |
| | 03/12/14 17:16:00 | 36330 | 12.44 | 0.87 | 0.00 | 6.26 | 153.07 | 97.61 | 3,061.81 |
| | 03/12/14 17:16:30 | 36360 | 12.57 | 1.17 | -0.01 | 6.18 | 154.18 | 97.16 | 3,077.63 |
| | 03/12/14 17:17:00 | 36390 | 12.51 | 1.20 | -0.01 | 6.23 | 154.18 | 96.71 | 3,090.27 |
| | 03/12/14 17:17:30 | 36420 | 12.93 | 1.58 | 0.00 | 5.92 | 154.73 | 96.71 | 3,090.26 |
| | 03/12/14 17:18:00 | 36450 | 12.88 | 1.92 | -0.02 | 5.94 | 151.96 | 96.71 | 3,072.12 |
| | 03/12/14 17:18:30 | 36480 | 13.06 | 2.13 | -0.02 | 5.84 | 150.86 | 96.26 | 3,059.42 |
| | 03/12/14 17:19:00 | 36510 | 13.01 | 2.23 | -0.02 | 5.89 | 151.96 | 95.81 | 3,065.76 |
| | 03/12/14 17:19:30 | 36540 | 12.97 | 1.95 | -0.01 | 5.91 | 152.52 | 95.47 | 3,093.19 |
| | 03/12/14 17:20:00 | 36570 | 12.75 | 1.38 | -0.01 | 6.09 | 180.75 | 95.47 | 3,827.92 |
| | 03/12/14 17:20:30 | 36600 | 12.40 | 1.57 | -0.01 | 6.27 | 308.91 | 95.81 | 4,254.97 |
| | 03/12/14 17:21:00 | 36630 | 11.29 | 0.50 | -0.01 | 7.10 | 313.06 | 96.26 | 4,355.17 |
| | 03/12/14 17:21:30 | 36660 | 11.64 | -0.02 | -0.01 | 6.86 | 311.95 | 96.26 | 4,339.14 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.0 | % |
| Stack Exhaust Flow (M2) | 280,468 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.20 | in. Hg |
| Relative Humidity | 21 | % |
| Ambient Temperature | 72 | $^{o}$F |
| Specific Humidity | 0.003443 | lb $H_2O$ / lb air |

70-100-70 Load, Run - 4.0X30PF R8

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/12/14 17:22:00 | 36690 | 11.87 | -0.01 | -0.02 | 6.70 | 315.83 | 96.26 | 4,377.83 |
| 03/12/14 17:22:30 | 36720 | 11.80 | 0.02 | -0.02 | 6.73 | 313.61 | 96.26 | 4,363.04 |
| 03/12/14 17:23:00 | 36750 | 11.59 | -0.08 | -0.01 | 6.87 | 313.06 | 96.26 | 4,363.18 |
| 03/12/14 17:23:30 | 36780 | 11.82 | -0.10 | -0.02 | 6.75 | 306.69 | 96.26 | 4,319.37 |
| 03/12/14 17:24:00 | 36810 | 12.14 | 0.10 | -0.02 | 6.52 | 300.05 | 96.26 | 4,306.69 |
| 03/12/14 17:24:30 | 36840 | 12.29 | 0.11 | -0.02 | 6.41 | 300.60 | 96.71 | 4,294.03 |
| 03/12/14 17:25:00 | 36870 | 12.56 | 0.08 | -0.01 | 6.23 | 306.14 | 97.16 | 4,331.49 |
| 03/12/14 17:25:30 | 36900 | 11.97 | 0.15 | 0.00 | 6.58 | 301.16 | 97.16 | 4,305.53 |
| 03/12/14 17:26:00 | 36930 | 11.90 | 0.03 | 0.00 | 6.71 | 298.94 | 97.16 | 4,295.11 |
| 03/12/14 17:26:30 | 36960 | 11.59 | -0.02 | -0.01 | 6.86 | 298.39 | 97.61 | 4,276.06 |
| 03/12/14 17:27:00 | 36990 | 13.27 | 2.91 | 0.00 | 5.71 | 154.18 | 97.61 | 3,123.29 |
| 03/12/14 17:27:30 | 37020 | 13.45 | 3.95 | -0.01 | 5.57 | 150.30 | 97.61 | 3,071.25 |
| 03/12/14 17:28:00 | 37050 | 13.31 | 3.80 | -0.01 | 5.68 | 154.18 | 97.61 | 3,104.80 |
| 03/12/14 17:28:30 | 37080 | 13.25 | 3.39 | -0.01 | 5.75 | 155.84 | 97.16 | 3,111.98 |
| 03/12/14 17:29:00 | 37110 | 12.99 | 3.54 | -0.02 | 5.92 | 152.52 | 96.71 | 3,083.74 |
| 03/12/14 17:29:30 | 37140 | 12.80 | 2.55 | -0.01 | 6.06 | 151.96 | 96.26 | 3,070.49 |
| **RAW AVERAGE** | | **12.69** | **0.34** | **-0.01** | **6.11** | **237.56** | **96.48** | **3,769.29** |

| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | **(%)** | **(ppmvd)** | **(ppmvw)** | **(%)** | **(in. $H_2O$)** | **($^{o}$F)** | **(SCFH)** |
| **Bias** | **Initial Zero** | 0.09 | 0.06 | -0.03 | 0.05 | | | |
| | **Final Zero** | 0.06 | 0.06 | -0.03 | 0.05 | | | |
| | **Avg. Zero** | 0.08 | 0.06 | -0.03 | 0.05 | | | |
| | **Initial UpScale** | 11.97 | 8.94 | 3.00 | 9.37 | | | |
| | **Final UpScale** | 11.98 | 8.87 | 2.95 | 9.45 | | | |
| | **Avg. UpScale** | 11.98 | 8.91 | 2.98 | 9.41 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| EMISSIONS DATA | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.73 | 0.29 | 0.02 | 6.10 |
| **Corrected Raw Average (ppm/% wet basis)** | 11.96 | 0.27 | 0.02 | 5.73 |
| **Emission Rate (lb/hr)** | N/A | 0.01 | 0.00 | N/A |

**John Zink Co, LLC**
**March 13, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 284,135 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.19 | in. Hg |
| Relative Humidity | 34 | % |
| Ambient Temperature | 57 | $^{o}$F |
| Specific Humidity | 0.003300 | lb $H_2O$ / lb air |

70-100-70 Load, Run - 4.0X30PF R9

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/13/14 8:40:04 | 5550 | 13.01 | -0.08 | 0.13 | 5.96 | 153.62 | 81.88 | 3,099.43 |
| | 03/13/14 8:40:34 | 5580 | 13.18 | -0.06 | 0.13 | 5.82 | 149.75 | 81.88 | 3,076.37 |
| | 03/13/14 8:41:04 | 5610 | 13.24 | -0.03 | 0.13 | 5.75 | 149.75 | 81.88 | 3,054.48 |
| | 03/13/14 8:41:34 | 5640 | 13.45 | 0.09 | 0.13 | 5.61 | 149.19 | 81.88 | 3,079.69 |
| | 03/13/14 8:42:04 | 5670 | 13.34 | 0.08 | 0.15 | 5.72 | 153.62 | 81.88 | 3,103.94 |
| | 03/13/14 8:42:34 | 5700 | 13.18 | -0.04 | 0.14 | 5.80 | 152.52 | 81.88 | 3,094.63 |
| | 03/13/14 8:43:04 | 5730 | 13.20 | -0.05 | 0.11 | 5.82 | 150.30 | 81.43 | 3,090.76 |
| | 03/13/14 8:43:34 | 5760 | 13.12 | -0.01 | 0.11 | 5.82 | 251.89 | 81.88 | 4,009.39 |
| | 03/13/14 8:44:04 | 5790 | 12.40 | -0.05 | 0.13 | 6.34 | 273.75 | 81.88 | 4,221.70 |
| | 03/13/14 8:44:34 | 5820 | 12.14 | -0.07 | 0.12 | 6.51 | 298.94 | 82.33 | 4,383.13 |
| | 03/13/14 8:45:04 | 5850 | 11.93 | -0.10 | 0.13 | 6.68 | 305.03 | 82.78 | 4,387.48 |
| | 03/13/14 8:45:34 | 5880 | 11.94 | -0.11 | 0.12 | 6.68 | 306.14 | 82.78 | 4,428.58 |
| | 03/13/14 8:46:04 | 5910 | 11.89 | -0.13 | 0.13 | 6.75 | 302.82 | 82.78 | 4,396.21 |
| | 03/13/14 8:46:34 | 5940 | 12.09 | -0.12 | 0.13 | 6.61 | 293.68 | 82.78 | 4,362.44 |
| | 03/13/14 8:47:04 | 5970 | 11.93 | -0.13 | 0.12 | 6.71 | 293.13 | 82.78 | 4,343.64 |
| | 03/13/14 8:47:34 | 6000 | 12.11 | -0.12 | 0.12 | 6.62 | 285.93 | 82.78 | 4,280.29 |
| | 03/13/14 8:48:04 | 6030 | 12.09 | -0.13 | 0.13 | 6.62 | 280.12 | 82.78 | 4,235.20 |
| | 03/13/14 8:48:34 | 6060 | 12.22 | -0.12 | 0.13 | 6.49 | 279.57 | 83.23 | 4,247.61 |
| | 03/13/14 8:49:04 | 6090 | 12.20 | -0.15 | 0.13 | 6.50 | 285.93 | 82.78 | 4,294.68 |
| | 03/13/14 8:49:34 | 6120 | 12.13 | -0.12 | 0.13 | 6.55 | 287.59 | 83.23 | 4,305.35 |
| | 03/13/14 8:50:04 | 6150 | 12.09 | -0.13 | 0.12 | 6.58 | 280.12 | 83.23 | 4,261.33 |
| | 03/13/14 8:50:34 | 6180 | 11.99 | -0.12 | 0.12 | 6.69 | 276.80 | 83.23 | 4,216.64 |
| | 03/13/14 8:51:04 | 6210 | 12.10 | -0.14 | 0.11 | 6.62 | 273.20 | 83.68 | 4,205.19 |
| | 03/13/14 8:51:34 | 6240 | 12.13 | -0.13 | 0.11 | 6.58 | 269.88 | 83.23 | 4,175.06 |
| | 03/13/14 8:52:04 | 6270 | 12.92 | -0.11 | 0.12 | 6.15 | 136.19 | 83.23 | 2,959.48 |
| | 03/13/14 8:52:34 | 6300 | 13.63 | 0.13 | 0.12 | 5.51 | 143.94 | 82.78 | 3,012.80 |
| | 03/13/14 8:53:04 | 6330 | 13.71 | 0.39 | 0.12 | 5.44 | 145.60 | 82.33 | 3,014.66 |
| | 03/13/14 8:53:34 | 6360 | 13.55 | 0.58 | 0.11 | 5.56 | 151.96 | 81.88 | 3,163.22 |
| | 03/13/14 8:54:04 | 6390 | 13.43 | 0.64 | 0.11 | 5.64 | 151.96 | 81.43 | 3,109.82 |
| | 03/13/14 8:54:34 | 6420 | 13.34 | 0.51 | 0.12 | 5.74 | 156.39 | 81.43 | 3,116.01 |
| | 03/13/14 8:55:04 | 6450 | 13.46 | 0.47 | 0.12 | 5.67 | 155.84 | 81.43 | 3,107.23 |
| | 03/13/14 8:55:34 | 6480 | 13.32 | 0.51 | 0.12 | 5.73 | 151.96 | 80.98 | 3,086.78 |
| | 03/13/14 8:56:04 | 6510 | 13.58 | 0.56 | 0.11 | 5.44 | 150.86 | 80.98 | 3,085.47 |
| | 03/13/14 8:56:34 | 6540 | 13.56 | 0.77 | 0.11 | 5.41 | 149.75 | 80.98 | 3,076.33 |
| | 03/13/14 8:57:04 | 6570 | 13.57 | 0.64 | 0.11 | 5.56 | 153.07 | 80.98 | 3,102.95 |
| | 03/13/14 8:57:34 | 6600 | 13.41 | 0.51 | 0.11 | 5.69 | 154.73 | 80.98 | 3,132.09 |
| | 03/13/14 8:58:04 | 6630 | 13.42 | 0.49 | 0.12 | 5.67 | 155.84 | 80.53 | 3,130.92 |
| | 03/13/14 8:58:34 | 6660 | 13.22 | 0.43 | 0.12 | 5.76 | 154.18 | 80.53 | 3,109.80 |
| | 03/13/14 8:59:04 | 6690 | 13.46 | 0.49 | 0.11 | 5.53 | 245.52 | 80.53 | 4,025.69 |
| | 03/13/14 8:59:34 | 6720 | 12.62 | 0.44 | 0.11 | 6.09 | 285.66 | 80.98 | 4,274.45 |
| | 03/13/14 9:00:04 | 6750 | 12.15 | -0.02 | 0.11 | 6.50 | 296.45 | 80.98 | 4,358.61 |
| A2 | 03/13/14 9:00:34 | 6780 | 12.33 | -0.07 | 0.12 | 6.43 | 276.25 | 81.43 | 4,222.16 |
| | 03/13/14 9:01:04 | 6810 | 12.29 | -0.04 | 0.11 | 6.40 | 280.12 | 81.88 | 4,247.99 |
| | 03/13/14 9:01:34 | 6840 | 12.34 | -0.04 | 0.11 | 6.39 | 272.09 | 81.43 | 4,190.42 |
| | 03/13/14 9:02:04 | 6870 | 12.46 | -0.01 | 0.11 | 6.33 | 268.77 | 81.43 | 4,143.25 |
| | 03/13/14 9:02:34 | 6900 | 12.57 | 0.00 | 0.12 | 6.26 | 264.34 | 81.43 | 4,130.18 |
| | 03/13/14 9:03:04 | 6930 | 12.51 | 0.03 | 0.11 | 6.30 | 277.35 | 81.88 | 4,225.52 |
| | 03/13/14 9:03:34 | 6960 | 12.41 | 0.01 | 0.11 | 6.36 | 278.46 | 81.88 | 4,215.82 |
| | 03/13/14 9:04:04 | 6990 | 12.41 | 0.02 | 0.10 | 6.36 | 274.58 | 81.88 | 4,197.90 |
| | 03/13/14 9:04:34 | 7020 | 12.45 | 0.00 | 0.10 | 6.31 | 274.58 | 81.88 | 4,204.07 |
| | 03/13/14 9:05:04 | 7050 | 12.43 | 0.00 | 0.09 | 6.33 | 267.66 | 81.43 | 4,147.41 |

**John Zink Co, LLC**
**March 13, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 284,135 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.19 | in. Hg |
| Relative Humidity | 34 | % |
| Ambient Temperature | 57 | $^{o}$F |
| Specific Humidity | 0.003300 | lb $H_2O$ / lb air |

70-100-70 Load, Run - 4.0X30PF R9

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/13/14 9:05:34 | 7080 | 12.59 | 0.01 | 0.09 | 6.24 | 264.34 | 81.88 | 4,113.35 |
| | 03/13/14 9:06:04 | 7110 | 12.64 | 0.03 | 0.11 | 6.18 | 265.45 | 82.33 | 4,144.57 |
| | 03/13/14 9:06:34 | 7140 | 12.51 | 0.04 | 0.11 | 6.27 | 274.03 | 82.33 | 4,192.93 |
| | 03/13/14 9:07:04 | 7170 | 12.59 | 0.03 | 0.10 | 6.29 | 158.88 | 82.33 | 3,173.94 |
| | 03/13/14 9:07:34 | 7200 | 13.35 | 0.22 | 0.10 | 5.71 | 149.75 | 81.88 | 3,068.80 |
| | 03/13/14 9:08:04 | 7230 | 13.50 | 0.66 | 0.11 | 5.59 | 149.19 | 81.88 | 3,042.77 |
| | 03/13/14 9:08:34 | 7260 | 13.64 | 1.09 | 0.11 | 5.49 | 144.49 | 81.43 | 3,013.63 |
| | 03/13/14 9:09:04 | 7290 | 13.65 | 1.60 | 0.10 | 5.49 | 148.64 | 80.98 | 3,059.23 |
| | 03/13/14 9:09:34 | 7320 | 13.62 | 1.91 | 0.10 | 5.51 | 150.86 | 80.98 | 3,079.62 |
| | 03/13/14 9:10:04 | 7350 | 13.50 | 1.58 | 0.10 | 5.57 | 150.86 | 81.43 | 3,099.12 |
| | 03/13/14 9:10:34 | 7380 | 13.44 | 1.45 | 0.10 | 5.62 | 154.18 | 80.98 | 3,114.12 |
| | 03/13/14 9:11:04 | 7410 | 13.39 | 1.29 | 0.08 | 5.68 | 148.64 | 80.53 | 3,079.85 |
| | 03/13/14 9:11:34 | 7440 | 13.48 | 1.30 | 0.08 | 5.59 | 147.53 | 80.53 | 3,062.67 |
| | 03/13/14 9:12:04 | 7470 | 13.62 | 1.62 | 0.10 | 5.47 | 150.30 | 80.53 | 3,069.38 |
| | 03/13/14 9:12:34 | 7500 | 13.49 | 1.75 | 0.10 | 5.65 | 150.30 | 80.53 | 3,066.20 |
| | 03/13/14 9:13:04 | 7530 | 13.48 | 1.51 | 0.10 | 5.67 | 150.30 | 80.53 | 3,088.69 |
| | 03/13/14 9:13:34 | 7560 | 13.44 | 1.49 | 0.10 | 5.65 | 267.66 | 80.98 | 4,135.17 |
| | 03/13/14 9:14:04 | 7590 | 12.51 | 1.05 | 0.10 | 6.23 | 275.14 | 80.98 | 4,200.05 |
| | 03/13/14 9:14:34 | 7620 | 12.42 | 0.14 | 0.10 | 6.33 | 270.99 | 80.98 | 4,179.91 |
| | 03/13/14 9:15:04 | 7650 | 12.43 | 0.07 | 0.10 | 6.32 | 276.80 | 81.43 | 4,212.71 |
| | 03/13/14 9:15:34 | 7680 | 12.37 | 0.01 | 0.10 | 6.36 | 276.80 | 81.43 | 4,210.31 |
| | 03/13/14 9:16:04 | 7710 | 12.35 | -0.01 | 0.10 | 6.39 | 277.91 | 81.88 | 4,236.69 |
| | 03/13/14 9:16:34 | 7740 | 12.34 | -0.02 | 0.10 | 6.39 | 276.80 | 81.43 | 4,199.92 |
| | 03/13/14 9:17:04 | 7770 | 12.40 | -0.03 | 0.09 | 6.38 | 275.14 | 81.88 | 4,188.47 |
| | 03/13/14 9:17:34 | 7800 | 12.44 | -0.05 | 0.08 | 6.34 | 266.00 | 81.88 | 4,138.13 |
| | 03/13/14 9:18:04 | 7830 | 12.49 | -0.02 | 0.10 | 6.29 | 265.45 | 81.88 | 4,138.72 |
| | 03/13/14 9:18:34 | 7860 | 12.48 | -0.03 | 0.10 | 6.27 | 276.80 | 81.88 | 4,220.45 |
| | 03/13/14 9:19:04 | 7890 | 12.28 | -0.05 | 0.09 | 6.41 | 277.35 | 82.33 | 4,226.36 |
| | 03/13/14 9:19:34 | 7920 | 12.27 | -0.08 | 0.09 | 6.46 | 277.35 | 82.33 | 4,206.96 |
| | 03/13/14 9:20:04 | 7950 | 12.37 | -0.07 | 0.08 | 6.38 | 277.91 | 82.33 | 4,196.70 |
| A3 | 03/13/14 9:20:34 | 7980 | 12.40 | -0.06 | 0.09 | 6.34 | 271.54 | 82.33 | 4,150.55 |
| | 03/13/14 9:21:04 | 8010 | 12.44 | -0.05 | 0.10 | 6.35 | 276.25 | 82.78 | 4,213.37 |
| | 03/13/14 9:21:34 | 8040 | 12.70 | 0.05 | 0.10 | 6.18 | 278.46 | 82.33 | 4,202.32 |
| | 03/13/14 9:22:04 | 8070 | 12.93 | 0.24 | 0.10 | 5.93 | 280.67 | 82.33 | 4,232.55 |
| | 03/13/14 9:22:34 | 8100 | 12.85 | 0.23 | 0.10 | 6.07 | 177.98 | 82.33 | 3,303.55 |
| | 03/13/14 9:23:04 | 8130 | 13.57 | 0.94 | 0.09 | 5.60 | 156.39 | 81.88 | 3,094.90 |
| | 03/13/14 9:23:34 | 8160 | 13.70 | 1.48 | 0.09 | 5.48 | 149.75 | 82.33 | 3,069.49 |
| | 03/13/14 9:24:04 | 8190 | 13.79 | 1.77 | 0.09 | 5.39 | 149.19 | 82.33 | 3,089.39 |
| | 03/13/14 9:24:34 | 8220 | 13.77 | 2.53 | 0.10 | 5.39 | 149.75 | 81.88 | 3,071.39 |
| | 03/13/14 9:25:04 | 8250 | 13.71 | 2.72 | 0.10 | 5.44 | 149.75 | 81.43 | 3,063.92 |
| | 03/13/14 9:25:34 | 8280 | 13.62 | 2.53 | 0.09 | 5.49 | 151.96 | 81.43 | 3,088.69 |
| | 03/13/14 9:26:04 | 8310 | 13.56 | 2.19 | 0.10 | 5.54 | 154.18 | 80.98 | 3,104.28 |
| | 03/13/14 9:26:34 | 8340 | 13.63 | 1.73 | 0.10 | 5.52 | 150.86 | 81.43 | 3,081.84 |
| | 03/13/14 9:27:04 | 8370 | 13.65 | 1.95 | 0.10 | 5.44 | 149.75 | 81.43 | 3,059.67 |
| | 03/13/14 9:27:34 | 8400 | 13.66 | 2.17 | 0.10 | 5.46 | 145.87 | 81.43 | 3,040.79 |
| | 03/13/14 9:28:04 | 8430 | 13.64 | 2.37 | 0.10 | 5.46 | 149.19 | 80.98 | 3,081.63 |
| | 03/13/14 9:28:34 | 8460 | 13.58 | 2.12 | 0.10 | 5.51 | 150.30 | 80.98 | 3,088.33 |
| | 03/13/14 9:29:04 | 8490 | 13.64 | 2.16 | 0.09 | 5.48 | 153.07 | 80.98 | 3,085.07 |
| | 03/13/14 9:29:34 | 8520 | 13.64 | 1.99 | 0.09 | 5.46 | 151.96 | 81.43 | 3,082.72 |
| | 03/13/14 9:30:04 | 8550 | 13.31 | 2.17 | 0.10 | 5.63 | 309.74 | 81.43 | 4,426.84 |
| | 03/13/14 9:30:34 | 8580 | 12.41 | 0.80 | 0.10 | 6.32 | 289.81 | 81.88 | 4,316.53 |

**John Zink Co, LLC**
**March 13, 2014**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.3 | % |
| Stack Exhaust Flow (M2) | 284,135 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.19 | in. Hg |
| Relative Humidity | 34 | % |
| Ambient Temperature | 57 | $^{o}$F |
| Specific Humidity | 0.003300 | lb $H_2O$ / lb air |

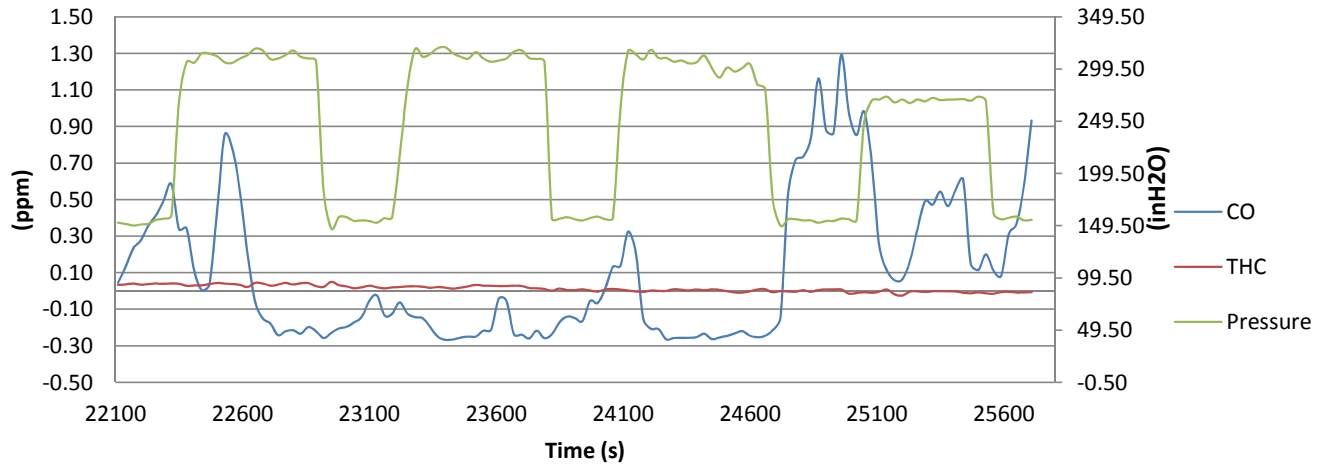
70-100-70 Load, Run - 4.0X30PF R9

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/13/14 9:31:04 | 8610 | 12.48 | 0.16 | 0.09 | 6.29 | 297.84 | 82.33 | 4,369.58 |
| 03/13/14 9:31:34 | 8640 | 12.35 | 0.22 | 0.09 | 6.39 | 297.84 | 82.33 | 4,364.33 |
| 03/13/14 9:32:04 | 8670 | 12.23 | 0.06 | 0.08 | 6.46 | 300.05 | 82.78 | 4,362.79 |
| 03/13/14 9:32:34 | 8700 | 12.32 | 0.03 | 0.08 | 6.45 | 293.13 | 83.23 | 4,350.62 |
| 03/13/14 9:33:04 | 8730 | 12.50 | 0.14 | 0.08 | 6.28 | 291.47 | 83.23 | 4,338.97 |
| 03/13/14 9:33:34 | 8760 | 12.45 | 0.11 | 0.08 | 6.30 | 300.05 | 83.23 | 4,376.11 |
| 03/13/14 9:34:04 | 8790 | 12.40 | 0.05 | 0.08 | 6.38 | 301.71 | 83.68 | 4,379.66 |
| 03/13/14 9:34:34 | 8820 | 12.27 | -0.01 | 0.09 | 6.46 | 304.48 | 84.13 | 4,374.93 |
| 03/13/14 9:35:04 | 8850 | 12.41 | -0.04 | 0.10 | 6.37 | 300.05 | 84.13 | 4,368.10 |
| 03/13/14 9:35:34 | 8880 | 12.39 | -0.01 | 0.09 | 6.37 | 294.24 | 84.57 | 4,342.77 |
| 03/13/14 9:36:04 | 8910 | 12.34 | 0.04 | 0.08 | 6.41 | 285.93 | 84.13 | 4,285.12 |
| 03/13/14 9:36:34 | 8940 | 12.53 | 0.05 | 0.09 | 6.28 | 285.93 | 84.57 | 4,294.81 |
| 03/13/14 9:37:04 | 8970 | 12.57 | 0.06 | 0.09 | 6.21 | 292.02 | 84.57 | 4,311.56 |
| 03/13/14 9:37:34 | 9000 | 13.00 | 0.14 | 0.09 | 5.97 | 150.86 | 84.13 | 3,067.33 |
| 03/13/14 9:38:04 | 9030 | 13.54 | 0.66 | 0.10 | 5.53 | 153.07 | 84.13 | 3,078.95 |
| 03/13/14 9:38:34 | 9060 | 13.59 | 1.15 | 0.10 | 5.50 | 150.86 | 84.13 | 3,075.12 |
| 03/13/14 9:39:04 | 9090 | 14.25 | 1.41 | 0.09 | 5.38 | 149.75 | 83.68 | 3,048.33 |
| 03/13/14 9:39:34 | 9120 | 13.95 | 2.05 | 0.09 | 5.33 | 146.98 | 83.68 | 3,033.30 |
| **RAW AVERAGE** | | **12.90** | **0.53** | **0.11** | **6.01** | **222.40** | **82.08** | **3,719.78** |

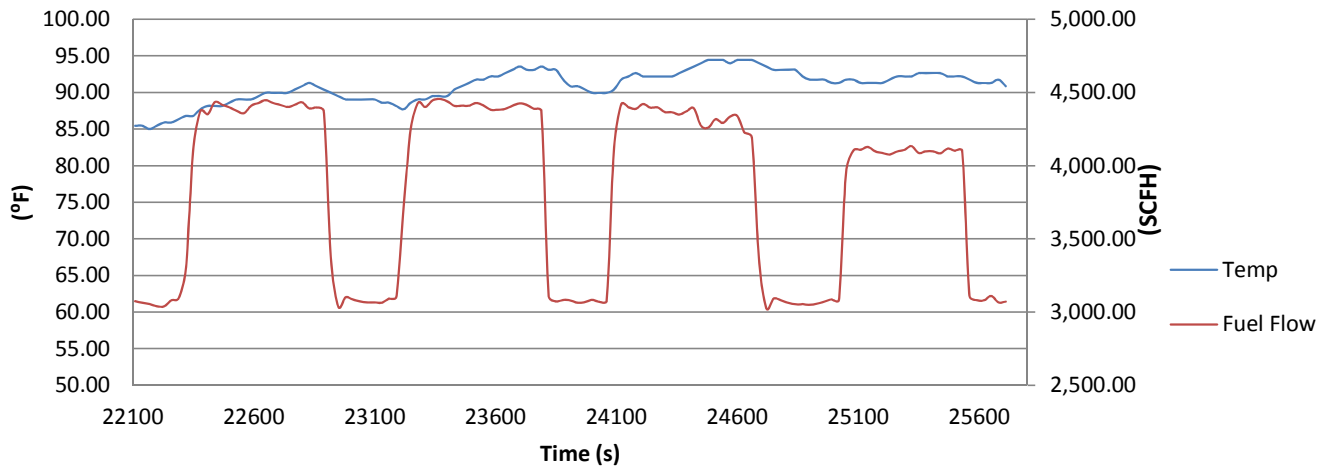
| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | Serial Number: | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | (%) | (ppmvd) | (ppmvw) | (%) | (in. $H_2O$) | ($^{o}$F) | (SCFH) |
| Bias | Initial Zero | 0.11 | -0.07 | 0.04 | 0.02 | | | |
| | Final Zero | 0.12 | 0.04 | 0.03 | 0.06 | | | |
| | Avg. Zero | 0.12 | -0.02 | 0.04 | 0.04 | | | |
| | Initial UpScale | 12.13 | 8.93 | 3.12 | 9.37 | | | |
| | Final UpScale | 12.01 | 9.00 | 3.00 | 9.42 | | | |
| | Avg. UpScale | 12.07 | 8.97 | 3.06 | 9.40 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| EMISSIONS DATA | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| Corrected Raw Average (ppm/% dry basis) | 12.83 | 0.55 | 0.07 | 6.02 |
| Corrected Raw Average (ppm/% wet basis) | 12.15 | 0.52 | 0.07 | 5.70 |
| Emission Rate (lb/hr) | N/A | 0.01 | 0.00 | N/A |

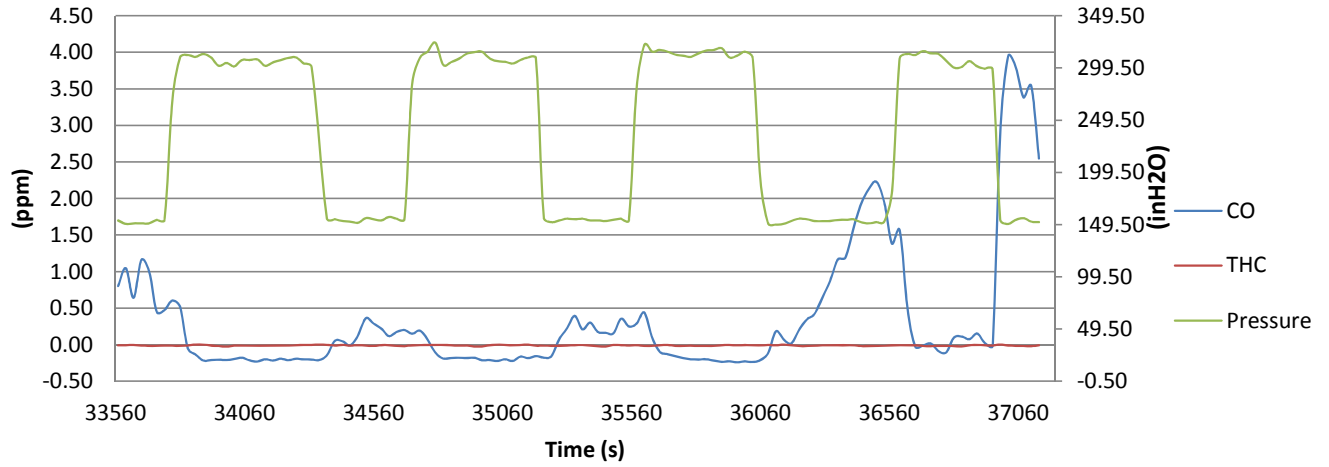
## 4.0X30PF R7



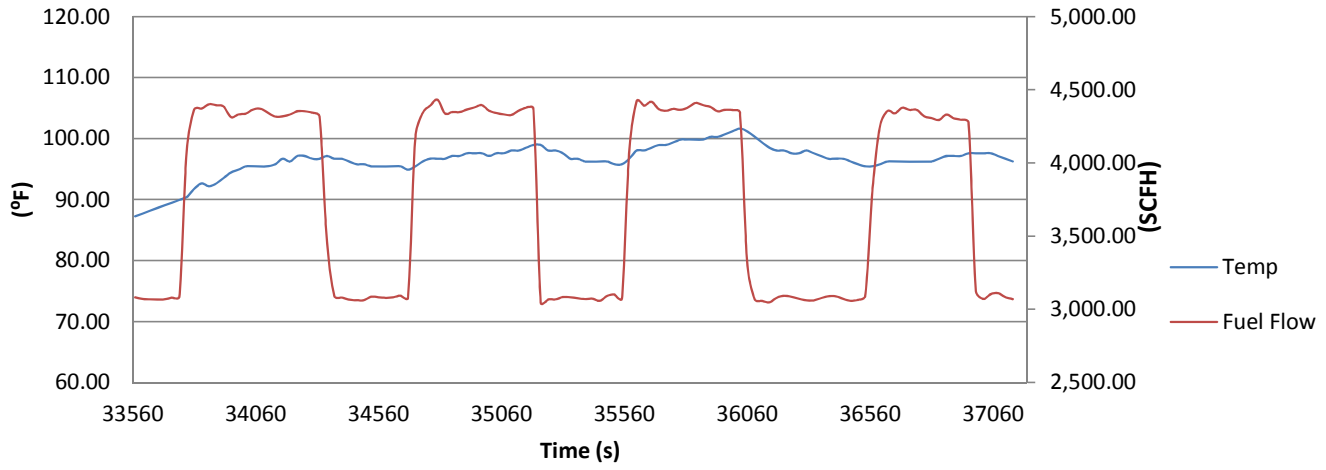

## 4.0X30PF R7



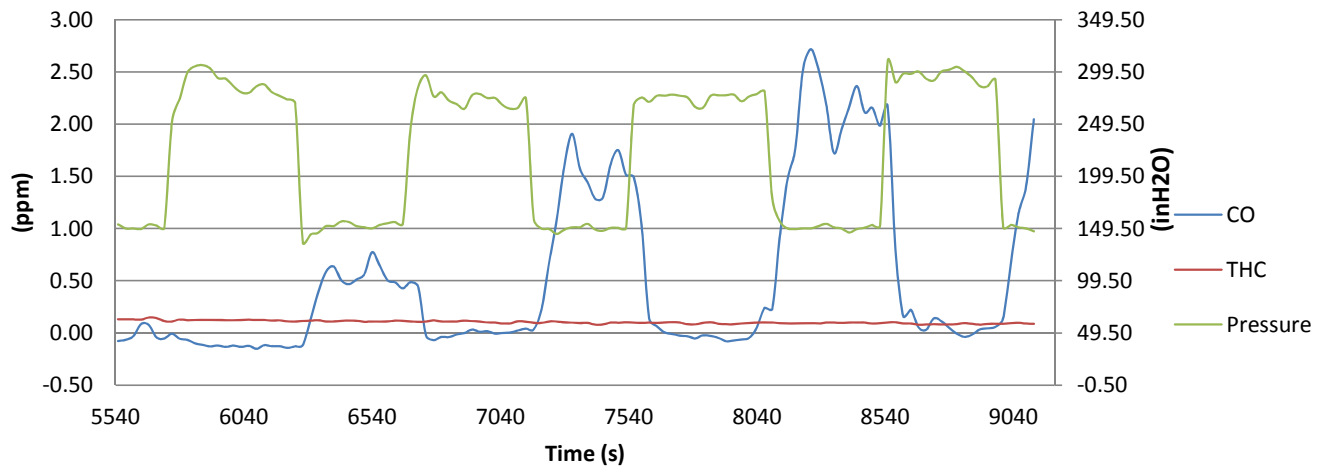

## 4.0X30PF R8



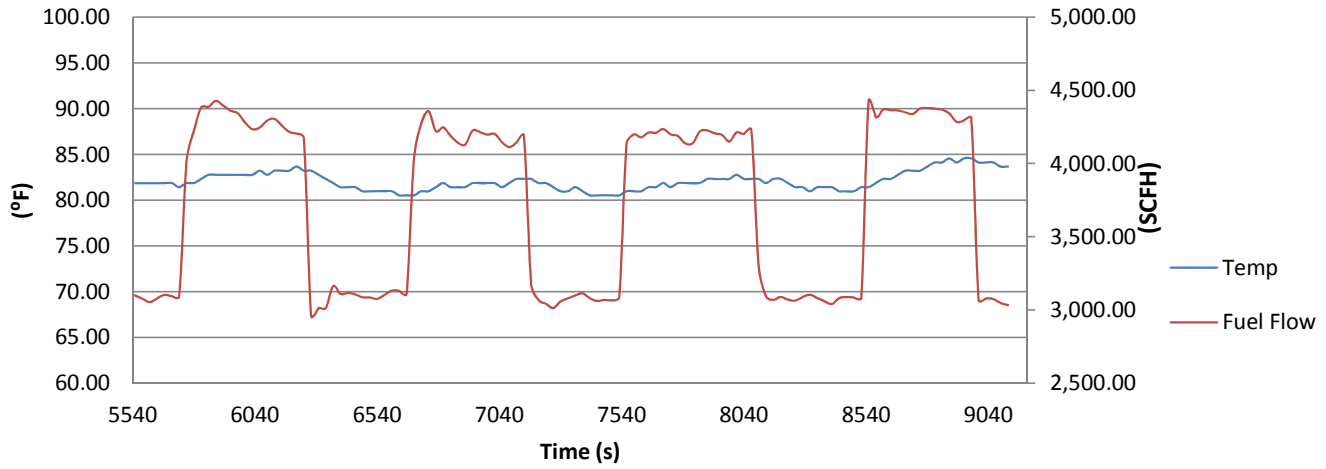
## 4.0X30PF R8

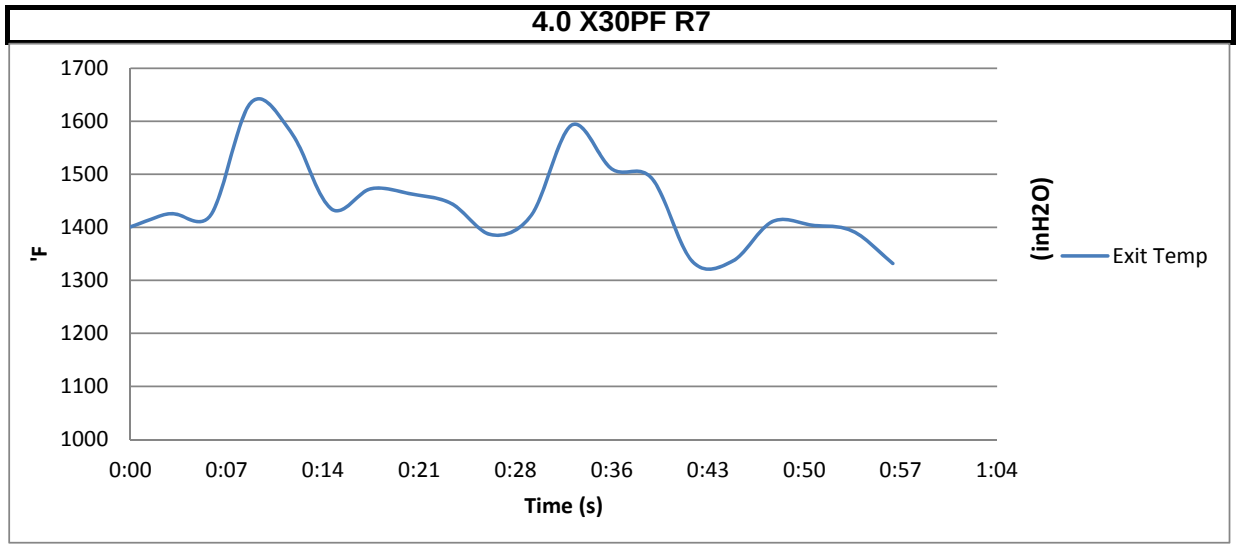


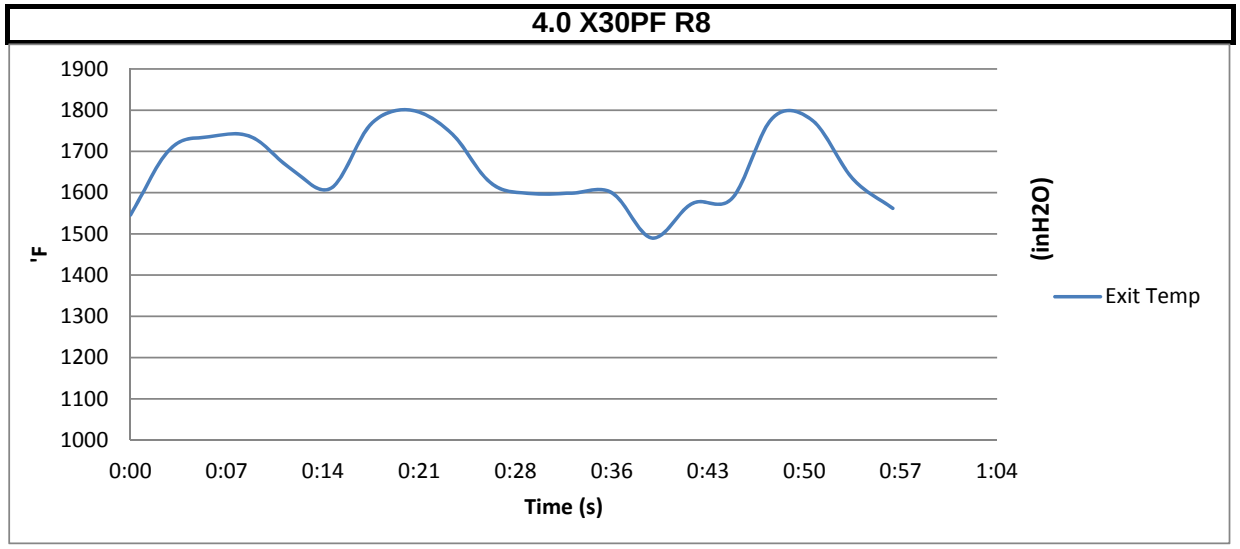

## 4.0X30PF R9

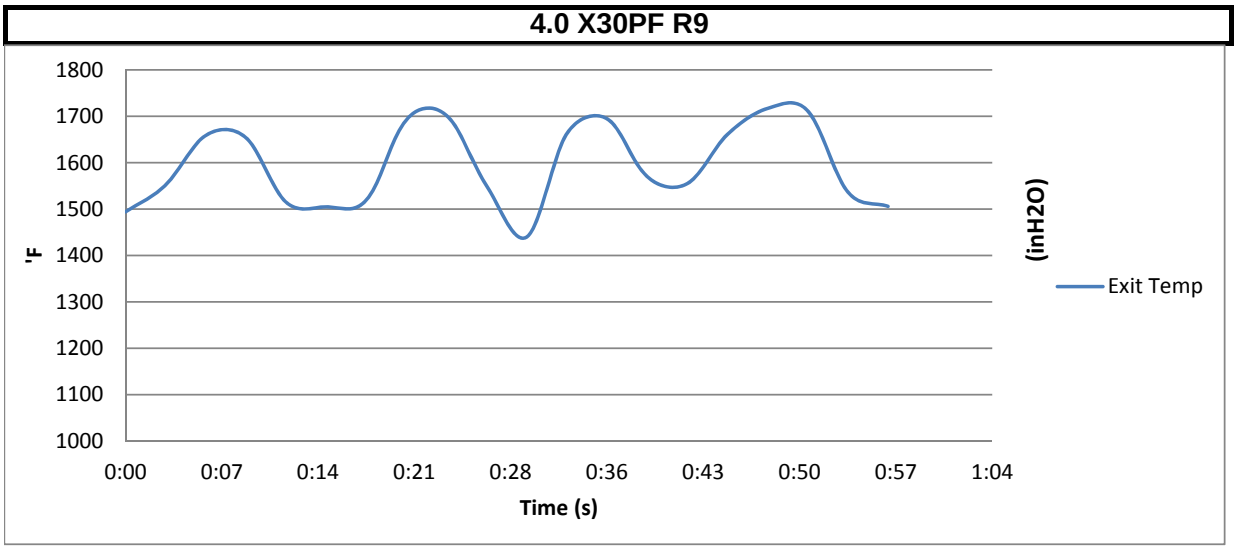



## 4.0X30PF R9




4.0 X30PF R7
1700
1600
1500
1400
1300
1200
1100
1000
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp


4.0 X30PF R8
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp


4.0 X30PF R9
1800
1700
1600
1500
1400
1300
1200
1100
1000
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp

# EMISSION DATA RECORDS

## 90-100% Fixed Rate Unit Operations Data

| METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE |
|---|

| Source Information | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Fuel Type** | Gas, Propene |

| Test Information | | | |
|---|---|---|---|
| **Project #** | | jz-14-tulsa.ok-comp#1 | |
| **Operator** | | TP | |
| **Date for Preliminary Run** | (mm/dd/yy) | 03/11/14 | |
| **Standard Temperature** | | 68 | °F |
| **Standard Pressure** | | 29.92 | in Hg |
| **Required Sample Vol.** | RM4, 8.1.1.2 | 21 | scf |
| **Run Duration** | ≤0.75 cfm | 60 | minutes |
| **Unit Number** | | 1 | |
| **Base Run Number** | | 90-100% | |
| **Number of Ports Available** | | 2 | |
| **Number of Ports Used** | | 2 | |
| **Port Inside Diameter** | | 4.00 | in |
| **Stack Shape** | | Circular | |

| Test Equipment Information | | | | | |
|---|---|---|---|---|---|
| **Run** | | **10** | **11** | **12** | |
| **Test Date** | (mm/dd/yy) | 03/13/14 | 03/13/14 | 03/13/14 | |
| **Load** | % or w/DB | 90-100 | 90-100 | 90-100 | |
| **Meter Box Number** | from ACS | samp-cp-0008 | samp-cp-0008 | samp-cp-0008 | |
| **Meter Calibration Factor** | (Y) | 0.924 | 0.924 | 0.924 | |
| **Orifice Meter Coefficient** | ($\Delta H_@$) | 1.700 | 1.700 | 1.700 | in $H_2O$ |
| **Pitot Identification** | from ACS | A4174 | A4174 | A4174 | |
| **Pitot Tube Coefficient** | ($C_p$) | 0.819 | 0.819 | 0.819 | |
| **Probe Number** | from ACS | samp-hp-0003 | samp-hp-0003 | samp-hp-0003 | |
| **Probe Length** | | 60.0 | 60 | 60 | in |
| **(SS, Glass …. ) Liner Material** | from list | inconel | inconel | inconel | |
| **Impinger Case Number** | from ACS | samp-bh-0016 | samp-bh-0016 | samp-bh-0016 | |

| Testing Company Information | |
|---|---|
| **Company Name** | Air Hygiene International, Inc. (Tulsa, Oklahoma) |
| **Address** | 1600 W Tacoma Street |
| **City, State Zip** | Broken Arrow, Oklahoma 74012 |
| **Project Manager** | Min Sum Lee |
| **Phone Number** | (918) 307-8865 |
| **Fax Number** | (918) 307-9131 |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] - RESULTS

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| **Historical Data** | **90-100%-10** | **90-100%-11** | **90-100%-12** | **Average** | **Units** |
|---|---|---|---|---|---|
| Run Start Time | 10:27 | 12:50 | 14:05 | | hh:mm |
| Run Stop Time | 11:29 | 13:52 | 15:07 | | hh:mm |
| Test Date | 03/13/14 | 03/13/14 | 03/13/14 | | mm/dd/yy |
| Meter Calibration Factor | 0.924 | 0.924 | 0.924 | | |
| Pitot Tube Coefficient | 0.819 | 0.819 | 0.819 | | |
| **Stack Test Data** | **90-100%-10** | **90-100%-11** | **90-100%-12** | **Average** | **Units** |
| Initial Meter Volume | 329.925 | 377.503 | 426.158 | | $ft^3$ |
| Final Meter Volume | 377.115 | 425.893 | 474.566 | | $ft^3$ |
| Total Meter Volume | 47.190 | 48.390 | 48.408 | 47.996 | $ft^3$ |
| Total Sampling Time | 60.00 | 60.00 | 60.00 | 60.00 | min |
| Average Meter Temperature | 69.48 | 77.00 | 78.65 | 75.04 | °F |
| Average Stack Temperature | 1631.95 | 1664.85 | 1685.80 | 1660.87 | °F |
| Barometric Pressure | 30.20 | 30.15 | 30.09 | 30.15 | in Hg |
| Stack Static Pressure | 0.00 | 0.00 | 0.00 | 0.00 | in $H_2O$ |
| Absolute Stack Pressure | 30.20 | 30.15 | 30.09 | 30.15 | in Hg |
| Average Orifice Pressure Drop | 1.70 | 1.70 | 1.70 | 1.70 | in $H_2O$ |
| Absolute Meter Pressure | 30.33 | 30.28 | 30.22 | 30.27 | in Hg |
| Avg Square Root Pitot Pressure | 0.25 | 0.24 | 0.26 | 0.25 | √(in $H_2O$) |
| **Moisture Content Data** | **90-100%-10** | **90-100%-11** | **90-100%-12** | **Average** | **Units** |
| Impinger Water Weight Gain | 46.80 | 52.50 | 52.50 | 50.60 | g |
| Silica Gel Weight Gain | 11.10 | 11.60 | 8.30 | 10.33 | g |
| Total Water Volume Collected | 58.00 | 64.22 | 60.91 | 61.04 | ml |
| Standard Water Vapor Volume | 2.73 | 3.02 | 2.87 | 2.87 | scf |
| Standard Meter Volume | 44.1 | 44.5 | 44.3 | 44.3 | dscf |
| Calculated Stack Moisture | 5.83 | 6.36 | 6.08 | 6.09 | % |
| Saturated Stack Moisture | 100.00 | 100.00 | 100.00 | 100.00 | % |
| Reported Stack Moisture Content | 5.83 | 6.36 | 6.08 | 6.09 | % |
| **Gas Analysis Data** | **90-100%-10** | **90-100%-11** | **90-100%-12** | **Average** | **Units** |
| Carbon Dioxide Content | 5.8 | 6.1 | 6.1 | 6.0 | % |
| Oxygen Content | 14.2 | 13.9 | 13.9 | 14.0 | % |
| Nitrogen Content | 80.0 | 80.0 | 80.1 | 80.0 | % |
| Stack Dry Molecular Weight | 29.50 | 29.53 | 29.52 | 29.52 | lb/lb-mole |
| Stack Wet Molecular Weight | 28.83 | 28.80 | 28.82 | 28.81 | lb/lb-mole |
| Percent Excess Air | 205.2 | 192.4 | 192.2 | 196.6 | % |
| **Volumetric Flow Rate Data** | **90-100%-10** | **90-100%-11** | **90-100%-12** | **Average** | **Units** |
| Average Stack Gas Velocity | 26.90 | 26.80 | 28.20 | 27.30 | ft/sec |
| Stack Cross-Sectional Area | 12.57 | 12.57 | 12.57 | 12.57 | $ft^2$ |
| Actual Stack Flow Rate | 20,284 | 20,203 | 21,263 | 20,583 | acfm |
| Wet Standard Stack Flow Rate | 310 | 304 | 316 | 310 | wkscfh |
| Dry Standard Stack Flow Rate | 291,965 | 284,219 | 296,509 | 290,898 | dscfh |

## METHOD 3C - DETERMINATION OF DRY MOLECULAR WEIGHT BY ANALYZER

| | | | | | |
|---|---|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Preliminary Date** | 03/11/14 | | |
| **Sampling Location** | 4.0X30PF | **Operator** | TP | | |
| **Project #** | jz-14-tulsa.ok-comp#1 | **# of Ports Used** | 2 | | |
| **Fuel Type** | Gas, Propene | **Min. Fuel Factor** | N/A | **Max. Fuel Factor** | N/A |

| **Gas Analysis Data** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Run Number** | 90-100%-10 | | **Date** | 03/13/14 | **Run Start Time** | 10:27 | **Run Stop Time** | 11:29 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | % | |
| 01:02 | 5.8 | 14.2 | 0.0 | 80.0 | 29.50 | 1.155 | 205.2 | N/A |

| **Gas Analysis Data** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Run Number** | 90-100%-11 | | **Date** | 03/13/14 | **Run Start Time** | 12:50 | **Run Stop Time** | 13:52 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | % | |
| 01:02 | 6.1 | 13.9 | 0.0 | 80.0 | 29.53 | 1.151 | 192.4 | N/A |

| **Gas Analysis Data** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Run Number** | 90-100%-12 | | **Date** | 03/13/14 | **Run Start Time** | 14:05 | **Run Stop Time** | 15:07 |
| **Sample Analysis Time** | **$CO_2$ Conc.** | **$O_2$ Conc.** | **CO Conc.** | **$N_2$ Conc.** | **Dry Molecular Weight** | **Calculated Fuel Factor** | **Excess Air** | **Fuel Factor in Range** |
| | (%$CO_2$) | (%$O_2$) | (ppmCO) | (%$N_2$) | ($M_d$) | $(F_o)_{avg}$ | $(\%EA)_{avg}$ | |
| hh:mm | % | % | ppm | % | lb/lb-mole | | % | |
| 01:02 | 6.1 | 13.9 | 0.0 | 80.1 | 29.52 | 1.157 | 192.2 | N/A |

## METHOD 4 - DETERMINATION OF MOISTURE CONTENT IN STACK GASES

| | | | |
|---|---|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility | **Preliminary Date** | 03/11/14 |
| **Sampling Location** | 4.0X30PF | **Operator** | TP |
| **Project #** | jz-14-tulsa.ok-comp#1 | **Ports Used** | 2 |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 90-100%-10 | | **Date** | 03/13/14 | **Start Time** | 10:27 | **Stop Time** | 11:29 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 47.190 | dcf | | **Barometric Pressure** | ($P_b$) | 30.20 | in Hg |
| **Average Stack Temp** | | ($t_s$)$_{avg}$ | 1632 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | ($t_m$)$_{avg}$ | 69 | °F | | **Avg Orifice Pressure** | ($\Delta H$)$_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 739.30 | 689.90 | 593.50 | 886.60 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 707.30 | 677.30 | 591.30 | 875.50 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 32.0 | 12.6 | 2.2 | 11.1 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 57.90 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.730 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 44.071 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 5.83 | % | | **Final Moisture Content** | ($B_{ws}$) | 5.83 | % |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 90-100%-11 | | **Date** | 03/13/14 | **Start Time** | 12:50 | **Stop Time** | 13:52 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 48.390 | dcf | | **Barometric Pressure** | ($P_b$) | 30.15 | in Hg |
| **Average Stack Temp** | | ($t_s$)$_{avg}$ | 1665 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | ($t_m$)$_{avg}$ | 77 | °F | | **Avg Orifice Pressure** | ($\Delta H$)$_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 771.60 | 768.20 | 582.40 | 898.20 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 732.40 | 758.30 | 579.00 | 886.60 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 39.2 | 9.9 | 3.4 | 11.6 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 64.10 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 3.022 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 44.485 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 6.36 | % | | **Final Moisture Content** | ($B_{ws}$) | 6.36 | % |

| **Moisture Content Data** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Run Number** | | 90-100%-12 | | **Date** | 03/13/14 | **Start Time** | 14:05 | **Stop Time** | 15:07 |
| **Meter Box Number** | | samp-cp-0008 | | | | **Meter Cal Factor** | (Y) | 0.924 | |
| **Total Meter Volume** | | ($V_m$) | 48.408 | dcf | | **Barometric Pressure** | ($P_b$) | 30.09 | in Hg |
| **Average Stack Temp** | | ($t_s$)$_{avg}$ | 1686 | °F | | **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Average Meter Temp** | | ($t_m$)$_{avg}$ | 79 | °F | | **Avg Orifice Pressure** | ($\Delta H$)$_{avg}$ | 1.70 | in $H_2O$ |
| | | **Impinger 1** | **Impinger 2** | **Impinger 3** | **Impinger 4** | **Impinger 5** | **Impinger 6** | **Impinger 7** | **Impinger 8** |
| | | (g) | (g) | (g) | (g) | | | | |
| **Contents** | | $H_2O$ | $H_2O$ | - | Sil Gel | | | | |
| **Final Value** | ($V_f$),($W_f$) | 777.80 | 700.90 | 596.50 | 894.90 | | | | |
| **Initial Value** | ($V_i$),($W_i$) | 739.30 | 689.90 | 593.50 | 886.60 | | | | |
| **Net Value** | ($V_n$),($W_n$) | 38.5 | 11.0 | 3.0 | 8.3 | | | | |
| **Results** | | | | | | | | | |
| **Total Weight** | | ($W_t$) | 60.80 | g | | **Water Vol Weighed** | ($V_{wsg(std)}$) | 2.867 | scf |
| **Std Meter Volume** | | ($V_{m(std)}$) | 44.277 | dscf | | **Sat. Moisture Content** | ($B_{ws(svp)}$) | 100.00 | % |
| **Calc Moisture Content** | | ($B_{ws(calc)}$) | 6.08 | % | | **Final Moisture Content** | ($B_{ws}$) | 6.08 | % |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/13/14 |
| **Operator** | TP |
| **Run Number** | 90-100%-10 |

| Ideal Nozzle Diameter and IsoKinetic Factor Setup | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1632.0 | °F |
| **Average Meter Temp** | ($t_m$) | 69.5 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.25 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 5.83 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.50 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.75 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| Leak Checks | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.035 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.025 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.020 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.035 | in $H_2O$ for | 15.0 | sec |

| Sampling Equipment | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | samp-hp-0003 | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4103 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | samp-bh-0016 | | |

| Pressures | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.20 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.20 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.33 | in Hg |

| Nozzle Measurements | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| Run Time | | | |
|---|---|---|---|
| **Start** | 10:27 | **End** | 11:29 |

| Weights | Imp 1 | Imp 2 | Imp 3 | Imp 4 | Imp 5 | Imp 6 | Imp 7 | Imp 8 |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 707.3 | 677.3 | 591.3 | 875.5 | | | | |
| **Post** | 739.3 | 689.9 | 593.5 | 886.6 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| Traverse Point # | Sampling Time (Θ) | Timer Time | Dry Gas Meter Reading ($V_m$) | Velocity Head (Δp) | Desired Orifice ΔH ($\Delta H_d$) | Actual Orifice ΔH ($\Delta H_a$) | Stack Temp ($t_s$) | Snorkel Temp (248±25°F) | Filter Temp (248±25°F) | Impinger Exit Temp (≤68°F) | Cond. Temp (≤--°F) | CPM Filter Temp (--±--°F) | Meter Inlet Temp ($t_{mi}$) | Meter Outlet Temp ($t_{mo}$) | Pump Vacuum | Square Root ΔP ($\Delta p^{1/2}$) | Local Stack Velocity ($v_s$)$_l$ | Cumul. Meter Volume ($V_m$)$_{std}$ | Cumul. Percent IsoKinetic (I) | Est-Run Meter Volume ($V_m$)$_{std}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 329.925 | 0.035 | 1.700 | 1.70 | 1477 | 240 | | 58 | | | 61 | 60 | 3.0 | 0.19 | 19.55 | 2.275 | | 45.505 |
| A-2 | 3.0 | 00:03:00 | 332.320 | 0.035 | 1.700 | 1.70 | 1547 | 240 | | 55 | | | 64 | 60 | 3.0 | 0.19 | 19.90 | 4.620 | | 46.198 |
| A-3 | 6.0 | 00:06:00 | 334.795 | 0.035 | 1.700 | 1.70 | 1564 | 240 | | 57 | | | 68 | 61 | 3.0 | 0.19 | 19.98 | 6.727 | | 44.845 |
| A-4 | 9.0 | 00:09:00 | 337.030 | 0.045 | 1.700 | 1.70 | 1569 | 240 | | 59 | | | 69 | 61 | 3.0 | 0.21 | 22.69 | 8.884 | | 44.418 |
| A-5 | 12.0 | 00:12:00 | 339.320 | 0.055 | 1.700 | 1.70 | 1618 | 240 | | 63 | | | 71 | 61 | 3.0 | 0.23 | 25.38 | 11.041 | | 44.165 |
| A-6 | 15.0 | 00:15:00 | 341.615 | 0.080 | 1.700 | 1.70 | 1661 | 240 | | 59 | | | 72 | 62 | 3.0 | 0.28 | 30.93 | 13.232 | | 44.107 |
| A-7 | 18.0 | 00:18:00 | 343.950 | 0.090 | 1.700 | 1.70 | 1692 | 240 | | 57 | | | 74 | 63 | 3.0 | 0.30 | 33.04 | 15.412 | | 44.034 |
| A-8 | 21.0 | 00:21:00 | 346.280 | 0.065 | 1.700 | 1.70 | 1667 | 240 | | 56 | | | 74 | 63 | 3.0 | 0.25 | 27.92 | 17.597 | | 43.992 |
| A-9 | 24.0 | 00:24:00 | 348.615 | 0.060 | 1.700 | 1.70 | 1667 | 240 | | 56 | | | 75 | 64 | 3.0 | 0.24 | 26.82 | 19.805 | | 44.012 |
| A-10 | 27.0 | 00:27:00 | 350.980 | 0.060 | 1.700 | 1.70 | 1628 | 240 | | 57 | | | 77 | 65 | 3.0 | 0.24 | 26.57 | 22.022 | | 44.043 |
| B-1 | 30.0 | 00:30:00 | 353.360 | 0.065 | 1.700 | 1.70 | 1597 | 240 | | 57 | | | 75 | 66 | 3.0 | 0.25 | 27.45 | 24.203 | | 44.005 |
| B-2 | 33.0 | 00:33:00 | 355.700 | 0.075 | 1.700 | 1.70 | 1695 | 240 | | 57 | | | 76 | 66 | 3.0 | 0.27 | 30.18 | 26.358 | | 43.931 |
| B-3 | 36.0 | 00:36:00 | 358.015 | 0.060 | 1.700 | 1.70 | 1694 | 240 | | 58 | | | 77 | 67 | 3.0 | 0.24 | 26.99 | 28.473 | | 43.805 |
| B-4 | 39.0 | 00:39:00 | 360.290 | 0.065 | 1.700 | 1.70 | 1685 | 240 | | 58 | | | 78 | 67 | 3.0 | 0.25 | 28.03 | 30.613 | | 43.733 |
| B-5 | 42.0 | 00:42:00 | 362.595 | 0.080 | 1.700 | 1.70 | 1667 | 240 | | 60 | | | 78 | 68 | 3.0 | 0.28 | 30.97 | 33.564 | | 44.751 |
| B-6 | 45.0 | 00:45:00 | 365.775 | 0.080 | 1.700 | 1.70 | 1663 | 240 | | 60 | | | 78 | 68 | 3.0 | 0.28 | 30.94 | 35.062 | | 43.827 |
| B-7 | 48.0 | 00:48:00 | 367.390 | 0.075 | 1.700 | 1.70 | 1660 | 240 | | 60 | | | 78 | 69 | 3.0 | 0.27 | 29.94 | 37.296 | | 43.877 |
| B-8 | 51.0 | 00:51:00 | 369.800 | 0.070 | 1.700 | 1.70 | 1645 | 240 | | 60 | | | 78 | 69 | 3.0 | 0.26 | 28.82 | 39.557 | | 43.952 |
| B-9 | 54.0 | 00:54:00 | 372.240 | 0.060 | 1.700 | 1.70 | 1632 | 240 | | 60 | | | 78 | 69 | 3.0 | 0.24 | 26.60 | 41.879 | | 44.083 |
| B-10 | 57.0 | 00:57:00 | 374.745 | 0.055 | 1.700 | 1.70 | 1611 | 240 | | 60 | | | 79 | 70 | 3.0 | 0.23 | 25.34 | 44.071 | | 44.071 |
| Last Pt | 60.0 | 01:00:00 | 377.115 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 377.115 | | | | | | | | | | | **Max Vac** | 3.0 | **Final Values** | | 44.071 | | |
| **Average Values** | | | | 0.06 | | 1.70 | 1632 | 240 | | 58 | | | 74 | 65 | | 0.25 | 26.90 | | | |
| | | | | | | | | | | | | | 69 | | | | | | | |

## METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/13/14 |
| **Operator** | TP |
| **Run Number** | 90-100%-11 |

| Ideal Nozzle Diameter and IsoKinetic Factor Setup | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1664.9 | °F |
| **Average Meter Temp** | ($t_m$) | 77.0 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.24 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 6.36 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.53 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.73 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| Leak Checks | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.045 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.035 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.020 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.015 | in $H_2O$ for | 15.0 | sec |

| Sampling Equipment | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | samp-cp-0008 | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4058 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | samp-bh-0016 | | |

| Pressures | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.15 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.15 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.28 | in Hg |

| Nozzle Measurements | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| Run Time | | | |
|---|---|---|---|
| **Start** | 12:50 | **End** | 13:52 |

| Weights | Imp 1 | Imp 2 | Imp 3 | Imp 4 | Imp 5 | Imp 6 | Imp 7 | Imp 8 |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 732.4 | 758.3 | 579.0 | 886.6 | | | | |
| **Post** | 771.6 | 768.2 | 582.4 | 898.2 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **Wash Volumes** | | | | | ml |
| | | | | | ml |

| Traverse Point # | Sampling Time (Θ) | Timer Time | Dry Gas Meter Reading ($V_m$) | Velocity Head (Δp) | Desired Orifice ΔH ($\Delta H_d$) | Actual Orifice ΔH ($\Delta H_a$) | Stack Temp ($t_s$) | Snorkel Temp (248±25°F) | Filter Temp (248±25°F) | Impinger Exit Temp (≤68°F) | Cond. Temp (≤--°F) | CPM Filter Temp (--±--°F) | Meter Inlet Temp ($t_{mi}$) | Meter Outlet Temp ($t_{mo}$) | Pump Vacuum | Square Root ΔP ($\Delta p^{1/2}$) | Local Stack Velocity ($v_s$)$_l$ | Cumul. Meter Volume ($V_m$)$_{std}$ | Cumul. Percent IsoKinetic (I) | Est-Run Meter Volume ($V_m$)$_{std}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 377.503 | 0.050 | 1.700 | 1.70 | 1550 | 240 | | 69 | | | 72 | 71 | 3.0 | 0.22 | 23.83 | 2.282 | | 45.642 |
| A-2 | 3.0 | 00:03:00 | 379.960 | 0.045 | 1.700 | 1.70 | 1568 | 240 | | 61 | | | 74 | 71 | 3.0 | 0.21 | 22.71 | 4.526 | | 45.256 |
| A-3 | 6.0 | 00:06:00 | 382.380 | 0.050 | 1.700 | 1.70 | 1573 | 240 | | 58 | | | 75 | 71 | 3.0 | 0.22 | 23.97 | 6.767 | | 45.113 |
| A-4 | 9.0 | 00:09:00 | 384.800 | 0.050 | 1.700 | 1.70 | 1581 | 240 | | 58 | | | 77 | 71 | 3.0 | 0.22 | 24.02 | 8.986 | | 44.928 |
| A-5 | 12.0 | 00:12:00 | 387.200 | 0.055 | 1.700 | 1.70 | 1640 | 240 | | 60 | | | 78 | 72 | 3.0 | 0.23 | 25.55 | 10.799 | | 43.195 |
| A-6 | 15.0 | 00:15:00 | 389.165 | 0.065 | 1.700 | 1.70 | 1696 | 240 | | 62 | | | 78 | 72 | 3.0 | 0.25 | 28.14 | 13.461 | | 44.870 |
| A-7 | 18.0 | 00:18:00 | 392.050 | 0.065 | 1.700 | 1.70 | 1751 | 240 | | 63 | | | 79 | 73 | 3.0 | 0.25 | 28.50 | 15.681 | | 44.801 |
| A-8 | 21.0 | 00:21:00 | 394.460 | 0.060 | 1.700 | 1.70 | 1728 | 240 | | 64 | | | 79 | 73 | 3.0 | 0.24 | 27.24 | 17.928 | | 44.819 |
| A-9 | 24.0 | 00:24:00 | 396.900 | 0.050 | 1.700 | 1.70 | 1670 | 240 | | 63 | | | 80 | 74 | 3.0 | 0.22 | 24.53 | 20.180 | | 44.845 |
| A-10 | 27.0 | 00:27:00 | 399.350 | 0.055 | 1.700 | 1.70 | 1663 | 240 | | 64 | | | 81 | 74 | 3.0 | 0.23 | 25.69 | 22.430 | | 44.860 |
| B-1 | 30.0 | 00:30:00 | 401.800 | 0.065 | 1.700 | 1.70 | 1642 | 240 | | 65 | | | 80 | 74 | 3.0 | 0.25 | 27.79 | 24.637 | | 44.794 |
| B-2 | 33.0 | 00:33:00 | 404.200 | 0.060 | 1.700 | 1.70 | 1707 | 240 | | 65 | | | 82 | 74 | 3.0 | 0.24 | 27.11 | 26.779 | | 44.632 |
| B-3 | 36.0 | 00:36:00 | 406.535 | 0.065 | 1.700 | 1.70 | 1703 | 240 | | 64 | | | 83 | 75 | 3.0 | 0.25 | 28.19 | 29.037 | | 44.672 |
| B-4 | 39.0 | 00:39:00 | 409.000 | 0.065 | 1.700 | 1.70 | 1699 | 240 | | 64 | | | 83 | 75 | 3.0 | 0.25 | 28.16 | 31.189 | | 44.556 |
| B-5 | 42.0 | 00:42:00 | 411.350 | 0.075 | 1.700 | 1.70 | 1718 | 240 | | 65 | | | 83 | 76 | 3.0 | 0.27 | 30.39 | 33.367 | | 44.489 |
| B-6 | 45.0 | 00:45:00 | 413.730 | 0.075 | 1.700 | 1.70 | 1724 | 240 | | 63 | | | 83 | 76 | 3.0 | 0.27 | 30.43 | 35.577 | | 44.471 |
| B-7 | 48.0 | 00:48:00 | 416.145 | 0.070 | 1.700 | 1.70 | 1681 | 240 | | 60 | | | 83 | 76 | 3.0 | 0.26 | 29.10 | 37.814 | | 44.487 |
| B-8 | 51.0 | 00:51:00 | 418.590 | 0.065 | 1.700 | 1.70 | 1680 | 240 | | 59 | | | 83 | 77 | 3.0 | 0.25 | 28.04 | 40.017 | | 44.463 |
| B-9 | 54.0 | 00:54:00 | 421.000 | 0.060 | 1.700 | 1.70 | 1663 | 240 | | 59 | | | 84 | 77 | 3.0 | 0.24 | 26.83 | 42.223 | | 44.445 |
| B-10 | 57.0 | 00:57:00 | 423.415 | 0.055 | 1.700 | 1.70 | 1660 | 240 | | 60 | | | 84 | 77 | 3.0 | 0.23 | 25.67 | 44.486 | | 44.486 |
| Last Pt | 60.0 | 01:00:00 | 425.893 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 425.893 | | | | | | | | | | | **Max Vac** | 3.0 | **Final Values** | | 44.486 | | |
| **Average Values** | | | | 0.06 | | 1.70 | 1665 | 240 | | 62 | | | 80 | 74 | | 0.24 | 26.80 | | | |
| | | | | | | | | | | | | | 77 | | | | | | | |

**METHOD 4 (MOISTURE) [MULTI POINT, NO VARIATION] SOURCE SAMPLING TITLE PAGE ISOKINETIC SAMPLING DATA**

| | |
|---|---|
| **Plant Name** | John Zink Tulsa R&D Facility |
| **Sampling Location** | 4.0X30PF |
| **Project #** | jz-14-tulsa.ok-comp#1 |

| | |
|---|---|
| **Date** | 03/13/14 |
| **Operator** | TP |
| **Run Number** | 90-100%-12 |

| **Ideal Nozzle Diameter and IsoKinetic Factor Setup** | | | |
|---|---|---|---|
| **Pitot Coefficient** | ($C_p$) | 0.819 | |
| **Average Stack Temp** | ($t_s$) | 1685.8 | °F |
| **Average Meter Temp** | ($t_m$) | 78.7 | |
| **Orifice Meter Coefficient** | ($\Delta H@$) | 1.700 | in $H_2O$ |
| **Square Root ΔP** | ($\Delta p^{1/2}_{avg}$) | 0.26 | in $H_2O$ |
| **Stack Moisture Content** | ($B_{ws}$) | 6.08 | % |
| **Stack Dry Molecular Weight** | ($M_d$) | 29.52 | lb/lb-mole |
| **Estimated Orifice Flow Rate** | ($Q_m$) | 0.74 | acfm |
| **ΔP to ΔH Isokinetic Factor** | (K) | | |

| **Leak Checks** | | | | | |
|---|---|---|---|---|---|
| **Train** | **Pre** | 0.000 | ft³/min@ | 15.0 | in Hg |
| PASS | **Post** | 0.000 | ft³/min@ | 15.0 | in Hg |
| **Pitot** | **Pre (+)** | 0.025 | in $H_2O$ for | 15.0 | sec |
| < 3.0 | **Pre (-)** | 0.015 | in $H_2O$ for | 15.0 | sec |
| | **Post (+)** | 0.030 | in $H_2O$ for | 15.0 | sec |
| | **Post (-)** | 0.030 | in $H_2O$ for | 15.0 | sec |

| **Sampling Equipment** | | | |
|---|---|---|---|
| **Meter Box Number** | samp-cp-0008 | | |
| **Meter Cal Factor** | (Y) | 0.924 | |
| **Nozzle Number** | samp-cp-0008 | | |
| **Average Nozzle Diameter** | ($D_{na}$) | | in |
| **Suggested Nozzle Diameter** | ($D_{ni}$) | 0.4033 | in |
| **Probe Number** | samp-hp-0003 | | in |
| **Probe Length** | 60 | | in |
| **Liner Material** | inconel | | |
| **Sample Case / Oven Number** | | | |
| **Impinger Case Number** | samp-bh-0016 | | |

| **Pressures** | | | |
|---|---|---|---|
| **Barometric Pressure** | ($P_b$) | 30.09 | in Hg |
| **Stack Static Pressure** | ($P_{static}$) | 0.00 | in $H_2O$ |
| **Absolute Stack Pressure** | ($P_s$) | 30.09 | in Hg |
| **Absolute Meter Pressure** | ($P_m$) | 30.22 | in Hg |

| **Nozzle Measurements** | | | | |
|---|---|---|---|---|
| **Pre** | | | | **PASS** |
| **Post** | | | | **PASS** |

| **Run Time** | | | |
|---|---|---|---|
| **Start** | 14:05 | **End** | 15:07 |

| **Weights** | **Imp 1** | **Imp 2** | **Imp 3** | **Imp 4** | **Imp 5** | **Imp 6** | **Imp 7** | **Imp 8** |
|---|---|---|---|---|---|---|---|---|
| **Pre** | 739.3 | 689.9 | 593.5 | 886.6 | | | | |
| **Post** | 777.8 | 700.9 | 596.5 | 894.9 | | | | |

| **Wash Volumes** | | | | | |
|---|---|---|---|---|---|
| | | | | | ml |
| | | | | | ml |

| **Traverse Point #** | **Sampling Time (Θ)** | **Timer Time** | **Dry Gas Meter Reading ($V_m$)** | **Velocity Head (Δp)** | **Desired Orifice ΔH ($\Delta H_d$)** | **Actual Orifice ΔH ($\Delta H_a$)** | **Stack Temp ($t_s$)** | **Snorkel Temp (248±25°F)** | **Filter Temp (248±25°F)** | **Impinger Exit Temp (≤68°F)** | **Cond. Temp (≤--°F)** | **CPM Filter Temp (--±--°F)** | **Meter Inlet Temp ($t_{mi}$)** | **Meter Outlet Temp ($t_{mo}$)** | **Pump Vacuum** | **Square Root ΔP ($\Delta p^{1/2}$)** | **Local Stack Velocity ($v_s$)$_l$** | **Cumul. Meter Volume ($V_m$)$_{std}$** | **Cumul. Percent IsoKinetic (I)** | **Est-Run Meter Volume ($V_m$)$_{std}$** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | min | hh:mm:ss | ft³ | in $H_2O$ | in $H_2O$ | in $H_2O$ | °F | °F | °F | °F | °F | °F | °F | °F | in Hg | √(in $H_2O$) | ft/sec | dscf | % | dscf |
| A-1 | 0.0 | 00:00:00 | 426.158 | 0.050 | 1.700 | 1.70 | 1606 | 240 | | 69 | | | 81 | 75 | 2.5 | 0.22 | 24.18 | 2.282 | | 45.642 |
| A-2 | 3.0 | 00:03:00 | 428.650 | 0.055 | 1.700 | 1.70 | 1601 | 240 | | 65 | | | 84 | 75 | 2.5 | 0.23 | 25.32 | 4.501 | | 45.012 |
| A-3 | 6.0 | 00:06:00 | 431.080 | 0.055 | 1.700 | 1.70 | 1637 | 240 | | 63 | | | 84 | 75 | 2.5 | 0.23 | 25.55 | 6.757 | | 45.046 |
| A-4 | 9.0 | 00:09:00 | 433.550 | 0.065 | 1.700 | 1.70 | 1694 | 240 | | 64 | | | 83 | 75 | 2.5 | 0.25 | 28.15 | 9.019 | | 45.096 |
| A-5 | 12.0 | 00:12:00 | 436.025 | 0.070 | 1.700 | 1.70 | 1720 | 240 | | 60 | | | 83 | 75 | 2.5 | 0.26 | 29.38 | 11.108 | | 44.431 |
| A-6 | 15.0 | 00:15:00 | 438.310 | 0.070 | 1.700 | 1.70 | 1677 | 240 | | 60 | | | 83 | 75 | 2.5 | 0.26 | 29.09 | 13.334 | | 44.445 |
| A-7 | 18.0 | 00:18:00 | 440.745 | 0.065 | 1.700 | 1.70 | 1713 | 240 | | 60 | | | 82 | 75 | 2.5 | 0.25 | 28.27 | 15.589 | | 44.540 |
| A-8 | 21.0 | 00:21:00 | 443.210 | 0.060 | 1.700 | 1.70 | 1704 | 240 | | 60 | | | 82 | 75 | 2.5 | 0.24 | 27.10 | 17.775 | | 44.439 |
| A-9 | 24.0 | 00:24:00 | 445.600 | 0.055 | 1.700 | 1.70 | 1696 | 240 | | 60 | | | 83 | 75 | 2.5 | 0.23 | 25.90 | 20.024 | | 44.498 |
| A-10 | 27.0 | 00:27:00 | 448.060 | 0.060 | 1.700 | 1.70 | 1661 | 240 | | 60 | | | 85 | 75 | 2.5 | 0.24 | 26.83 | 22.248 | | 44.495 |
| B-1 | 30.0 | 00:30:00 | 450.497 | 0.065 | 1.700 | 1.70 | 1680 | 240 | | 61 | | | 80 | 75 | 2.5 | 0.25 | 28.05 | 24.469 | | 44.488 |
| B-2 | 33.0 | 00:33:00 | 452.920 | 0.070 | 1.700 | 1.70 | 1745 | 240 | | 61 | | | 81 | 75 | 2.5 | 0.26 | 29.55 | 26.689 | | 44.482 |
| B-3 | 36.0 | 00:36:00 | 455.345 | 0.075 | 1.700 | 1.70 | 1721 | 240 | | 61 | | | 81 | 75 | 2.5 | 0.27 | 30.42 | 28.846 | | 44.378 |
| B-4 | 39.0 | 00:39:00 | 457.700 | 0.080 | 1.700 | 1.70 | 1735 | 240 | | 61 | | | 81 | 75 | 2.5 | 0.28 | 31.52 | 31.044 | | 44.348 |
| B-5 | 42.0 | 00:42:00 | 460.100 | 0.080 | 1.700 | 1.70 | 1731 | 240 | | 61 | | | 82 | 75 | 2.5 | 0.28 | 31.49 | 33.194 | | 44.258 |
| B-6 | 45.0 | 00:45:00 | 462.450 | 0.080 | 1.700 | 1.70 | 1699 | 240 | | 61 | | | 83 | 75 | 2.5 | 0.28 | 31.26 | 35.406 | | 44.257 |
| B-7 | 48.0 | 00:48:00 | 464.870 | 0.075 | 1.700 | 1.70 | 1683 | 240 | | 62 | | | 83 | 75 | 2.5 | 0.27 | 30.16 | 37.627 | | 44.267 |
| B-8 | 51.0 | 00:51:00 | 467.300 | 0.065 | 1.700 | 1.70 | 1683 | 240 | | 62 | | | 82 | 74 | 2.5 | 0.25 | 28.07 | 39.825 | | 44.250 |
| B-9 | 54.0 | 00:54:00 | 469.700 | 0.060 | 1.700 | 1.70 | 1648 | 240 | | 62 | | | 83 | 74 | 2.5 | 0.24 | 26.75 | 42.112 | | 44.329 |
| B-10 | 57.0 | 00:57:00 | 472.200 | 0.060 | 1.700 | 1.70 | 1682 | 240 | | 63 | | | 83 | 74 | 2.5 | 0.24 | 26.97 | 44.277 | | 44.277 |
| Last Pt | 60.0 | 01:00:00 | 474.566 | | | | | | | | | | | | | | | | | |
| **Final Val** | 60.0 | 01:00:00 | 474.566 | | | | | | | | | | | **Max Vac** | 2.5 | **Final Values** | | 44.277 | | |
| **Average Values** | | | | 0.07 | | 1.70 | 1686 | 240 | | 62 | | | 82 | 75 | | 0.26 | 28.20 | | | |
| | | | | | | | | | | | | | 79 | | | | | | | |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.8 | % |
| Stack Exhaust Flow (M2) | 291,965 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.20 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 63 | $^{o}$F |
| Specific Humidity | 0.003365 | lb $H_2O$ / lb air |

90-100 Load, Run - 4.0X30PF R10

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/13/14 10:27:04 | 11970 | 13.08 | 0.34 | 0.10 | 5.84 | 227.53 | 86.82 | 3,755.09 |
| | 03/13/14 10:27:34 | 12000 | 13.04 | 0.40 | 0.11 | 5.88 | 226.14 | 86.82 | 3,755.01 |
| | 03/13/14 10:28:04 | 12030 | 13.12 | 2.48 | 0.14 | 5.81 | 230.30 | 87.27 | 3,768.02 |
| | 03/13/14 10:28:34 | 12060 | 13.26 | 11.99 | 0.13 | 5.68 | 232.51 | 87.72 | 3,789.19 |
| | 03/13/14 10:29:04 | 12090 | 13.10 | 19.85 | 0.11 | 5.79 | 227.53 | 87.72 | 3,767.65 |
| | 03/13/14 10:29:34 | 12120 | 13.11 | 7.91 | 0.11 | 5.82 | 225.04 | 87.72 | 3,734.33 |
| | 03/13/14 10:30:04 | 12150 | 13.23 | 1.52 | 0.11 | 5.76 | 224.48 | 87.72 | 3,713.44 |
| | 03/13/14 10:30:34 | 12180 | 13.25 | 0.90 | 0.11 | 5.74 | 224.48 | 87.72 | 3,740.07 |
| | 03/13/14 10:31:04 | 12210 | 12.95 | 0.54 | 0.11 | 5.92 | 228.64 | 88.17 | 3,765.43 |
| | 03/13/14 10:31:34 | 12240 | 13.11 | 0.30 | 0.11 | 5.91 | 227.53 | 88.17 | 3,769.28 |
| | 03/13/14 10:32:04 | 12270 | 13.32 | 0.09 | 0.11 | 5.73 | 228.08 | 88.17 | 3,745.05 |
| | 03/13/14 10:32:34 | 12300 | 13.40 | 0.25 | 0.11 | 5.62 | 226.14 | 88.62 | 3,712.31 |
| | 03/13/14 10:33:04 | 12330 | 13.31 | 0.12 | 0.11 | 5.71 | 229.19 | 88.62 | 3,748.16 |
| | 03/13/14 10:33:34 | 12360 | 13.18 | 0.03 | 0.11 | 5.79 | 227.53 | 88.17 | 3,744.12 |
| | 03/13/14 10:34:04 | 12390 | 13.15 | 0.10 | 0.11 | 5.86 | 227.53 | 88.17 | 3,756.58 |
| | 03/13/14 10:34:34 | 12420 | 12.91 | 0.13 | 0.11 | 5.98 | 230.85 | 88.17 | 3,756.62 |
| | 03/13/14 10:35:04 | 12450 | 13.10 | 0.03 | 0.11 | 5.86 | 230.30 | 88.17 | 3,767.12 |
| | 03/13/14 10:35:34 | 12480 | 13.25 | -0.01 | 0.10 | 5.74 | 230.30 | 88.62 | 3,799.89 |
| | 03/13/14 10:36:04 | 12510 | 13.11 | -0.06 | 0.10 | 5.84 | 234.17 | 88.62 | 3,801.57 |
| | 03/13/14 10:36:34 | 12540 | 13.02 | -0.05 | 0.10 | 5.92 | 237.49 | 89.07 | 3,837.78 |
| | 03/13/14 10:37:04 | 12570 | 13.00 | -0.05 | 0.11 | 5.91 | 246.63 | 89.07 | 3,907.95 |
| | 03/13/14 10:37:34 | 12600 | 12.71 | -0.12 | 0.10 | 6.11 | 249.95 | 89.07 | 3,922.79 |
| | 03/13/14 10:38:04 | 12630 | 12.63 | -0.23 | 0.09 | 6.16 | 247.18 | 89.07 | 3,916.74 |
| | 03/13/14 10:38:34 | 12660 | 12.75 | -0.19 | 0.09 | 6.10 | 247.18 | 89.07 | 3,957.04 |
| | 03/13/14 10:39:04 | 12690 | 12.52 | -0.17 | 0.09 | 6.26 | 250.50 | 89.07 | 3,945.29 |
| | 03/13/14 10:39:34 | 12720 | 12.75 | -0.16 | 0.10 | 6.10 | 249.95 | 89.52 | 3,967.17 |
| | 03/13/14 10:40:04 | 12750 | 12.73 | -0.21 | 0.10 | 6.12 | 250.78 | 89.52 | 3,973.99 |
| | 03/13/14 10:40:34 | 12780 | 12.56 | -0.18 | 0.10 | 6.19 | 260.19 | 89.07 | 4,023.75 |
| | 03/13/14 10:41:04 | 12810 | 12.68 | -0.20 | 0.10 | 6.14 | 259.64 | 89.07 | 4,023.30 |
| | 03/13/14 10:41:34 | 12840 | 12.71 | -0.21 | 0.10 | 6.08 | 256.32 | 89.52 | 4,013.80 |
| | 03/13/14 10:42:04 | 12870 | 12.59 | -0.25 | 0.10 | 6.14 | 261.85 | 89.52 | 4,068.54 |
| | 03/13/14 10:42:34 | 12900 | 12.25 | -0.24 | 0.09 | 6.43 | 263.79 | 89.97 | 4,087.00 |
| | 03/13/14 10:43:04 | 12930 | 12.55 | -0.27 | 0.10 | 6.25 | 270.43 | 89.52 | 4,119.73 |
| | 03/13/14 10:43:34 | 12960 | 12.55 | -0.25 | 0.09 | 6.24 | 269.88 | 89.52 | 4,139.69 |
| | 03/13/14 10:44:04 | 12990 | 12.52 | -0.28 | 0.09 | 6.27 | 267.11 | 89.97 | 4,082.32 |
| | 03/13/14 10:44:34 | 13020 | 12.60 | -0.25 | 0.09 | 6.13 | 263.24 | 89.97 | 4,065.42 |
| | 03/13/14 10:45:04 | 13050 | 12.58 | -0.28 | 0.08 | 6.13 | 265.45 | 89.52 | 4,068.93 |
| | 03/13/14 10:45:34 | 13080 | 12.64 | -0.27 | 0.08 | 6.11 | 266.56 | 89.97 | 4,097.08 |
| | 03/13/14 10:46:04 | 13110 | 12.28 | -0.30 | 0.08 | 6.38 | 269.88 | 89.97 | 4,102.96 |
| | 03/13/14 10:46:34 | 13140 | 12.17 | -0.27 | 0.08 | 6.54 | 272.65 | 89.97 | 4,142.69 |
| | 03/13/14 10:47:04 | 13170 | 12.45 | -0.23 | 0.11 | 6.27 | 270.99 | 89.97 | 4,119.18 |
| | 03/13/14 10:47:34 | 13200 | 12.66 | -0.24 | 0.10 | 6.21 | 266.56 | 89.97 | 4,090.16 |
| A2 | 03/13/14 10:48:04 | 13230 | 12.92 | -0.25 | 0.08 | 6.12 | 266.00 | 89.97 | 4,057.40 |
| | 03/13/14 10:48:34 | 13260 | 12.70 | -0.27 | 0.09 | 6.15 | 264.90 | 90.42 | 4,090.18 |
| | 03/13/14 10:49:04 | 13290 | 12.38 | -0.31 | 0.10 | 6.36 | 270.99 | 90.42 | 4,120.64 |
| | 03/13/14 10:49:34 | 13320 | 12.51 | -0.27 | 0.09 | 6.27 | 269.88 | 90.42 | 4,140.90 |
| | 03/13/14 10:50:04 | 13350 | 12.60 | -0.21 | 0.10 | 6.12 | 266.56 | 90.87 | 4,093.34 |
| | 03/13/14 10:50:34 | 13380 | 12.57 | -0.20 | 0.09 | 6.16 | 264.34 | 91.32 | 4,073.29 |
| | 03/13/14 10:51:04 | 13410 | 12.65 | -0.17 | 0.09 | 6.10 | 259.64 | 91.32 | 4,056.99 |
| | 03/13/14 10:51:34 | 13440 | 12.58 | -0.15 | 0.09 | 6.15 | 264.34 | 90.87 | 4,073.88 |
| | 03/13/14 10:52:04 | 13470 | 12.61 | -0.18 | 0.10 | 6.13 | 265.45 | 90.87 | 4,086.88 |
| | 03/13/14 10:52:34 | 13500 | 12.66 | -0.19 | 0.10 | 6.09 | 267.66 | 91.32 | 4,119.72 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.8 | % |
| Stack Exhaust Flow (M2) | 291,965 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.20 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 63 | $^{o}$F |
| Specific Humidity | 0.003365 | lb $H_2O$ / lb air |

90-100 Load, Run - 4.0X30PF R10

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/13/14 10:53:04 | 13530 | 12.54 | -0.19 | 0.10 | 6.17 | 268.77 | 91.77 | 4,093.31 |
| | 03/13/14 10:53:34 | 13560 | 12.55 | -0.21 | 0.09 | 6.22 | 263.79 | 91.77 | 4,081.34 |
| | 03/13/14 10:54:04 | 13590 | 12.66 | -0.21 | 0.08 | 6.16 | 263.79 | 92.21 | 4,063.11 |
| | 03/13/14 10:54:34 | 13620 | 12.56 | -0.19 | 0.09 | 6.21 | 267.66 | 92.21 | 4,105.21 |
| | 03/13/14 10:55:04 | 13650 | 12.53 | -0.21 | 0.09 | 6.23 | 267.66 | 92.21 | 4,092.80 |
| | 03/13/14 10:55:34 | 13680 | 12.46 | -0.21 | 0.09 | 6.26 | 268.77 | 92.21 | 4,122.84 |
| | 03/13/14 10:56:04 | 13710 | 12.52 | -0.23 | 0.09 | 6.24 | 268.77 | 92.21 | 4,136.02 |
| | 03/13/14 10:56:34 | 13740 | 12.42 | -0.22 | 0.09 | 6.29 | 267.66 | 92.66 | 4,089.00 |
| | 03/13/14 10:57:04 | 13770 | 12.50 | -0.23 | 0.08 | 6.24 | 264.90 | 92.66 | 4,108.77 |
| | 03/13/14 10:57:34 | 13800 | 12.54 | -0.20 | 0.08 | 6.21 | 267.11 | 92.66 | 4,092.94 |
| | 03/13/14 10:58:04 | 13830 | 12.50 | -0.16 | 0.09 | 6.29 | 267.11 | 92.66 | 4,119.43 |
| | 03/13/14 10:58:34 | 13860 | 12.41 | -0.18 | 0.09 | 6.42 | 270.43 | 92.21 | 4,122.52 |
| | 03/13/14 10:59:04 | 13890 | 12.63 | -0.22 | 0.09 | 6.17 | 267.11 | 92.66 | 4,107.49 |
| | 03/13/14 10:59:34 | 13920 | 12.55 | -0.18 | 0.09 | 6.20 | 263.24 | 92.66 | 4,085.22 |
| | 03/13/14 11:00:04 | 13950 | 12.56 | -0.16 | 0.09 | 6.20 | 263.24 | 92.66 | 4,081.45 |
| | 03/13/14 11:00:34 | 13980 | 12.55 | -0.17 | 0.09 | 6.20 | 266.56 | 93.11 | 4,084.73 |
| | 03/13/14 11:01:04 | 14010 | 12.51 | -0.20 | 0.09 | 6.21 | 267.66 | 93.11 | 4,099.39 |
| | 03/13/14 11:01:34 | 14040 | 12.64 | -0.23 | 0.09 | 6.24 | 271.54 | 93.56 | 4,114.34 |
| | 03/13/14 11:02:04 | 14070 | 12.92 | -0.28 | 0.08 | 6.35 | 267.66 | 94.01 | 4,105.35 |
| | 03/13/14 11:02:34 | 14100 | 12.60 | -0.26 | 0.08 | 6.25 | 264.34 | 94.01 | 4,079.31 |
| | 03/13/14 11:03:04 | 14130 | 12.57 | -0.25 | 0.09 | 6.21 | 265.45 | 94.46 | 4,088.71 |
| | 03/13/14 11:03:34 | 14160 | 12.52 | -0.23 | 0.08 | 6.22 | 265.45 | 94.91 | 4,075.05 |
| | 03/13/14 11:04:04 | 14190 | 12.55 | -0.22 | 0.09 | 6.20 | 267.11 | 94.91 | 4,118.71 |
| | 03/13/14 11:04:34 | 14220 | 12.34 | -0.27 | 0.08 | 6.38 | 266.00 | 94.91 | 4,102.10 |
| | 03/13/14 11:05:04 | 14250 | 12.47 | -0.28 | 0.08 | 6.26 | 263.79 | 94.91 | 4,093.44 |
| | 03/13/14 11:05:34 | 14280 | 12.45 | -0.26 | 0.08 | 6.27 | 262.13 | 94.91 | 4,060.47 |
| | 03/13/14 11:06:04 | 14310 | 12.53 | -0.25 | 0.08 | 6.18 | 263.79 | 94.91 | 4,070.26 |
| | 03/13/14 11:06:34 | 14340 | 12.51 | -0.26 | 0.08 | 6.19 | 263.24 | 95.47 | 4,083.07 |
| | 03/13/14 11:07:04 | 14370 | 12.46 | -0.24 | 0.09 | 6.25 | 266.56 | 95.47 | 4,119.01 |
| | 03/13/14 11:07:34 | 14400 | 12.48 | -0.27 | 0.08 | 6.26 | 268.22 | 95.47 | 4,120.17 |
| A3 | 03/13/14 11:08:04 | 14430 | 12.75 | -0.25 | 0.08 | 6.10 | 267.11 | 95.47 | 4,094.60 |
| | 03/13/14 11:08:34 | 14460 | 13.04 | -0.04 | 0.09 | 5.86 | 264.90 | 95.47 | 4,082.32 |
| | 03/13/14 11:09:04 | 14490 | 13.10 | 0.29 | 0.08 | 5.80 | 267.11 | 95.47 | 4,084.97 |
| | 03/13/14 11:09:34 | 14520 | 13.09 | 0.40 | 0.09 | 5.78 | 264.34 | 95.47 | 4,094.93 |
| | 03/13/14 11:10:04 | 14550 | 12.98 | 0.22 | 0.09 | 5.88 | 268.22 | 95.81 | 4,094.73 |
| | 03/13/14 11:10:34 | 14580 | 13.06 | 0.20 | 0.09 | 5.83 | 267.11 | 95.81 | 4,099.77 |
| | 03/13/14 11:11:04 | 14610 | 13.00 | 0.45 | 0.08 | 5.89 | 264.34 | 95.47 | 4,080.27 |
| | 03/13/14 11:11:34 | 14640 | 13.14 | 0.30 | 0.09 | 5.83 | 267.11 | 95.81 | 4,079.71 |
| | 03/13/14 11:12:04 | 14670 | 13.30 | 0.21 | 0.08 | 5.74 | 263.24 | 96.71 | 4,075.22 |
| | 03/13/14 11:12:34 | 14700 | 13.05 | -0.02 | 0.09 | 5.89 | 267.66 | 96.71 | 4,122.11 |
| | 03/13/14 11:13:04 | 14730 | 13.23 | 0.16 | 0.09 | 6.07 | 267.11 | 97.16 | 4,108.00 |
| | 03/13/14 11:13:34 | 14760 | 12.95 | -0.04 | 0.08 | 6.21 | 267.66 | 97.16 | 4,090.57 |
| | 03/13/14 11:14:04 | 14790 | 13.28 | -0.03 | 0.09 | 5.87 | 263.24 | 98.06 | 4,070.15 |
| | 03/13/14 11:14:34 | 14820 | 12.97 | -0.08 | 0.09 | 5.98 | 264.34 | 98.06 | 4,063.27 |
| | 03/13/14 11:15:04 | 14850 | 12.97 | -0.16 | 0.08 | 6.02 | 264.34 | 98.51 | 4,053.38 |
| | 03/13/14 11:15:34 | 14880 | 13.05 | -0.17 | 0.08 | 5.93 | 267.66 | 98.51 | 4,086.70 |
| | 03/13/14 11:16:04 | 14910 | 12.83 | -0.13 | 0.08 | 6.01 | 265.45 | 98.51 | 4,086.12 |
| | 03/13/14 11:16:34 | 14940 | 12.84 | -0.18 | 0.08 | 6.02 | 264.34 | 98.51 | 4,084.08 |
| | 03/13/14 11:17:04 | 14970 | 13.13 | 0.11 | 0.08 | 5.79 | 264.90 | 98.51 | 4,074.04 |
| | 03/13/14 11:17:34 | 15000 | 13.10 | -0.02 | 0.08 | 5.87 | 266.00 | 98.96 | 4,062.07 |
| | 03/13/14 11:18:04 | 15030 | 13.06 | 0.09 | 0.09 | 5.87 | 265.45 | 99.40 | 4,056.51 |
| | 03/13/14 11:18:34 | 15060 | 13.06 | 0.04 | 0.09 | 5.96 | 269.33 | 99.40 | 4,096.05 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 5.8 | % |
| Stack Exhaust Flow (M2) | 291,965 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.20 | in. Hg |
| Relative Humidity | 28 | % |
| Ambient Temperature | 63 | $^{o}$F |
| Specific Humidity | 0.003365 | lb $H_2O$ / lb air |

90-100 Load, Run - 4.0X30PF R10

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/13/14 11:19:04 | 15090 | 13.06 | 0.03 | 0.09 | 5.89 | 267.11 | 99.40 | 4,091.29 |
| 03/13/14 11:19:34 | 15120 | 12.82 | 0.02 | 0.10 | 6.05 | 267.66 | 99.40 | 4,088.38 |
| 03/13/14 11:20:04 | 15150 | 12.99 | -0.10 | 0.08 | 5.89 | 262.13 | 99.85 | 4,062.27 |
| 03/13/14 11:20:34 | 15180 | 12.92 | -0.14 | 0.08 | 5.97 | 263.24 | 99.85 | 4,058.08 |
| 03/13/14 11:21:04 | 15210 | 13.09 | 0.05 | 0.09 | 5.86 | 263.24 | 99.85 | 4,051.62 |
| 03/13/14 11:21:34 | 15240 | 12.99 | 0.14 | 0.09 | 5.90 | 267.66 | 99.40 | 4,093.11 |
| 03/13/14 11:22:04 | 15270 | 13.06 | 0.24 | 0.09 | 5.83 | 267.11 | 98.96 | 4,091.46 |
| 03/13/14 11:22:34 | 15300 | 12.89 | 0.28 | 0.08 | 5.97 | 268.22 | 98.51 | 4,081.41 |
| 03/13/14 11:23:04 | 15330 | 12.93 | 0.39 | 0.07 | 5.93 | 262.68 | 98.51 | 4,059.00 |
| 03/13/14 11:23:34 | 15360 | 13.17 | 0.31 | 0.07 | 5.79 | 262.68 | 98.51 | 4,058.21 |
| 03/13/14 11:24:04 | 15390 | 13.26 | 0.46 | 0.10 | 5.68 | 265.45 | 98.96 | 4,046.47 |
| 03/13/14 11:24:34 | 15420 | 13.09 | 0.27 | 0.09 | 5.82 | 269.33 | 98.96 | 4,098.47 |
| 03/13/14 11:25:04 | 15450 | 13.05 | 0.21 | 0.07 | 5.90 | 270.99 | 98.96 | 4,092.71 |
| 03/13/14 11:25:34 | 15480 | 13.06 | 0.18 | 0.08 | 5.83 | 268.22 | 98.96 | 4,075.69 |
| 03/13/14 11:26:04 | 15510 | 13.22 | 0.29 | 0.08 | 5.73 | 266.56 | 98.96 | 4,070.62 |
| 03/13/14 11:26:34 | 15540 | 13.31 | 0.68 | 0.08 | 5.63 | 262.68 | 98.96 | 4,061.63 |
| 03/13/14 11:27:04 | 15570 | 13.22 | 0.47 | 0.08 | 5.71 | 266.00 | 99.40 | 4,054.84 |
| **RAW AVERAGE** | | **12.82** | **0.32** | **0.09** | **6.04** | **258.87** | **93.11** | **4,024.51** |

| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | **(%)** | **(ppmvd)** | **(ppmvw)** | **(%)** | **(in. $H_2O$)** | **($^{o}$F)** | **(SCFH)** |
| **Bias** | **Initial Zero** | 0.12 | 0.04 | 0.03 | 0.06 | | | |
| | **Final Zero** | 0.09 | 0.07 | 0.03 | 0.08 | | | |
| | **Avg. Zero** | 0.11 | 0.06 | 0.03 | 0.07 | | | |
| | **Initial UpScale** | 12.01 | 9.00 | 3.00 | 9.42 | | | |
| | **Final UpScale** | 11.97 | 9.11 | 3.05 | 9.44 | | | |
| | **Avg. UpScale** | 11.99 | 9.06 | 3.03 | 9.43 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| EMISSIONS DATA | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.84 | 0.26 | 0.06 | 6.01 |
| **Corrected Raw Average (ppm/% wet basis)** | 12.08 | 0.24 | 0.06 | 5.65 |
| **Emission Rate (lb/hr)** | N/A | 0.01 | 0.00 | N/A |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 284,219 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.15 | in. Hg |
| Relative Humidity | 17 | % |
| Ambient Temperature | 66 | $^{o}$F |
| Specific Humidity | 0.002269 | lb $H_2O$ / lb air |

90-100 Load, Run - 4.0X30PF R11

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/13/14 12:50:04 | 20550 | 12.79 | -0.43 | 0.09 | 5.98 | 231.40 | 101.20 | 3,735.55 |
| | 03/13/14 12:50:34 | 20580 | 12.74 | -0.42 | 0.09 | 6.03 | 229.74 | 101.20 | 3,740.99 |
| | 03/13/14 12:51:04 | 20610 | 12.89 | -0.38 | 0.07 | 5.87 | 229.19 | 101.20 | 3,724.68 |
| | 03/13/14 12:51:34 | 20640 | 12.36 | -0.42 | 0.09 | 6.34 | 231.96 | 100.75 | 3,755.28 |
| | 03/13/14 12:52:04 | 20670 | 13.00 | -0.43 | 0.10 | 5.95 | 231.40 | 101.20 | 3,766.66 |
| | 03/13/14 12:52:34 | 20700 | 13.03 | -0.38 | 0.08 | 5.83 | 230.85 | 101.65 | 3,756.30 |
| | 03/13/14 12:53:04 | 20730 | 12.73 | -0.42 | 0.09 | 6.06 | 232.51 | 102.10 | 3,745.08 |
| | 03/13/14 12:53:34 | 20760 | 12.80 | -0.43 | 0.09 | 6.04 | 228.08 | 102.10 | 3,736.62 |
| | 03/13/14 12:54:04 | 20790 | 12.58 | -0.45 | 0.08 | 6.19 | 229.74 | 102.10 | 3,722.31 |
| | 03/13/14 12:54:34 | 20820 | 12.69 | -0.44 | 0.08 | 6.12 | 231.40 | 102.10 | 3,759.87 |
| | 03/13/14 12:55:04 | 20850 | 12.45 | -0.45 | 0.08 | 6.32 | 234.17 | 101.65 | 3,764.43 |
| | 03/13/14 12:55:34 | 20880 | 12.83 | -0.45 | 0.09 | 6.04 | 233.62 | 101.65 | 3,763.33 |
| | 03/13/14 12:56:04 | 20910 | 12.60 | -0.45 | 0.07 | 6.13 | 231.96 | 101.65 | 3,750.37 |
| | 03/13/14 12:56:34 | 20940 | 12.44 | -0.46 | 0.07 | 6.32 | 229.19 | 101.65 | 3,741.50 |
| | 03/13/14 12:57:04 | 20970 | 12.71 | -0.44 | 0.08 | 6.17 | 229.19 | 101.65 | 3,735.84 |
| | 03/13/14 12:57:34 | 21000 | 12.70 | -0.42 | 0.08 | 6.15 | 230.30 | 102.10 | 3,738.77 |
| | 03/13/14 12:58:04 | 21030 | 12.71 | -0.44 | 0.08 | 6.12 | 231.96 | 102.10 | 3,771.48 |
| | 03/13/14 12:58:34 | 21060 | 12.91 | -0.43 | 0.09 | 6.01 | 231.40 | 102.55 | 3,756.84 |
| | 03/13/14 12:59:04 | 21090 | 13.03 | -0.40 | 0.10 | 5.88 | 233.62 | 102.55 | 3,774.54 |
| | 03/13/14 12:59:34 | 21120 | 12.99 | -0.41 | 0.09 | 5.92 | 236.39 | 103.00 | 3,799.76 |
| | 03/13/14 13:00:04 | 21150 | 13.01 | -0.44 | 0.09 | 5.93 | 236.94 | 103.45 | 3,814.30 |
| | 03/13/14 13:00:34 | 21180 | 12.78 | -0.02 | 0.09 | 6.02 | 243.31 | 103.45 | 3,836.22 |
| | 03/13/14 13:01:04 | 21210 | 12.37 | -0.03 | 0.09 | 6.26 | 246.63 | 104.35 | 3,862.31 |
| | 03/13/14 13:01:34 | 21240 | 12.43 | -0.04 | 0.08 | 6.32 | 245.52 | 104.80 | 3,866.59 |
| | 03/13/14 13:02:04 | 21270 | 12.57 | -0.04 | 0.09 | 6.21 | 243.31 | 104.35 | 3,853.31 |
| | 03/13/14 13:02:34 | 21300 | 12.59 | -0.01 | 0.09 | 6.15 | 249.95 | 104.35 | 3,923.70 |
| | 03/13/14 13:03:04 | 21330 | 12.62 | -0.01 | 0.09 | 6.16 | 254.66 | 104.35 | 3,928.19 |
| | 03/13/14 13:03:34 | 21360 | 12.17 | -0.03 | 0.09 | 6.43 | 261.85 | 103.90 | 4,003.52 |
| | 03/13/14 13:04:04 | 21390 | 12.51 | -0.04 | 0.10 | 6.21 | 264.90 | 103.90 | 4,026.67 |
| | 03/13/14 13:04:34 | 21420 | 12.57 | -0.03 | 0.09 | 6.17 | 259.08 | 104.35 | 3,962.05 |
| | 03/13/14 13:05:04 | 21450 | 12.41 | -0.03 | 0.08 | 6.28 | 267.11 | 104.35 | 4,060.43 |
| | 03/13/14 13:05:34 | 21480 | 11.94 | -0.07 | 0.08 | 6.61 | 267.11 | 103.90 | 4,085.39 |
| | 03/13/14 13:06:04 | 21510 | 11.87 | -0.07 | 0.09 | 6.73 | 273.20 | 103.90 | 4,099.28 |
| | 03/13/14 13:06:34 | 21540 | 12.21 | -0.07 | 0.08 | 6.50 | 274.58 | 104.80 | 4,121.76 |
| | 03/13/14 13:07:04 | 21570 | 12.29 | -0.04 | 0.08 | 6.45 | 272.09 | 104.80 | 4,093.44 |
| | 03/13/14 13:07:34 | 21600 | 12.29 | -0.01 | 0.08 | 6.42 | 269.33 | 104.80 | 4,075.55 |
| | 03/13/14 13:08:04 | 21630 | 12.30 | -0.01 | 0.09 | 6.41 | 268.77 | 105.25 | 4,068.85 |
| | 03/13/14 13:08:34 | 21660 | 12.06 | -0.01 | 0.08 | 6.58 | 266.56 | 104.80 | 4,057.37 |
| | 03/13/14 13:09:04 | 21690 | 11.86 | -0.02 | 0.08 | 6.71 | 263.79 | 103.90 | 4,036.75 |
| | 03/13/14 13:09:34 | 21720 | 11.75 | -0.01 | 0.08 | 6.82 | 269.33 | 103.45 | 4,068.51 |
| | 03/13/14 13:10:04 | 21750 | 12.13 | -0.05 | 0.06 | 6.56 | 270.99 | 103.45 | 4,090.31 |
| | 03/13/14 13:10:34 | 21780 | 12.28 | -0.02 | 0.07 | 6.46 | 271.54 | 103.90 | 4,097.52 |
| A2 | 03/13/14 13:11:04 | 21810 | 12.30 | 0.02 | 0.07 | 6.43 | 270.99 | 104.35 | 4,082.16 |
| | 03/13/14 13:11:34 | 21840 | 12.28 | 0.03 | 0.07 | 6.45 | 268.77 | 103.90 | 4,065.99 |
| | 03/13/14 13:12:04 | 21870 | 12.15 | 0.01 | 0.07 | 6.39 | 263.24 | 103.45 | 4,060.43 |
| | 03/13/14 13:12:34 | 21900 | 12.06 | -0.01 | 0.08 | 6.51 | 268.77 | 103.45 | 4,078.69 |
| | 03/13/14 13:13:04 | 21930 | 12.13 | -0.02 | 0.08 | 6.43 | 268.22 | 103.45 | 4,099.39 |
| | 03/13/14 13:13:34 | 21960 | 12.33 | -0.05 | 0.08 | 6.34 | 269.33 | 103.90 | 4,088.93 |
| | 03/13/14 13:14:04 | 21990 | 12.33 | 0.01 | 0.09 | 6.32 | 267.11 | 104.35 | 4,077.20 |
| | 03/13/14 13:14:34 | 22020 | 12.38 | -0.04 | 0.09 | 6.28 | 268.77 | 104.35 | 4,062.99 |
| | 03/13/14 13:15:04 | 22050 | 12.57 | 0.01 | 0.09 | 6.16 | 265.45 | 104.80 | 4,051.77 |
| | 03/13/14 13:15:34 | 22080 | 12.51 | 0.04 | 0.08 | 6.19 | 268.22 | 104.35 | 4,062.40 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 284,219 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.15 | in. Hg |
| Relative Humidity | 17 | % |
| Ambient Temperature | 66 | $^{o}$F |
| Specific Humidity | 0.002269 | lb $H_2O$ / lb air |

90-100 Load, Run - 4.0X30PF R11

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/13/14 13:16:04 | 22110 | 12.53 | 0.06 | 0.08 | 6.20 | 270.43 | 104.80 | 4,093.72 |
| | 03/13/14 13:16:34 | 22140 | 12.42 | 0.03 | 0.08 | 6.25 | 271.54 | 105.25 | 4,082.63 |
| | 03/13/14 13:17:04 | 22170 | 12.40 | 0.01 | 0.09 | 6.28 | 270.43 | 104.80 | 4,073.41 |
| | 03/13/14 13:17:34 | 22200 | 12.41 | 0.02 | 0.08 | 6.32 | 265.45 | 105.25 | 4,071.90 |
| | 03/13/14 13:18:04 | 22230 | 12.49 | 0.02 | 0.08 | 6.29 | 266.56 | 105.25 | 4,058.10 |
| | 03/13/14 13:18:34 | 22260 | 12.38 | 0.06 | 0.08 | 6.36 | 266.00 | 105.25 | 4,075.31 |
| | 03/13/14 13:19:04 | 22290 | 12.50 | 0.05 | 0.08 | 6.27 | 270.99 | 105.25 | 4,096.53 |
| | 03/13/14 13:19:34 | 22320 | 12.35 | 0.03 | 0.08 | 6.38 | 268.22 | 104.80 | 4,086.50 |
| | 03/13/14 13:20:04 | 22350 | 12.35 | 0.00 | 0.07 | 6.40 | 267.66 | 104.35 | 4,080.66 |
| | 03/13/14 13:20:34 | 22380 | 12.44 | 0.02 | 0.07 | 6.35 | 268.77 | 104.80 | 4,064.54 |
| | 03/13/14 13:21:04 | 22410 | 12.52 | 0.03 | 0.08 | 6.25 | 263.79 | 104.35 | 4,053.26 |
| | 03/13/14 13:21:34 | 22440 | 12.45 | 0.09 | 0.08 | 6.31 | 267.11 | 104.35 | 4,066.20 |
| | 03/13/14 13:22:04 | 22470 | 12.33 | 0.03 | 0.07 | 6.41 | 270.43 | 104.35 | 4,096.64 |
| | 03/13/14 13:22:34 | 22500 | 12.35 | -0.01 | 0.07 | 6.38 | 268.77 | 103.90 | 4,084.68 |
| | 03/13/14 13:23:04 | 22530 | 12.45 | 0.02 | 0.07 | 6.32 | 267.66 | 104.35 | 4,077.02 |
| | 03/13/14 13:23:34 | 22560 | 12.52 | 0.04 | 0.07 | 6.27 | 268.22 | 104.80 | 4,065.76 |
| | 03/13/14 13:24:04 | 22590 | 12.47 | 0.06 | 0.07 | 6.31 | 264.90 | 104.80 | 4,051.67 |
| | 03/13/14 13:24:34 | 22620 | 12.47 | 0.03 | 0.07 | 6.31 | 271.54 | 104.80 | 4,093.95 |
| | 03/13/14 13:25:04 | 22650 | 12.23 | 0.00 | 0.08 | 6.48 | 272.09 | 104.35 | 4,113.95 |
| | 03/13/14 13:25:34 | 22680 | 12.90 | 0.06 | 0.08 | 6.04 | 272.09 | 104.80 | 4,102.71 |
| | 03/13/14 13:26:04 | 22710 | 12.59 | 0.27 | 0.07 | 6.20 | 269.33 | 104.35 | 4,088.70 |
| | 03/13/14 13:26:34 | 22740 | 12.73 | 0.34 | 0.07 | 6.17 | 268.22 | 104.35 | 4,085.88 |
| | 03/13/14 13:27:04 | 22770 | 12.75 | 0.29 | 0.08 | 6.13 | 266.00 | 104.35 | 4,077.64 |
| | 03/13/14 13:27:34 | 22800 | 12.65 | 0.24 | 0.09 | 6.21 | 271.54 | 104.35 | 4,081.85 |
| | 03/13/14 13:28:04 | 22830 | 12.77 | 0.18 | 0.08 | 6.14 | 271.54 | 104.80 | 4,107.59 |
| | 03/13/14 13:28:34 | 22860 | 12.90 | 0.27 | 0.07 | 6.04 | 272.09 | 104.80 | 4,101.95 |
| | 03/13/14 13:29:04 | 22890 | 12.94 | 0.32 | 0.07 | 6.00 | 271.54 | 105.25 | 4,095.32 |
| | 03/13/14 13:29:34 | 22920 | 12.83 | 0.41 | 0.08 | 6.07 | 270.43 | 104.80 | 4,081.47 |
| | 03/13/14 13:30:04 | 22950 | 12.81 | 0.36 | 0.08 | 6.12 | 267.11 | 104.80 | 4,076.85 |
| | 03/13/14 13:30:34 | 22980 | 12.89 | 0.34 | 0.08 | 6.04 | 270.99 | 104.80 | 4,109.19 |
| A3 | 03/13/14 13:31:04 | 23010 | 12.89 | 0.31 | 0.08 | 6.00 | 274.58 | 104.80 | 4,111.34 |
| | 03/13/14 13:31:34 | 23040 | 12.79 | 0.15 | 0.08 | 6.13 | 273.20 | 105.25 | 4,109.49 |
| | 03/13/14 13:32:04 | 23070 | 12.89 | 0.23 | 0.08 | 6.05 | 267.66 | 105.25 | 4,091.63 |
| | 03/13/14 13:32:34 | 23100 | 12.74 | 0.41 | 0.07 | 6.15 | 268.22 | 104.80 | 4,073.63 |
| | 03/13/14 13:33:04 | 23130 | 12.76 | 0.42 | 0.07 | 6.07 | 266.00 | 104.80 | 4,082.82 |
| | 03/13/14 13:33:34 | 23160 | 12.64 | 0.28 | 0.07 | 6.19 | 273.75 | 104.35 | 4,115.90 |
| | 03/13/14 13:34:04 | 23190 | 12.40 | 0.30 | 0.08 | 6.33 | 271.54 | 103.90 | 4,104.19 |
| | 03/13/14 13:34:34 | 23220 | 12.52 | 0.15 | 0.08 | 6.30 | 270.99 | 103.90 | 4,082.60 |
| | 03/13/14 13:35:04 | 23250 | 12.61 | 0.18 | 0.07 | 6.19 | 269.33 | 103.90 | 4,070.21 |
| | 03/13/14 13:35:34 | 23280 | 12.78 | 0.22 | 0.08 | 6.05 | 267.66 | 103.90 | 4,058.27 |
| | 03/13/14 13:36:04 | 23310 | 12.80 | 0.24 | 0.08 | 6.00 | 269.88 | 103.90 | 4,094.05 |
| | 03/13/14 13:36:34 | 23340 | 12.63 | 0.23 | 0.08 | 6.17 | 271.54 | 103.90 | 4,107.28 |
| | 03/13/14 13:37:04 | 23370 | 12.87 | 0.26 | 0.07 | 5.92 | 269.33 | 103.90 | 4,100.47 |
| | 03/13/14 13:37:34 | 23400 | 12.69 | 0.32 | 0.09 | 6.15 | 268.22 | 103.00 | 4,081.29 |
| | 03/13/14 13:38:04 | 23430 | 12.50 | 0.32 | 0.07 | 6.26 | 266.56 | 102.55 | 4,079.72 |
| | 03/13/14 13:38:34 | 23460 | 12.30 | 0.23 | 0.07 | 6.39 | 268.22 | 102.55 | 4,089.56 |
| | 03/13/14 13:39:04 | 23490 | 12.39 | 0.12 | 0.06 | 6.34 | 274.03 | 102.10 | 4,126.07 |
| | 03/13/14 13:39:34 | 23520 | 12.59 | 0.19 | 0.08 | 6.25 | 275.69 | 102.55 | 4,133.75 |
| | 03/13/14 13:40:04 | 23550 | 12.79 | 0.22 | 0.08 | 6.09 | 269.33 | 103.00 | 4,089.95 |
| | 03/13/14 13:40:34 | 23580 | 12.95 | 0.23 | 0.08 | 5.98 | 267.11 | 103.00 | 4,077.70 |
| | 03/13/14 13:41:04 | 23610 | 12.91 | 0.34 | 0.07 | 5.99 | 266.56 | 103.00 | 4,055.34 |
| | 03/13/14 13:41:34 | 23640 | 13.08 | 0.43 | 0.07 | 5.88 | 266.56 | 103.45 | 4,049.01 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.4 | % |
| Stack Exhaust Flow (M2) | 284,219 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.15 | in. Hg |
| Relative Humidity | 17 | % |
| Ambient Temperature | 66 | $^{o}$F |
| Specific Humidity | 0.002269 | lb $H_2O$ / lb air |

90-100 Load, Run - 4.0X30PF R11

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/13/14 13:42:04 | 23670 | 13.04 | 0.53 | 0.07 | 5.86 | 268.22 | 103.45 | 4,087.45 |
| 03/13/14 13:42:34 | 23700 | 12.96 | 0.44 | 0.08 | 5.91 | 268.22 | 103.00 | 4,097.17 |
| 03/13/14 13:43:04 | 23730 | 12.65 | 0.31 | 0.07 | 6.18 | 268.77 | 103.00 | 4,077.63 |
| 03/13/14 13:43:34 | 23760 | 12.89 | 0.31 | 0.08 | 5.97 | 264.34 | 103.00 | 4,072.89 |
| 03/13/14 13:44:04 | 23790 | 12.71 | 0.26 | 0.07 | 6.15 | 264.90 | 103.00 | 4,054.79 |
| 03/13/14 13:44:34 | 23820 | 13.02 | 0.30 | 0.07 | 5.89 | 263.79 | 103.00 | 4,049.76 |
| 03/13/14 13:45:04 | 23850 | 12.86 | 0.35 | 0.07 | 5.99 | 269.88 | 103.45 | 4,092.71 |
| 03/13/14 13:45:34 | 23880 | 12.76 | 0.21 | 0.07 | 6.12 | 268.22 | 103.45 | 4,091.79 |
| 03/13/14 13:46:04 | 23910 | 13.08 | 0.29 | 0.07 | 5.86 | 268.22 | 103.90 | 4,078.48 |
| 03/13/14 13:46:34 | 23940 | 12.93 | 0.39 | 0.07 | 5.93 | 266.00 | 103.90 | 4,066.59 |
| 03/13/14 13:47:04 | 23970 | 12.95 | 0.28 | 0.07 | 5.97 | 266.00 | 104.35 | 4,063.98 |
| 03/13/14 13:47:34 | 24000 | 13.21 | 0.38 | 0.07 | 5.77 | 264.34 | 104.35 | 4,061.34 |
| 03/13/14 13:48:04 | 24030 | 13.01 | 0.41 | 0.07 | 5.84 | 274.58 | 104.35 | 4,109.16 |
| 03/13/14 13:48:34 | 24060 | 12.68 | 0.29 | 0.07 | 6.16 | 275.14 | 103.90 | 4,107.51 |
| 03/13/14 13:49:04 | 24090 | 12.85 | 0.32 | 0.08 | 6.04 | 272.65 | 104.35 | 4,105.40 |
| 03/13/14 13:49:34 | 24120 | 12.96 | 0.42 | 0.08 | 5.89 | 269.33 | 104.35 | 4,083.90 |
| 03/13/14 13:50:04 | 24150 | 12.88 | 0.29 | 0.07 | 6.02 | 270.99 | 104.35 | 4,089.20 |
| **RAW AVERAGE** | | **12.60** | **0.05** | **0.08** | **6.19** | **261.31** | **103.76** | **4,013.82** |

| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | **(%)** | **(ppmvd)** | **(ppmvw)** | **(%)** | **(in. $H_2O$)** | **($^{o}$F)** | **(SCFH)** |
| **Bias** | **Initial Zero** | 0.09 | 0.07 | 0.03 | 0.08 | | | |
| | **Final Zero** | 0.05 | 0.19 | -0.02 | 0.09 | | | |
| | **Avg. Zero** | 0.07 | 0.13 | 0.01 | 0.09 | | | |
| | **Initial UpScale** | 11.97 | 9.11 | 3.05 | 9.44 | | | |
| | **Final UpScale** | 11.91 | 9.11 | 3.05 | 9.42 | | | |
| | **Avg. UpScale** | 11.94 | 9.11 | 3.05 | 9.43 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| **EMISSIONS DATA** | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.67 | 0.00 | 0.07 | 6.15 |
| **Corrected Raw Average (ppm/% wet basis)** | 11.86 | 0.00 | 0.07 | 5.76 |
| **Emission Rate (lb/hr)** | N/A | 0.00 | 0.00 | N/A |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.1 | % |
| Stack Exhaust Flow (M2) | 296,509 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.09 | in. Hg |
| Relative Humidity | 14 | % |
| Ambient Temperature | 71 | $^{o}$F |
| Specific Humidity | 0.002222 | lb $H_2O$ / lb air |

90-100 Load, Run - 4.0X30PF R12

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| A1 | 03/13/14 14:05:04 | 25050 | 12.77 | 0.02 | 0.08 | 6.25 | 231.96 | 104.80 | 3,734.01 |
| | 03/13/14 14:05:34 | 25080 | 12.64 | -0.03 | 0.08 | 6.29 | 232.51 | 105.25 | 3,746.81 |
| | 03/13/14 14:06:04 | 25110 | 13.13 | 0.02 | 0.08 | 5.92 | 235.28 | 105.25 | 3,762.81 |
| | 03/13/14 14:06:34 | 25140 | 12.93 | 0.05 | 0.08 | 6.03 | 233.06 | 104.80 | 3,759.24 |
| | 03/13/14 14:07:04 | 25170 | 12.72 | 0.01 | 0.08 | 6.19 | 233.06 | 104.80 | 3,750.08 |
| | 03/13/14 14:07:34 | 25200 | 12.80 | 0.02 | 0.08 | 6.16 | 232.51 | 104.80 | 3,736.40 |
| | 03/13/14 14:08:04 | 25230 | 13.03 | 0.02 | 0.08 | 5.97 | 231.40 | 104.80 | 3,723.82 |
| | 03/13/14 14:08:34 | 25260 | 13.15 | 0.06 | 0.08 | 5.85 | 234.73 | 104.80 | 3,753.02 |
| | 03/13/14 14:09:04 | 25290 | 13.17 | 0.05 | 0.08 | 5.81 | 235.28 | 104.80 | 3,767.95 |
| | 03/13/14 14:09:34 | 25320 | 12.91 | 0.02 | 0.08 | 5.98 | 243.31 | 104.80 | 3,838.63 |
| | 03/13/14 14:10:04 | 25350 | 13.09 | -0.01 | 0.09 | 5.88 | 242.20 | 104.80 | 3,832.18 |
| | 03/13/14 14:10:34 | 25380 | 12.85 | -0.01 | 0.09 | 6.04 | 243.31 | 105.25 | 3,845.11 |
| | 03/13/14 14:11:04 | 25410 | 12.81 | -0.04 | 0.09 | 6.08 | 250.50 | 105.25 | 3,921.40 |
| | 03/13/14 14:11:34 | 25440 | 12.75 | -0.06 | 0.09 | 6.10 | 257.98 | 105.25 | 3,982.42 |
| | 03/13/14 14:12:04 | 25470 | 12.71 | -0.05 | 0.09 | 6.08 | 260.19 | 105.70 | 4,005.94 |
| | 03/13/14 14:12:34 | 25500 | 12.51 | -0.09 | 0.09 | 6.23 | 260.74 | 105.70 | 4,015.57 |
| | 03/13/14 14:13:04 | 25530 | 12.58 | -0.08 | 0.07 | 6.24 | 269.33 | 105.70 | 4,082.41 |
| | 03/13/14 14:13:34 | 25560 | 12.42 | -0.09 | 0.08 | 6.34 | 273.75 | 106.15 | 4,111.82 |
| | 03/13/14 14:14:04 | 25590 | 12.42 | -0.10 | 0.09 | 6.33 | 273.20 | 105.70 | 4,099.05 |
| | 03/13/14 14:14:34 | 25620 | 12.22 | -0.10 | 0.08 | 6.48 | 275.14 | 105.70 | 4,107.55 |
| | 03/13/14 14:15:04 | 25650 | 12.21 | -0.11 | 0.09 | 6.46 | 274.03 | 105.70 | 4,105.78 |
| | 03/13/14 14:15:34 | 25680 | 12.50 | -0.10 | 0.09 | 6.26 | 272.09 | 105.70 | 4,083.72 |
| | 03/13/14 14:16:04 | 25710 | 12.53 | -0.11 | 0.08 | 6.23 | 267.11 | 105.70 | 4,068.92 |
| | 03/13/14 14:16:34 | 25740 | 12.31 | -0.10 | 0.08 | 6.38 | 268.77 | 106.15 | 4,065.07 |
| | 03/13/14 14:17:04 | 25770 | 12.30 | -0.11 | 0.09 | 6.36 | 268.22 | 106.60 | 4,067.70 |
| | 03/13/14 14:17:34 | 25800 | 12.28 | -0.10 | 0.09 | 6.42 | 270.99 | 106.60 | 4,113.61 |
| | 03/13/14 14:18:04 | 25830 | 12.18 | -0.11 | 0.08 | 6.43 | 272.09 | 106.15 | 4,108.38 |
| | 03/13/14 14:18:34 | 25860 | 12.09 | -0.09 | 0.08 | 6.51 | 273.20 | 105.70 | 4,103.61 |
| | 03/13/14 14:19:04 | 25890 | 12.33 | 0.00 | 0.08 | 6.40 | 270.99 | 105.70 | 4,085.62 |
| | 03/13/14 14:19:34 | 25920 | 12.14 | 0.07 | 0.08 | 6.53 | 266.00 | 105.25 | 4,071.87 |
| | 03/13/14 14:20:04 | 25950 | 12.52 | 0.01 | 0.08 | 6.22 | 267.66 | 105.25 | 4,062.97 |
| | 03/13/14 14:20:34 | 25980 | 12.45 | -0.04 | 0.07 | 6.28 | 268.22 | 105.25 | 4,086.68 |
| | 03/13/14 14:21:04 | 26010 | 12.45 | -0.04 | 0.09 | 6.26 | 270.99 | 105.70 | 4,102.35 |
| | 03/13/14 14:21:34 | 26040 | 12.39 | -0.06 | 0.09 | 6.28 | 272.65 | 105.70 | 4,102.56 |
| | 03/13/14 14:22:04 | 26070 | 12.24 | -0.03 | 0.08 | 6.39 | 267.66 | 105.25 | 4,078.09 |
| | 03/13/14 14:22:34 | 26100 | 12.23 | -0.04 | 0.07 | 6.44 | 268.22 | 105.25 | 4,080.32 |
| | 03/13/14 14:23:04 | 26130 | 12.38 | -0.04 | 0.09 | 6.34 | 266.00 | 105.25 | 4,070.90 |
| | 03/13/14 14:23:34 | 26160 | 12.42 | -0.05 | 0.08 | 6.28 | 271.54 | 105.25 | 4,087.22 |
| | 03/13/14 14:24:04 | 26190 | 12.34 | -0.04 | 0.08 | 6.35 | 272.09 | 105.25 | 4,100.83 |
| | 03/13/14 14:24:34 | 26220 | 12.23 | -0.05 | 0.07 | 6.45 | 270.43 | 104.80 | 4,097.07 |
| | 03/13/14 14:25:04 | 26250 | 12.19 | -0.04 | 0.08 | 6.45 | 268.22 | 104.35 | 4,083.18 |
| A2 | 03/13/14 14:25:34 | 26280 | 12.10 | -0.08 | 0.08 | 6.54 | 264.90 | 104.35 | 4,068.87 |
| | 03/13/14 14:26:04 | 26310 | 12.23 | -0.05 | 0.08 | 6.42 | 267.11 | 104.35 | 4,068.53 |
| | 03/13/14 14:26:34 | 26340 | 12.36 | -0.06 | 0.08 | 6.32 | 271.54 | 104.35 | 4,092.46 |
| | 03/13/14 14:27:04 | 26370 | 12.42 | -0.05 | 0.09 | 6.29 | 270.99 | 104.80 | 4,096.92 |
| | 03/13/14 14:27:34 | 26400 | 12.40 | -0.04 | 0.08 | 6.29 | 268.77 | 104.80 | 4,094.83 |
| | 03/13/14 14:28:04 | 26430 | 12.19 | -0.07 | 0.07 | 6.41 | 265.45 | 104.80 | 4,068.65 |
| | 03/13/14 14:28:34 | 26460 | 12.31 | -0.05 | 0.08 | 6.37 | 267.66 | 104.35 | 4,063.34 |
| | 03/13/14 14:29:04 | 26490 | 12.36 | -0.05 | 0.08 | 6.33 | 263.79 | 104.35 | 4,050.13 |
| | 03/13/14 14:29:34 | 26520 | 12.52 | -0.03 | 0.08 | 6.20 | 272.65 | 104.80 | 4,105.43 |
| | 03/13/14 14:30:04 | 26550 | 12.34 | -0.05 | 0.06 | 6.34 | 273.75 | 104.80 | 4,118.10 |
| | 03/13/14 14:30:34 | 26580 | 12.33 | -0.04 | 0.06 | 6.35 | 272.65 | 105.25 | 4,101.54 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.1 | % |
| Stack Exhaust Flow (M2) | 296,509 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.09 | in. Hg |
| Relative Humidity | 14 | % |
| Ambient Temperature | 71 | $^{o}$F |
| Specific Humidity | 0.002222 | lb $H_2O$ / lb air |

90-100 Load, Run - 4.0X30PF R12

| | Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|---|
| | 03/13/14 14:31:04 | 26610 | 12.32 | -0.04 | 0.07 | 6.33 | 269.33 | 105.70 | 4,083.09 |
| | 03/13/14 14:31:34 | 26640 | 12.39 | -0.07 | 0.07 | 6.33 | 269.33 | 105.70 | 4,077.59 |
| | 03/13/14 14:32:04 | 26670 | 12.37 | -0.04 | 0.08 | 6.30 | 270.43 | 105.70 | 4,073.68 |
| | 03/13/14 14:32:34 | 26700 | 12.42 | -0.06 | 0.08 | 6.27 | 272.09 | 105.70 | 4,121.20 |
| | 03/13/14 14:33:04 | 26730 | 12.35 | -0.05 | 0.09 | 6.31 | 271.54 | 106.15 | 4,124.41 |
| | 03/13/14 14:33:34 | 26760 | 12.46 | -0.06 | 0.08 | 6.28 | 272.09 | 105.70 | 4,098.33 |
| | 03/13/14 14:34:04 | 26790 | 12.50 | -0.02 | 0.07 | 6.23 | 270.99 | 105.70 | 4,086.80 |
| | 03/13/14 14:34:34 | 26820 | 12.27 | -0.03 | 0.07 | 6.37 | 269.33 | 105.70 | 4,078.68 |
| | 03/13/14 14:35:04 | 26850 | 12.33 | -0.01 | 0.06 | 6.31 | 268.22 | 105.25 | 4,084.85 |
| | 03/13/14 14:35:34 | 26880 | 11.84 | -0.05 | 0.05 | 6.70 | 273.20 | 104.80 | 4,102.74 |
| | 03/13/14 14:36:04 | 26910 | 12.03 | -0.06 | 0.06 | 6.55 | 272.09 | 104.35 | 4,103.50 |
| | 03/13/14 14:36:34 | 26940 | 12.10 | -0.03 | 0.07 | 6.58 | 273.20 | 104.35 | 4,097.82 |
| | 03/13/14 14:37:04 | 26970 | 12.59 | 0.12 | 0.06 | 6.18 | 270.43 | 104.35 | 4,078.01 |
| | 03/13/14 14:37:34 | 27000 | 12.88 | 0.20 | 0.07 | 5.97 | 265.45 | 104.35 | 4,067.51 |
| | 03/13/14 14:38:04 | 27030 | 12.80 | 0.30 | 0.07 | 5.96 | 268.22 | 104.35 | 4,079.95 |
| | 03/13/14 14:38:34 | 27060 | 12.68 | 0.20 | 0.06 | 6.13 | 272.09 | 104.35 | 4,109.71 |
| | 03/13/14 14:39:04 | 27090 | 12.90 | 0.29 | 0.07 | 5.97 | 275.14 | 104.35 | 4,112.55 |
| | 03/13/14 14:39:34 | 27120 | 12.76 | 0.32 | 0.07 | 6.02 | 273.75 | 104.80 | 4,097.89 |
| | 03/13/14 14:40:04 | 27150 | 12.69 | 0.21 | 0.07 | 6.07 | 266.56 | 104.35 | 4,081.35 |
| | 03/13/14 14:40:34 | 27180 | 12.33 | 0.18 | 0.07 | 6.36 | 269.88 | 103.90 | 4,072.49 |
| | 03/13/14 14:41:04 | 27210 | 12.85 | 0.15 | 0.06 | 5.99 | 266.56 | 103.90 | 4,067.42 |
| | 03/13/14 14:41:34 | 27240 | 13.01 | 0.25 | 0.07 | 5.84 | 273.20 | 103.90 | 4,100.11 |
| | 03/13/14 14:42:04 | 27270 | 13.05 | 0.30 | 0.07 | 5.82 | 271.54 | 103.90 | 4,106.66 |
| | 03/13/14 14:42:34 | 27300 | 12.77 | 0.29 | 0.06 | 6.06 | 270.43 | 103.90 | 4,093.74 |
| | 03/13/14 14:43:04 | 27330 | 13.38 | 0.36 | 0.08 | 5.61 | 266.56 | 104.35 | 4,080.09 |
| | 03/13/14 14:43:34 | 27360 | 12.99 | 0.46 | 0.07 | 5.83 | 266.00 | 103.90 | 4,068.58 |
| | 03/13/14 14:44:04 | 27390 | 12.94 | 0.37 | 0.05 | 5.93 | 266.56 | 103.90 | 4,075.44 |
| | 03/13/14 14:44:34 | 27420 | 13.49 | 0.48 | 0.07 | 5.54 | 273.75 | 104.35 | 4,109.27 |
| | 03/13/14 14:45:04 | 27450 | 13.07 | 0.53 | 0.08 | 5.79 | 273.20 | 104.35 | 4,114.00 |
| A3 | 03/13/14 14:45:34 | 27480 | 12.79 | 0.34 | 0.06 | 6.04 | 270.99 | 103.90 | 4,088.82 |
| | 03/13/14 14:46:04 | 27510 | 12.95 | 0.37 | 0.06 | 5.90 | 267.11 | 103.90 | 4,071.13 |
| | 03/13/14 14:46:34 | 27540 | 12.76 | 0.37 | 0.06 | 6.04 | 267.66 | 103.45 | 4,076.76 |
| | 03/13/14 14:47:04 | 27570 | 13.02 | 0.34 | 0.07 | 5.88 | 268.77 | 103.45 | 4,083.56 |
| | 03/13/14 14:47:34 | 27600 | 13.06 | 0.29 | 0.07 | 5.82 | 273.75 | 104.35 | 4,109.00 |
| | 03/13/14 14:48:04 | 27630 | 12.88 | 0.32 | 0.06 | 5.98 | 271.54 | 103.90 | 4,114.92 |
| | 03/13/14 14:48:34 | 27660 | 12.91 | 0.34 | 0.06 | 5.97 | 269.33 | 103.90 | 4,095.28 |
| | 03/13/14 14:49:04 | 27690 | 13.29 | 0.39 | 0.06 | 5.67 | 270.99 | 103.90 | 4,085.03 |
| | 03/13/14 14:49:34 | 27720 | 12.94 | 0.35 | 0.07 | 5.92 | 267.66 | 103.90 | 4,068.59 |
| | 03/13/14 14:50:04 | 27750 | 12.99 | 0.29 | 0.07 | 5.91 | 273.75 | 104.35 | 4,116.40 |
| | 03/13/14 14:50:34 | 27780 | 12.95 | 0.41 | 0.06 | 5.88 | 275.69 | 104.35 | 4,135.68 |
| | 03/13/14 14:51:04 | 27810 | 12.76 | 0.36 | 0.07 | 6.06 | 277.91 | 103.90 | 4,124.49 |
| | 03/13/14 14:51:34 | 27840 | 12.57 | 0.24 | 0.06 | 6.22 | 275.14 | 103.90 | 4,108.30 |
| | 03/13/14 14:52:04 | 27870 | 12.71 | 0.22 | 0.06 | 6.11 | 272.65 | 103.90 | 4,103.40 |
| | 03/13/14 14:52:34 | 27900 | 12.92 | 0.30 | 0.06 | 5.98 | 268.22 | 104.35 | 4,089.80 |
| | 03/13/14 14:53:04 | 27930 | 12.81 | 0.36 | 0.06 | 5.96 | 274.58 | 104.35 | 4,108.39 |
| | 03/13/14 14:53:34 | 27960 | 12.75 | 0.24 | 0.07 | 6.09 | 276.80 | 104.35 | 4,120.90 |
| | 03/13/14 14:54:04 | 27990 | 12.85 | 0.34 | 0.07 | 5.95 | 275.69 | 104.35 | 4,128.57 |
| | 03/13/14 14:54:34 | 28020 | 12.59 | 0.31 | 0.08 | 6.17 | 272.09 | 104.35 | 4,114.78 |
| | 03/13/14 14:55:04 | 28050 | 12.80 | 0.22 | 0.05 | 6.07 | 272.09 | 104.35 | 4,086.02 |
| | 03/13/14 14:55:34 | 28080 | 13.03 | 0.35 | 0.06 | 5.97 | 266.56 | 103.90 | 4,083.06 |
| | 03/13/14 14:56:04 | 28110 | 12.75 | 0.34 | 0.07 | 6.10 | 271.54 | 103.90 | 4,106.86 |
| | 03/13/14 14:56:34 | 28140 | 12.46 | 0.22 | 0.06 | 6.33 | 275.69 | 103.90 | 4,113.82 |

**John Zink Co, LLC**
**ZTOF040X30PF**
**Tulsa R&D Facility**

**Unit Data**

| | | |
|---|---|---|
| Meas. Stack Moisture | 6.1 | % |
| Stack Exhaust Flow (M2) | 296,509 | SCFH |

**Weather Data**

| | | |
|---|---|---|
| Barometric Pressure | 30.09 | in. Hg |
| Relative Humidity | 14 | % |
| Ambient Temperature | 71 | $^{o}$F |
| Specific Humidity | 0.002222 | lb $H_2O$ / lb air |

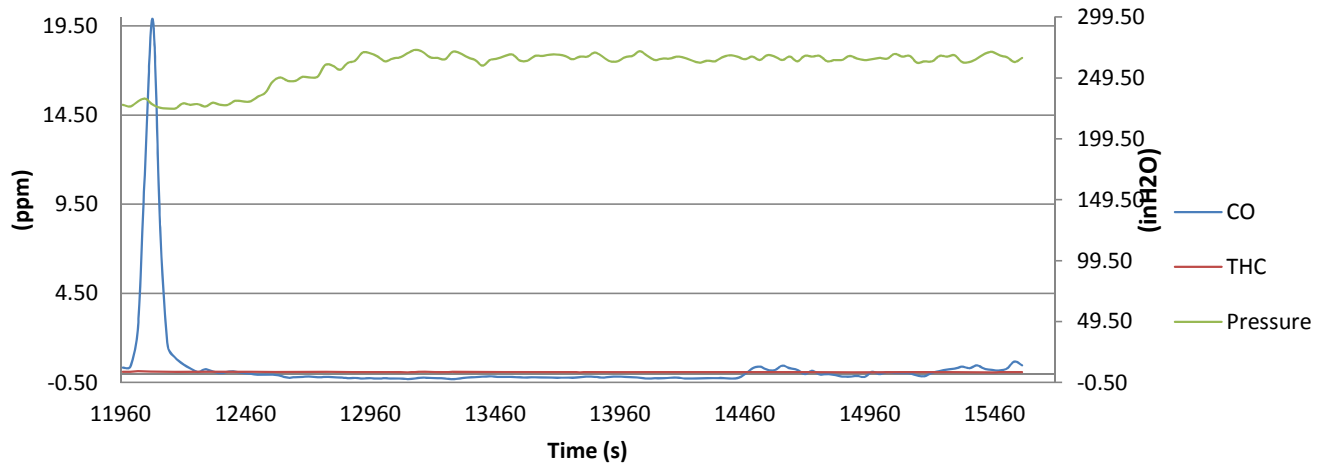
90-100 Load, Run - 4.0X30PF R12

| Date/Time (mm/dd/yy hh:mm:ss) | Elapsed Time (seconds) | $O_2$ (%) | CO (ppmvd) | THC (ppmvw) | $CO_2$ (%) | Fuel Pressure in. $H_2O$ | Fuel Temp. $^{o}$F | Fuel Flow SCFH |
|---|---|---|---|---|---|---|---|---|
| 03/13/14 14:57:04 | 28170 | 12.15 | 0.22 | 0.06 | 6.58 | 270.99 | 103.45 | 4,118.04 |
| 03/13/14 14:57:34 | 28200 | 12.85 | 0.15 | 0.06 | 6.12 | 273.20 | 103.90 | 4,101.14 |
| 03/13/14 14:58:04 | 28230 | 12.74 | 0.33 | 0.05 | 6.13 | 269.88 | 103.45 | 4,095.46 |
| 03/13/14 14:58:34 | 28260 | 12.73 | 0.23 | 0.06 | 6.20 | 266.56 | 103.45 | 4,070.17 |
| 03/13/14 14:59:04 | 28290 | 12.86 | 0.23 | 0.08 | 6.06 | 270.43 | 103.45 | 4,092.68 |
| 03/13/14 14:59:34 | 28320 | 12.95 | 0.25 | 0.10 | 6.02 | 275.14 | 103.90 | 4,118.37 |
| 03/13/14 15:00:04 | 28350 | 12.88 | 0.33 | 0.09 | 6.04 | 272.09 | 103.90 | 4,116.48 |
| 03/13/14 15:00:34 | 28380 | 12.60 | 0.29 | 0.08 | 6.25 | 269.33 | 103.45 | 4,098.00 |
| 03/13/14 15:01:04 | 28410 | 12.98 | 0.30 | 0.07 | 6.00 | 269.88 | 103.90 | 4,096.19 |
| 03/13/14 15:01:34 | 28440 | 13.11 | 0.36 | 0.07 | 5.89 | 268.22 | 104.35 | 4,078.16 |
| 03/13/14 15:02:04 | 28470 | 12.98 | 0.39 | 0.06 | 5.97 | 269.88 | 104.35 | 4,102.90 |
| 03/13/14 15:02:34 | 28500 | 13.04 | 0.25 | 0.07 | 5.97 | 272.65 | 104.80 | 4,110.98 |
| 03/13/14 15:03:04 | 28530 | 12.94 | 0.49 | 0.07 | 5.95 | 272.65 | 104.35 | 4,108.17 |
| 03/13/14 15:03:34 | 28560 | 12.97 | 0.36 | 0.06 | 6.01 | 270.99 | 104.35 | 4,102.95 |
| 03/13/14 15:04:04 | 28590 | 12.82 | 0.60 | 0.06 | 6.00 | 267.66 | 103.90 | 4,091.81 |
| 03/13/14 15:04:34 | 28620 | 12.65 | 0.31 | 0.06 | 6.17 | 267.66 | 104.35 | 4,082.37 |
| **RAW AVERAGE** | | **12.64** | **0.12** | **0.07** | **6.16** | **266.72** | **104.69** | **4,057.92** |

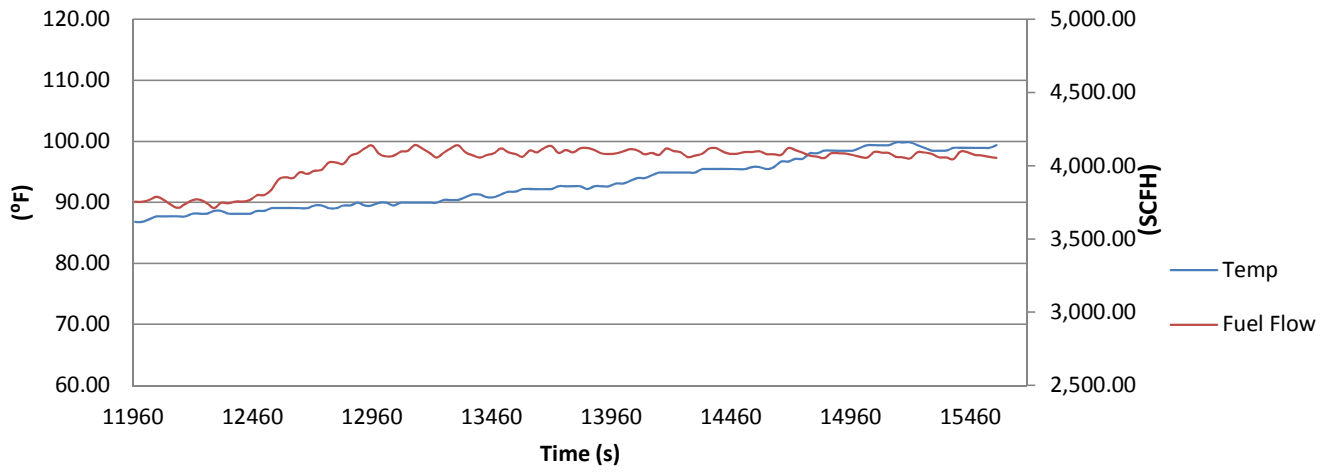
| | | $O_2$ | CO | THC | $CO_2$ | Press. Trans | Temp. Trans. | F-Flow Trans. |
|---|---|---|---|---|---|---|---|---|
| | **Serial Number:** | INST-22-0004 | INST-CO-0022 | INST-TH-0009 | INST-C2-0016 | F-13 LINE 2-3-4 PRESS | F-13 Line 1-3 TE | F-13 Line Orifice |
| | | (%) | (ppmvd) | (ppmvw) | (%) | (in. $H_2O$) | ($^{o}$F) | (SCFH) |
| **Bias** | **Initial Zero** | 0.05 | 0.19 | -0.02 | 0.09 | | | |
| | **Final Zero** | 0.07 | 0.01 | -0.03 | 0.05 | | | |
| | **Avg. Zero** | 0.06 | 0.10 | -0.03 | 0.07 | | | |
| | **Initial UpScale** | 11.91 | 9.11 | 3.05 | 9.42 | | | |
| | **Final UpScale** | 11.99 | 9.01 | 3.04 | 9.33 | | | |
| | **Avg. UpScale** | 11.95 | 9.06 | 3.05 | 9.38 | | | |
| **Upscale Cal Gas** | | 12.00 | 8.98 | 3.04 | 9.42 | | | |

| EMISSIONS DATA | $O_2$ | CO | THC | $CO_2$ |
|---|---|---|---|---|
| **Corrected Raw Average (ppm/% dry basis)** | 12.70 | 0.02 | 0.10 | 6.16 |
| **Corrected Raw Average (ppm/% wet basis)** | 11.92 | 0.02 | 0.09 | 5.78 |
| **Emission Rate (lb/hr)** | N/A | 0.00 | 0.00 | N/A |

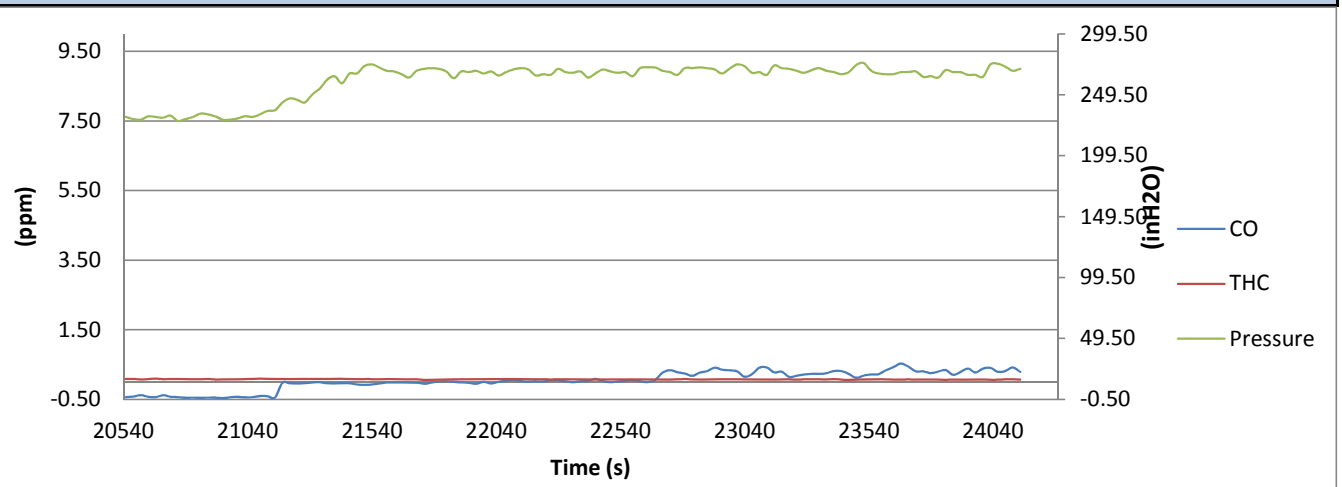
## 4.0X30PF R10



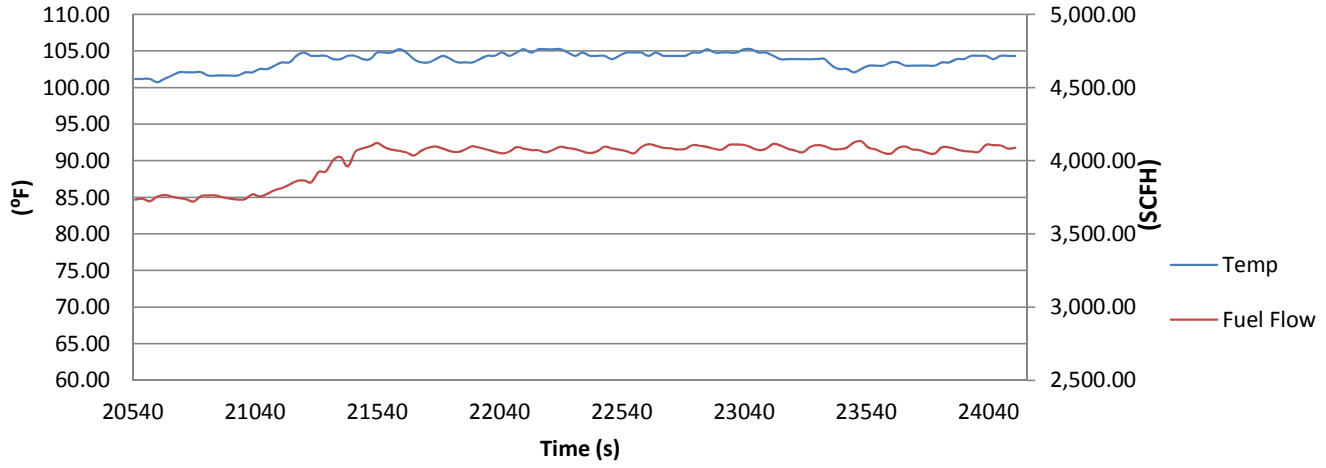

## 4.0X30PF R10



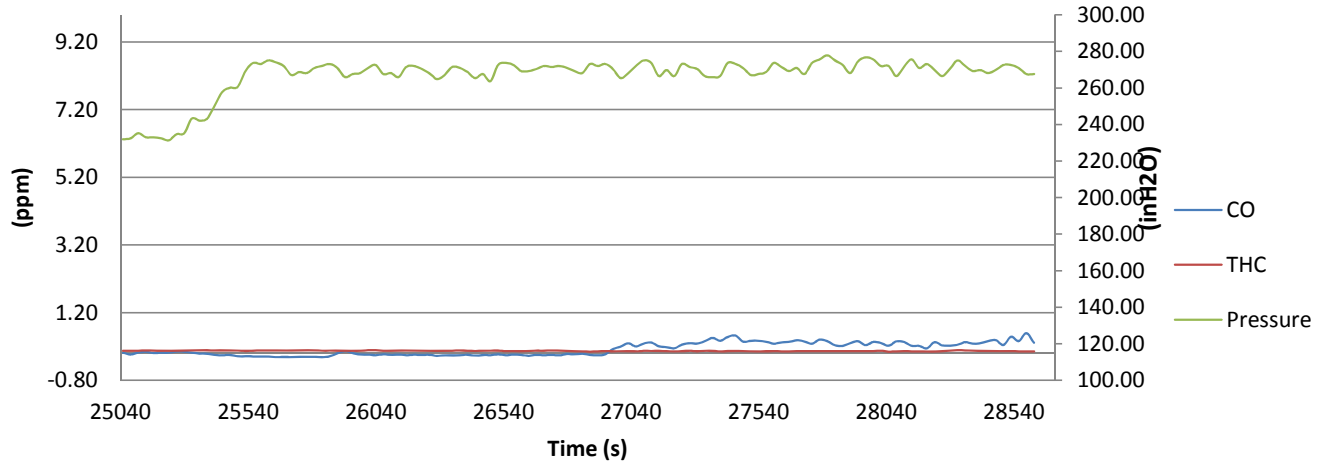

## 4.0X30PF R11



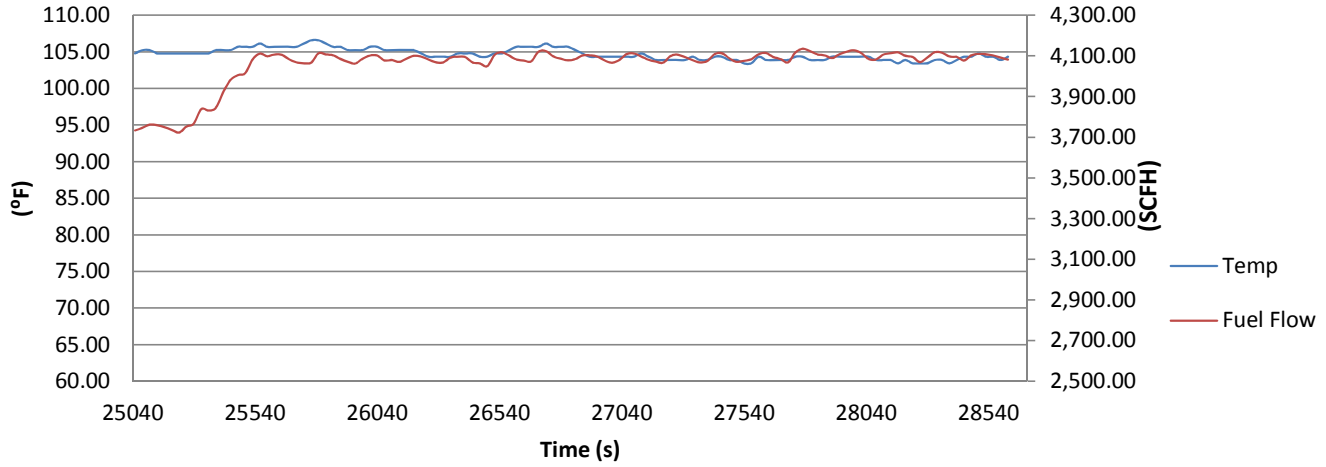
## 4.0X30PF R11

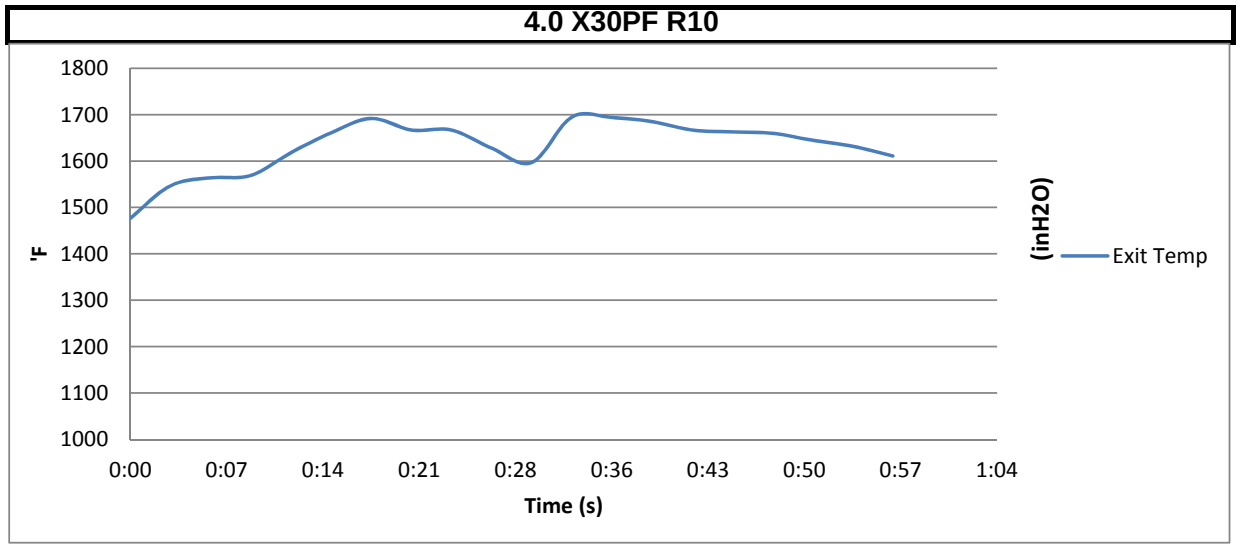


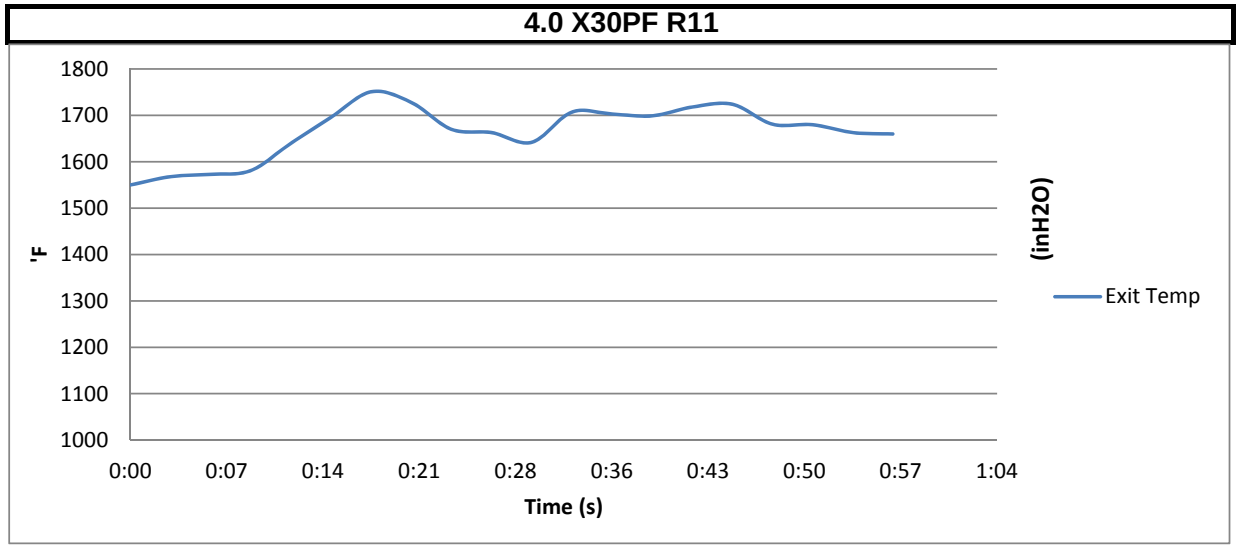

## 4.0X30PF R12

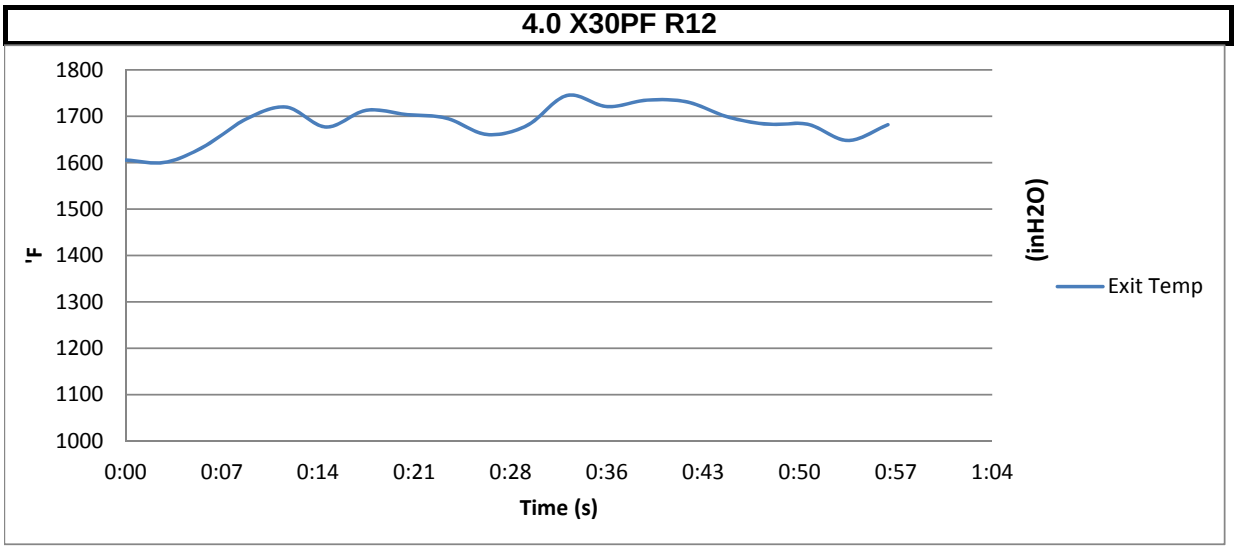



## 4.0X30PF R12




4.0 X30PF R10
1800
1700
1600
1500
1400
1300
1200
1100
1000
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp


4.0 X30PF R11
1800
1700
1600
1500
1400
1300
1200
1100
1000
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp


4.0 X30PF R12
1800
1700
1600
1500
1400
1300
1200
1100
1000
'F
0:00
0:07
0:14
0:21
0:28
0:36
0:43
0:50
0:57
1:04
Time (s)
(inH2O)
Exit Temp

# EMISSION DATA RECORDS

# VISUAL EMISSION DATA RECORD

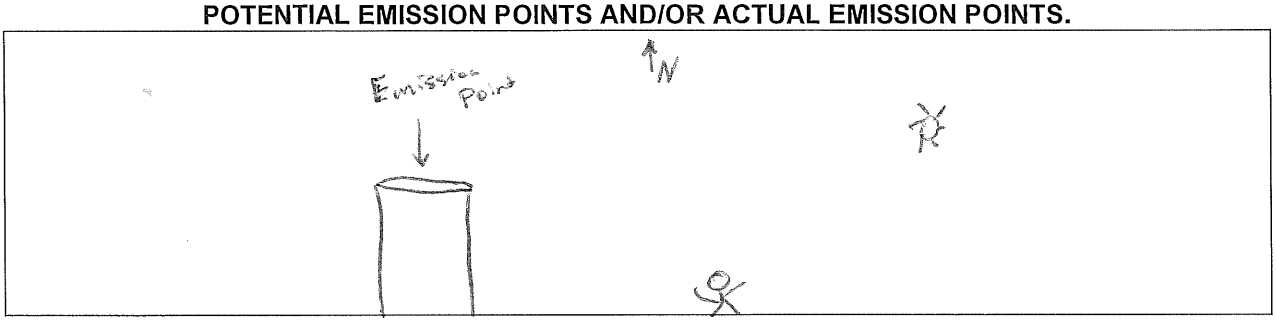
R1

AIR HYGIENE

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** Aron Katz | **OBSERVER:** Michael Whisenhunt / Zane Tarver<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3/11/14 |
| **SKY CONDITIONS:** CLEAR<br>**PRECIPITATION:** NONE | **WIND DIRECTION:** SE<br>**WIND SPEED:** 5mph<br>B.P. 29.49 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4430 PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




## OBSERVATIONS

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 13:16 | 20:00 (2T) | 0 | |
| 13:36 | 0 | – | |
| 13:36 | 20:00 (MW) | 0 | |
| 13:56 | 0 | – | |
| 13:56 | 20:00 (2T) | 0 | |
| 14:16 | 0 | – | |

Photo @ 14:00

SIGNATURE

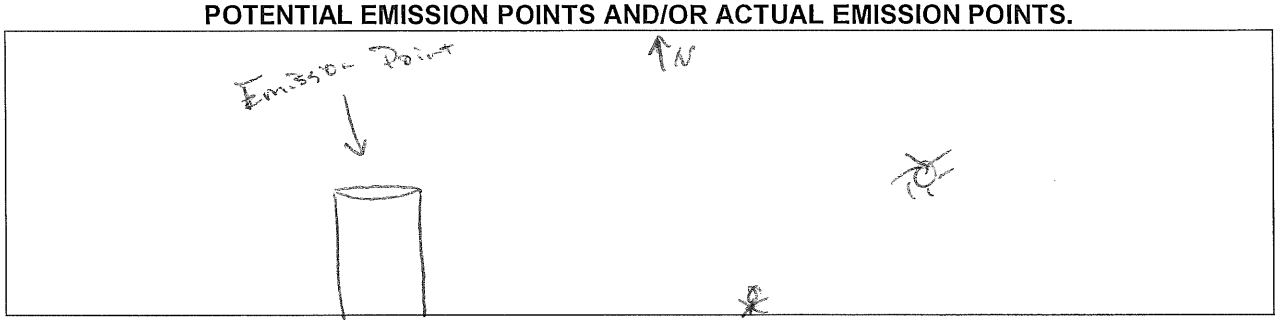
R2

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

AIR HYGIENE

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** Aron Kate | **OBSERVER:** Michael Whisenhunt Rani Tarver<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-11-14 |
| **SKY CONDITIONS:**<br>**PRECIPITATION:** | **WIND DIRECTION:** S<br>**WIND SPEED:** 5 mpL BP 29.41 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4X30PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




**OBSERVATIONS**

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 15:27 | 20 2T | 0 | |
| 15:47 | 0 | — | |
| 15:47 | 20 MW | 0 | |
| 16:07 | 0 | — | |
| 16:07 | 20 2T | 0 | |
| 16:27 | 0 | — | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Photo @ 15:54

SIGNATURE

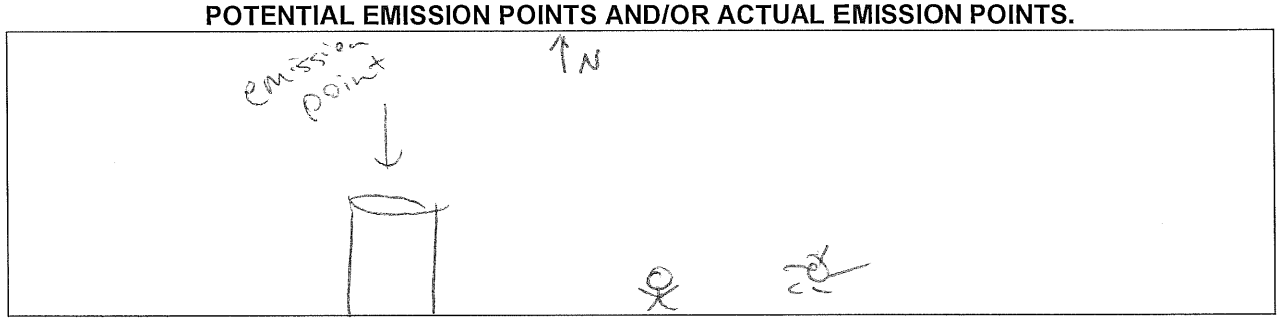
R3

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

AIR HYGIENE

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt / Dave Farrer<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3/11/14 |
| **SKY CONDITIONS:** scattered<br>**PRECIPITATION:** None | **WIND DIRECTION:** S<br>**WIND SPEED:** 5mph 29.40 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4x30PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




**OBSERVATIONS**

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 16:50 | | | |
| 17:10 | 20 MW | 0 | |
| 17:10 | 0 | — | |
| 17:30 | 20 2T | 0 | |
| 17:30 | 0 | — | |
| 17:50 | 20 | 0 | |
| | 0 MW | — | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Photo @ : 17:10

SIGNATURE

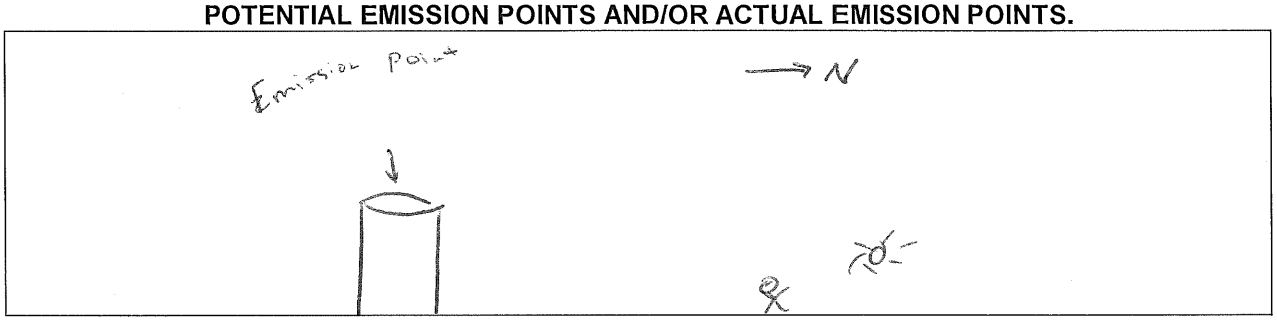
Run 4

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

AIR HYGIENE

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt / Matt Mcbride<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-12-14 |
| **SKY CONDITIONS:** Clear<br>**PRECIPITATION:** None | **WIND DIRECTION:** N<br>**WIND SPEED:** 4 mpL BP: 30.21 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4x30PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




## OBSERVATIONS

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 08:34 | 20 mw | 0 | |
| 8:54 | 0 | - | |
| 8:54 | 20 mm | 0 | |
| 9:14 | 0 | - | |
| 9:14 | 20 mw | 0 | |
| 9:34 | 0 | - | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Photo C 9:02

SIGNATURE

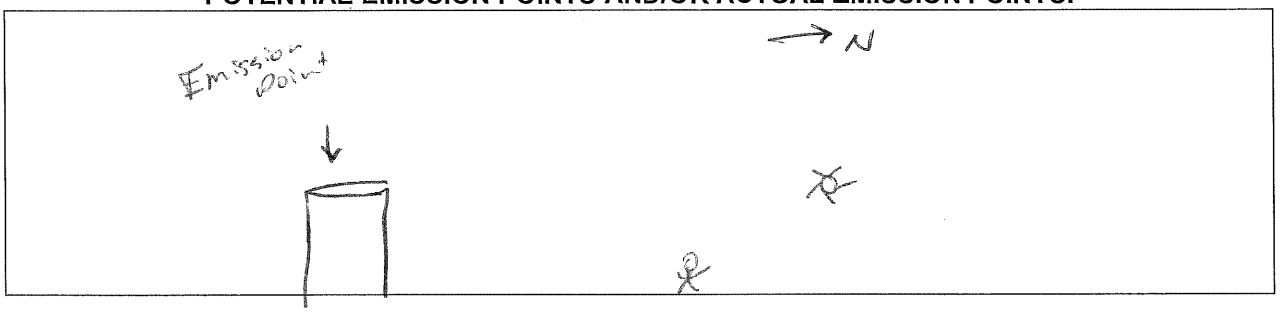
Run 5

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

AIR HYGIENE

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt / Matt McBride<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-12-14 |
| **SKY CONDITIONS:** Clear<br>**PRECIPITATION:** None | **WIND DIRECTION:** N<br>**WIND SPEED:** 14 mph BP: 30.26 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** CLX30PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




**OBSERVATIONS**

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 10:00 | 20 MW | 0 | |
| 10:20 | 0 | - | |
| 10:20 | 20 MM | 0 | |
| 10:40 | 0 | - | |
| 10:40 | 20 MW | 0 | |
| 11:00 | 0 | - | |

Photo @ 10:45

SIGNATURE

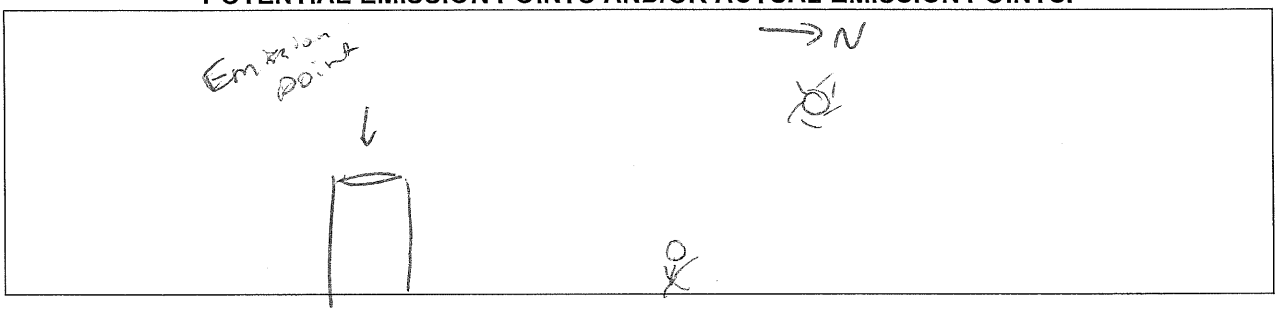
Run 6

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

AIR HYGIENE

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt / Matt Mcbride<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-12-14 |
| **SKY CONDITIONS:** Clear<br>**PRECIPITATION:** None | **WIND DIRECTION:** N<br>**WIND SPEED:** 12 mph 30.26 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4X30 PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




## OBSERVATIONS

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 11:22 | 20 MW | 0 | |
| 11:42 | 0 | — | |
| 11:42 | 20 MW | 0 | |
| 12:02 | 0 | — | |
| 12:02 | 20 MW | 0 | |
| 12:22 | 0 | — | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Photo @ 12:02

SIGNATURE

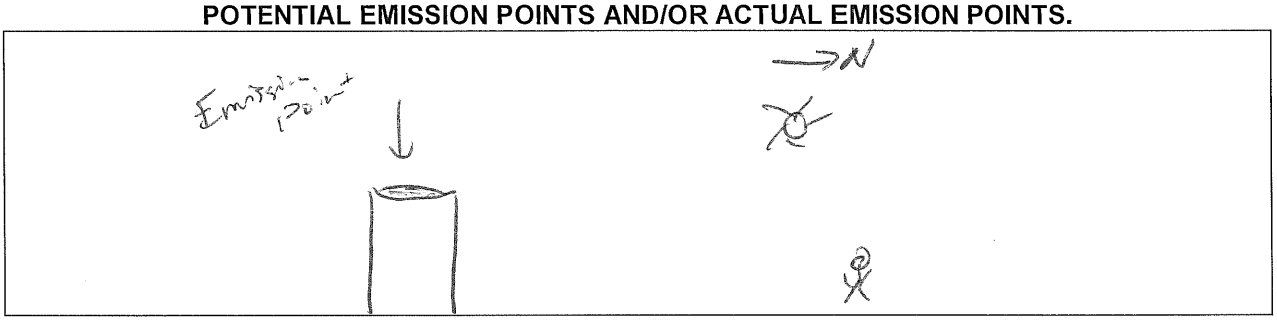
Run 7

AIR HYGIENE

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt / Matt McBride<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-12-14 |
| **SKY CONDITIONS:** Clear<br>**PRECIPITATION:** None | **WIND DIRECTION:** NW<br>**WIND SPEED:** 6 30.26 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4X30PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




**OBSERVATIONS**

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 13:19 | 20 MW | 0 | |
| 13:39 | 0 | – | |
| 13:39 | 20 MW | 0 | |
| 13:59 | 0 | – | |
| 13:59 | 20 MW | 0 | |
| 14:19 | 0 | – | |
| 14:19 | | | |

Photo @ 13:56

SIGNATURE

Matt McBride

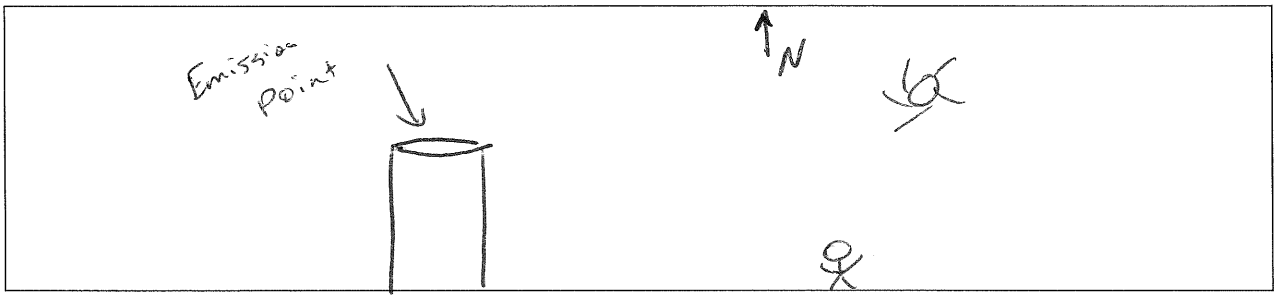
Run 8

AIR HYGIENE

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt/matt mcbride<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-12-14 |
| **SKY CONDITIONS:** Partly cloudy<br>**PRECIPITATION:** None | **WIND DIRECTION:** N<br>**WIND SPEED:** 9 mph BP: 30.19 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4V30PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




## OBSERVATIONS

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 16:30 | 20 MW | 0 | |
| 16:50 | 0 | - | |
| 16:50 | 20 MW | 0 | |
| 17:10 | 0 | - | |
| 17:10 | 20 MW | 0 | |
| 17:30 | 0 | - | |
| 17:30 | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Photo @ 17:22

SIGNATURE

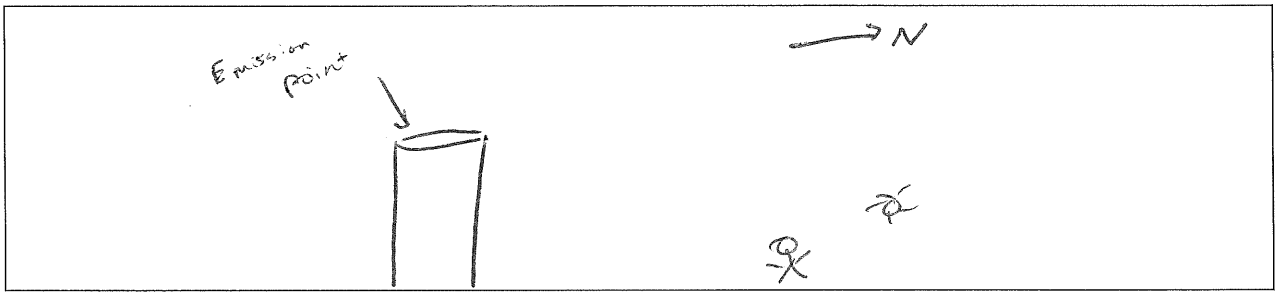
Run 9

# METHOD 22
# FUGITIVE OR SMOKE EMISSION INSPECTION FORM

AIR HYGIENE

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt / Matt McBride<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-13-14 |
| **SKY CONDITIONS:** Clear<br>**PRECIPITATION:** None | **WIND DIRECTION:** SW<br>**WIND SPEED:** 1 mph 30.19 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4X30PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




## OBSERVATIONS

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 8:40 | 20 mw | 0 | |
| 900 | 0 | — | |
| 9:00 | 20 mm | 0 | |
| 9:20 | 0 | — | |
| 9:20 | 20 mw | 0 | |
| 9:40 | 0 | — | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Photo @ 9:05

SIGNATURE

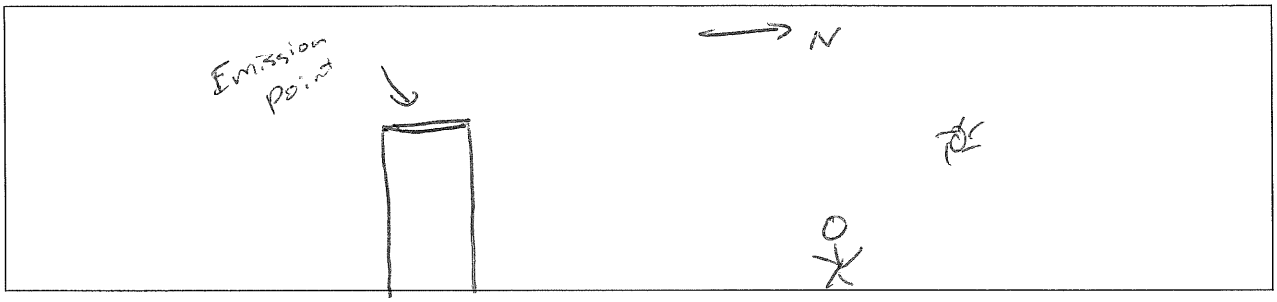
Run 10

AIR HYGIENE

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt / Matt Mcbride<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-13-14 |
| **SKY CONDITIONS:** Clear<br>**PRECIPITATION:** None | **WIND DIRECTION:** SW<br>**WIND SPEED:** 3 mph BP 30.2 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** 4470PF |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




**OBSERVATIONS**

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 10:27 | 20 MW | 0 | |
| 10:47 | 0 | – | |
| 10:47 | 20 MW | 0 | |
| 11:07 | 0 | – | |
| 11:07 | 20 MW | 0 | |
| 11:27 | 0 | – | |
| | | | |
| | | | |
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Photo @ 11:04

SIGNATURE

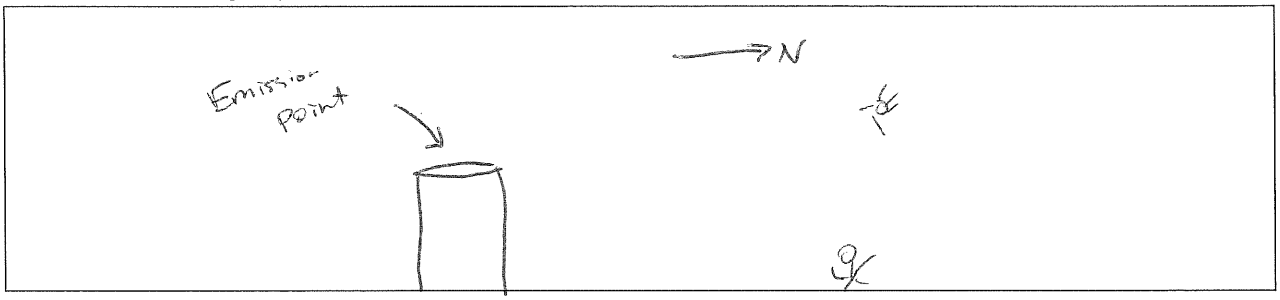
Run 11

AIR HYGIENE

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt/Matt Mcbride<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 3-13-14 |
| **SKY CONDITIONS:** Clear<br>**PRECIPITATION:** None | **WIND DIRECTION:** W<br>**WIND SPEED:** 8mph BP: 30.15 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




**OBSERVATIONS**

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 12:50 | | | |
| 13:10 | 20 mw | 0 | |
| 13:10 | 0 | - | |
| 13:30 | 20 mm | 0 | |
| 13:30 | 0 | - | |
| 13:50 | 20 mw | 0 | |
| | 0 | - | |
| | | | |
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Photo @ 13:12

SIGNATURE

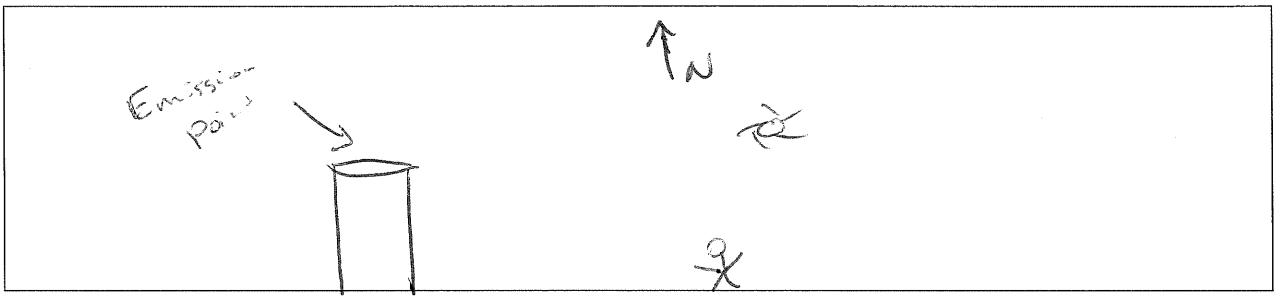
Run 12

# METHOD 22
# FUGITIVE OR SMOKE EMISSION
# INSPECTION FORM

AIR HYGIENE

| | |
|---|---|
| **COMPANY:** John Zink Co. LLC.<br>**LOCATION:** John Zink R&D Facility<br>**COMPANY REP:** | **OBSERVER:** Michael Whisenhunt<br>**AFFILIATION:** Air Hygiene Inc.<br>**DATE:** 8-13-14 |
| **SKY CONDITIONS:** Clear<br>**PRECIPITATION:** None | **WIND DIRECTION:** W<br>**WIND SPEED:** 5 BP: 30.09 |
| **INDUSTRY:** Manufacturing | **PROCESS UNIT:** |

**SKETCH PROCESS UNIT: INDICATE OBSERVER POSITION RELATIVE TO SOURCE; INDICATE POTENTIAL EMISSION POINTS AND/OR ACTUAL EMISSION POINTS.**




**OBSERVATIONS**

| CLOCK TIME | OBSERVATION PERIOD DURACTION (MIN:SEC) | ACCUMULATION EMISSION TIME (MIN:SEC) | OBSERVATION LOCATION |
|---|---|---|---|
| 14:05 | 20 MW | 0 | |
| 14:25 | 0 | — | |
| 14:28 | 20 MW | 0 | |
| 14:45 | 0 | — | |
| 14:45 | 20 MW | 0 | |
| 15:05 | 0 | — | |
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Photo @ 14:23

SIGNATURE

# APPENDIX C

# CALIBRATION GAS CERTIFICATIONS

AIR LIQUIDE

# CERTIFICATE OF ANALYSIS

**Certification Of Cylinder #: CC113383**

**Product: Nitrogen** **Grade: CEM Zero** **ACID RAIN**

| | | | |
|---|---|---|---|
| **Customer:** | | **Batch/Lot #:** | 170LAP27501C |
| **Date of Certification:** | 6/19/2012 | **Item Number:** | 7501-30AL |
| **P.O. Number:** | | **Valve:** | 580 |
| **Document Number:** | | **Cylinder Size:** | 30AL |

## ANALYSIS REPORT

| Major Component | Specification | Purity |
|---|---|---|
| Nitrogen CEM Zero | 99.9995%** | 99.9995% |

| Impurities | Specification | Actual Analysis |
|---|---|---|
| Moisture | <2 ppm | 1.0 PPM |
| Oxygen | <0.5 ppm | 0.4 PPM |
| Total Hydrocarbons | <0.1 ppm | <0.1 PPM |
| Carbon Dioxide | <1 ppm | 0.1 PPM |
| Carbon Monoxide | <0.5 ppm | ND |
| NOx* | <0.1 ppm | ND |
| SOx* | <0.1 ppm | ND |

**Excludes Argon

*Typical Property

**Notes:**

| | |
|---|---|
| EB0008506 | ALM006247 |
| CC69343 | CC203144 |
| CC92502 | BB0000375 |
| CC113383 | AAL16580 |
| AAL5944 | AAL3879 |
| ALM059777 | ALM038890 |
| ALM045085 | ALM048480 |
| ALM015296 | |

**Certified By:** ERIC DONALDSON

11426 Fairmont Pkwy
281-474-8400
**Phone:** LaPorte, TX 77571-6000

**Air Liquide America, L.P.**

AIR LIQUIDE Air Liquide America Specialty Gases LLC Scott

# RATA CLASS

*Dual-Analyzed Calibration Standard*

11426 FAIRMONT PKWY, LA PORTE, TX 77571 Phone: 800-248-1427 Fax: 281-474-8419

## CERTIFICATE™ OF ACCURACY: Interference Free Multi-Component EPA Protocol Gas

**Assay Laboratory - PGVP Vendor ID: A32012**

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
11426 FAIRMONT PKWY
LA PORTE, TX 77571

P.O. No.:
Document # : 45457634-001
Folio #:AH073

**Customer**
AIR HYGIENE

MIKE SCOTT
1800 WEST TACOMA ST
BROKEN ARROW OK 74012
US

### ANALYTICAL INFORMATION Gas Type : CO,NO,BALN

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

**Cylinder Number:** CC75555 **Certification Date:** 27Mar2012 **Exp. Date:** 29Mar2015
**Cylinder Pressure***:** 1950 PSIG **Batch No:** LAP0061243

| COMPONENT | CERTIFIED CONCENTRATION (Moles) | | ACCURACY** | TRACEABILITY |
|---|---|---|---|---|
| NITRIC OXIDE | 18.4 | PPM | +/- 1% | |
| CARBON MONOXIDE | 17.3 | PPM | +/- 1% | Direct NIST and VSL |
| NITROGEN - OXYGEN FREE | | BALANCE | | |
| TOTAL OXIDES OF NITROGEN | 18.5 | PPM | | Reference Value Only |

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

### REFERENCE STANDARD

| TYPE/SRM NO. | EXPIRATION DATE | CYLINDER NUMBER | CONCENTRATION | | COMPONENT |
|---|---|---|---|---|---|
| NTRM 2629 | 15Aug2013 | KAL003017 | 19.83 | PPM | NITRIC OXIDE |
| NTRM 2635 | 01Jun2016 | AAL073309 | 25.54 | PPM | CARBON MONOXIDE |

### INSTRUMENTATION

| INSTRUMENT/MODEL/SERIAL# | DATE LAST CALIBRATED | ANALYTICAL PRINCIPLE |
|---|---|---|
| NOX ANALYZER/400-CLD/7M07001 | 08Mar2012 | CHEMI |
| FTIR//000929060 | 06Mar2012 | FTIR |

### ANALYZER READINGS

(Z = Zero Gas R = Reference Gas T = Test Gas r = Correlation Coefficient)

**First Triad Analysis** **Second Triad Analysis** **Calibration Curve**

**NITRIC OXIDE**

Date: 21Mar2012 Response Unit: PPM
Z1 = 0.00000 R1 = 19.55000 T1 = 18.10000
R2 = 19.55000 Z2 = 0.00000 T2 = 18.10000
Z3 = 0.00000 T3 = 18.15000 R3 = 19.50000
Avg. Concentration: 18.39 PPM

Date: 28Mar2012 Response Unit: PPM
Z1 = 0.00000 R1 = 19.75000 T1 = 18.25000
R2 = 19.60000 Z2 = 0.00000 T2 = 18.12000
Z3 = 0.00000 T3 = 18.12000 R3 = 19.55000
Avg. Concentration: 18.34 PPM

Concentration = A + Bx + Cx2 + Dx3 + Ex4
r = 0.9999927
Constants: A = 0.043392918
B = 1.016595028 C =
D = E =

**CARBON MONOXIDE**

Date: 20Mar2012 Response Unit: PPM
Z1 = -0.00994 R1 = 25.52915 T1 = 17.22629
R2 = 25.59899 Z2 = -0.00458 T2 = 17.28559
Z3 = -0.00378 T3 = 17.29797 R3 = 25.61528
Avg. Concentration: 17.24 PPM

Date: 27Mar2012 Response Unit: PPM
Z1 = -0.00936 R1 = 25.54199 T1 = 17.30803
R2 = 25.56195 Z2 = 0.00050 T2 = 17.30976
Z3 = 0.01579 T3 = 17.33766 R3 = 25.57913
Avg. Concentration: 17.30 PPM

Concentration = A + Bx + Cx2 + Dx3 + Ex4
r = 9.99995E-1
Constants: A = -9.34270E+2
B = 1.76177E+0 C = 0.00000E+0
D = 0.00000E+0 E = 0.00000E+0

**Special Notes:** AH073 LIST ITEM AH073 ON CERTS AND TAGS CGA 660; DEW PT. 40 DEG.F.
The expiration date has been extended without re-assay per EPA 600/R23-23/542.

APPROVED BY: RON STITT

AIR LIQUIDE Air Liquide America Specialty Gases LLC Scott

# RATA CLASS

*Dual-Analyzed Calibration Standard*

11426 FAIRMONT PKWY, LA PORTE, TX 77571 Phone: 800-248-1427 Fax: 281-474-8419

## CERTIFICATE™ OF ACCURACY: Interference Free Multi-Component EPA Protocol Gas

**Assay Laboratory - PGVP Vendor ID: A32011**

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
11426 FAIRMONT PKWY
LA PORTE, TX 77571

P.O. No.:
Document # : 43038000-001
Folio #:AH071

**Customer**
AIR HYGIENE

MIKE SCOTT
5634 S. 122ND EAST AVE.
TULSA OK 74146
US

## ANALYTICAL INFORMATION Gas Type : CO,NO,BALN

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

**Cylinder Number:** CC113655 **Certification Date:** 13Sep2011 **Exp. Date:** 14Sep2014
**Cylinder Pressure***:** 2000 PSIG **Batch No:** LAP0048541

| COMPONENT | CERTIFIED CONCENTRATION (Moles) | | ACCURACY** | TRACEABILITY |
|---|---|---|---|---|
| CARBON MONOXIDE | 8.98 | PPM | +/- 1% | Direct NIST and VSL |
| NITRIC OXIDE | 8.96 | PPM | +/- 1% | |
| NITROGEN - OXYGEN FREE | | BALANCE | | |
| TOTAL OXIDES OF NITROGEN | 9.08 | PPM | | Reference Value Only |

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

### REFERENCE STANDARD

| TYPE/SRM NO. | EXPIRATION DATE | CYLINDER NUMBER | CONCENTRATION | | COMPONENT |
|---|---|---|---|---|---|
| NTRM 1677 | 01Jun2012 | KAL004005 | 9.855 | PPM | CARBON MONOXIDE |
| NTRM 2629 | 15Aug2013 | KAL003048 | 19.83 | PPM | NITRIC OXIDE |

### INSTRUMENTATION

| INSTRUMENT/MODEL/SERIAL# | DATE LAST CALIBRATED | ANALYTICAL PRINCIPLE |
|---|---|---|
| FTIR/000929060 | 01Sep2011 | FTIR |
| NOX ANALYZER/400-CLD/7M07001 | 29Aug2011 | CHEMI |

### ANALYZER READINGS

(Z = Zero Gas R = Reference Gas T = Test Gas r = Correlation Coefficient)

**CARBON MONOXIDE**

| First Triad Analysis | | | Second Triad Analysis | | | Calibration Curve | |
|---|---|---|---|---|---|---|---|
| Date: 03Sep2011 | Response Unit: PPM | | Date: 12Sep2011 | Response Unit: PPM | | Concentration = A + Bx + Cx2 + Dx3 + Ex4 | |
| Z1 = -0.01916 | R1 = 9.92474 | T1 = 9.06496 | Z1 = -0.01019 | R1 = 9.90254 | T1 = 9.06350 | r = 9.99991E-1 | |
| R2 = 9.96444 | Z2 = 0.03815 | T2 = 9.06560 | R2 = 9.95238 | Z2 = 0.01288 | T2 = 9.08433 | Constants: | A = 0.00000E+0 |
| Z3 = 0.05048 | T3 = 9.07921 | R3 = 10.02259 | Z3 = 0.02042 | T3 = 9.10360 | R3 = 9.97235 | B = 9.65718E-1 | C = 5.85000E-4 |
| Avg. Concentration: | 8.962 | PPM | Avg. Concentration: | 9.003 | PPM | D = 1.00000E-6 | E = 0.00000E+0 |

**NITRIC OXIDE**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Date: 08Sep2011 | Response Unit: PPM | | Date: 15Sep2011 | Response Unit: PPM | | Concentration = A + Bx + Cx2 + Dx3 + Ex4 | |
| Z1 = 0.00000 | R1 = 19.60000 | T1 = 8.88000 | Z1 = 0.00000 | R1 = 19.75000 | T1 = 8.96000 | r = 0.9999932 | |
| R2 = 19.60000 | Z2 = 0.00000 | T2 = 8.90000 | R2 = 19.75000 | Z2 = 0.00000 | T2 = 8.92000 | Constants: | A = -0.04400743 |
| Z3 = 0.00000 | T3 = 8.90000 | R3 = 19.65000 | Z3 = 0.00000 | T3 = 8.92000 | R3 = 19.65000 | B = 1.005705183 | C = |
| Avg. Concentration: | 8.966 | PPM | Avg. Concentration: | 8.960 | PPM | D = | E = |

**Special Notes:** WRITTEN CERT AND TAGS TO AIR HYGIENE WITH ITEM NUMBER AH071 CGA 660; DEW PT. 40 DEG.F.
The expiration date has been extended without re-assay per EPA 600/R23-23/542.

APPROVED BY: RON STITT

AIR LIQUIDE Air Liquide America Specialty Gases LLC

Scott

# RATA CLASS

*Dual-Analyzed Calibration Standard*

1290 COMBERMERE STREET, TROY, MI 48083 Phone: 248-589-2950 Fax: 248-589-2134

## CERTIFICATE OF ACCURACY: EPA Protocol Gas

**Assay Laboratory - PGVP Vendor ID: A22012**

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
1290 COMBERMERE STREET
TROY, MI 48083

P.O. No.: 48529652
Document # : 48529652-002

**Customer**
AIR HYGIENE

MAX CORBIN
1600 W TACOMA
BROKEN ARROW OK 74012
US

### ANALYTICAL INFORMATION Gas Type : NONE

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

**Cylinder Number:** ALM035126 **Certification Date:** 19Nov2012 **Exp. Date:** 20Nov2020
**Cylinder Pressure***:** 1950 PSIG **Batch No:** TRO0069975

| COMPONENT | CERTIFIED CONCENTRATION (Moles) | ACCURACY** | TRACEABILITY |
|---|---|---|---|
| PROPANE | 8.48 PPM | +/- 1% | Direct NIST and VSL |
| AIR | BALANCE | | |

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

### REFERENCE STANDARD

| TYPE/SRM NO. | EXPIRATION DATE | CYLINDER NUMBER | CONCENTRATION | COMPONENT |
|---|---|---|---|---|
| NTRM 1668 | 12Jul2018 | ALM038653 | 98.80 PPM | PROPANE |

### INSTRUMENTATION

| INSTRUMENT/MODEL/SERIAL# | DATE LAST CALIBRATED | ANALYTICAL PRINCIPLE |
|---|---|---|
| VARIAN/3400/7506 | 01Nov2012 | TCD/FID |

### ANALYZER READINGS

(Z = Zero Gas R = Reference Gas T = Test Gas r = Correlation Coefficient)

**First Triad Analysis**

**PROPANE**

Date: 19Nov2012 Response Unit: AREA

| | | |
|---|---|---|
| Z1 = 0.00000 | R1 = 2561613. | T1 = 218575.0 |
| R2 = 2563611. | Z2 = 0.00000 | T2 = 218288.0 |
| Z3 = 0.00000 | T3 = 218534.0 | R3 = 2564288. |

Avg. Concentration: 8.480 PPM

**Second Triad Analysis**

**Calibration Curve**

Concentration = A + Bx + Cx2 + Dx3 + Ex4
r = 0.999998155

| | |
|---|---|
| Constants: | A = -0.0106566 |
| B = 3.80809E-05 | C = 0 |
| D = 0 | E = 0 |

APPROVED BY: ROBERT LESNIAK

AIR LIQUIDE Air Liquide America Specialty Gases LLC Scott

# RATA CLASS

*Dual-Analyzed Calibration Standard*

1290 COMBERMERE STREET, TROY, MI 48083 Phone: 248-589-2950 Fax: 248-589-2134

## CERTIFICATE OF ACCURACY: EPA Protocol Gas

**Assay Laboratory - PGVP Vendor ID: A22012**

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
1290 COMBERMERE STREET
TROY, MI 48083

P.O. No.: 48529652
Document # : 48529652-003

**Customer**
AIR HYGIENE

MAX CORBIN
1600 W TACOMA
BROKEN ARROW OK 74012
US

## ANALYTICAL INFORMATION Gas Type : NONE

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

**Cylinder Number:** ALM030515 **Certification Date:** 19Nov2012 **Exp. Date:** 20Nov2020
**Cylinder Pressure***:** 2000 PSIG **Batch No:** TR00070121

| COMPONENT | CERTIFIED CONCENTRATION (Moles) | ACCURACY** | TRACEABILITY |
|---|---|---|---|
| PROPANE | 5.04 PPM | +/- 1% | Direct NIST and VSL |
| AIR | BALANCE | | |

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

### REFERENCE STANDARD

| TYPE/SRM NO. | EXPIRATION DATE | CYLINDER NUMBER | CONCENTRATION | COMPONENT |
|---|---|---|---|---|
| NTRM 1668 | 12Jul2018 | ALM038653 | 98.80 PPM | PROPANE |

### INSTRUMENTATION

| INSTRUMENT/MODEL/SERIAL# | DATE LAST CALIBRATED | ANALYTICAL PRINCIPLE |
|---|---|---|
| VARIAN/3400/7506 | 01Nov2012 | TCD/FID |

### ANALYZER READINGS

(Z=Zero Gas R=Reference Gas T=Test Gas r=Correlation Coefficient)

**First Triad Analysis**

**PROPANE**

Date: 19Nov2012 Response Unit: AREA

| | | |
|---|---|---|
| Z1=0.00000 | R1=2561613. | T1=129917.0 |
| R2=2563611. | Z2=0.00000 | T2=129951.0 |
| Z3=0.00000 | T3=130132.0 | R3=2564288. |

Avg. Concentration: 5.040 PPM

**Second Triad Analysis**

**Calibration Curve**

Concentration=A+Bx+Cx2+Dx3+Ex4
r=0.999998155
Constants: A=-0.0106566
B=3.80809E-05 C=0
D=0 E=0

APPROVED BY: ROBERT LESNIAK

AIR LIQUIDE Air Liquide America Specialty Gases LLC Scott

# RATA CLASS

*Dual-Analyzed Calibration Standard*

1290 COMBERMERE STREET, TROY, MI 48083 Phone: 248-589-2950 Fax: 248-589-2134

## CERTIFICATE OF ACCURACY: EPA Protocol Gas

**Assay Laboratory - PGVP Vendor ID: A22012**

AIR LIQUIDE AMERICA SPECIALTY GASES LLC
1290 COMBERMERE STREET
TROY, MI 48083

P.O. No.: 48529652
Document # : 48529652-004

**Customer**
AIR HYGIENE

MAX CORBIN
1600 W TACOMA
BROKEN ARROW OK 74012
US

## ANALYTICAL INFORMATION Gas Type : NONE

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1; September, 1997.

**Cylinder Number:** ALM066309 **Certification Date:** 19Nov2012 **Exp. Date:** 20Nov2020
**Cylinder Pressure***:** 2000 PSIG **Batch No:** TR00070134

| COMPONENT | CERTIFIED CONCENTRATION (Moles) | ACCURACY** | TRACEABILITY |
|---|---|---|---|
| PROPANE | 3.04 PPM | +/- 1% | Direct NIST and VSL |
| AIR | BALANCE | | |

*** Do not use when cylinder pressure is below 150 psig.
** Analytical accuracy is based on the requirements of EPA Protocol Procedure G1, September 1997.

**REFERENCE STANDARD**

| TYPE/SRM NO. | EXPIRATION DATE | CYLINDER NUMBER | CONCENTRATION | COMPONENT |
|---|---|---|---|---|
| NTRM 1668 | 12Jul2018 | ALM038653 | 98.80 PPM | PROPANE |

**INSTRUMENTATION**

| INSTRUMENT/MODEL/SERIAL# | DATE LAST CALIBRATED | ANALYTICAL PRINCIPLE |
|---|---|---|
| VARIAN/3400/7506 | 01Nov2012 | TCD/FID |

## ANALYZER READINGS

(Z = Zero Gas R = Reference Gas T = Test Gas r = Correlation Coefficient)

**First Triad Analysis**

**PROPANE**
Date: 19Nov2012 Response Unit: AREA
Z1 = 0.00000 R1 = 2561613. T1 = 78649.00
R2 = 2563611. Z2 = 0.00000 T2 = 78557.00
Z3 = 0.00000 T3 = 78234.00 R3 = 2564288.
Avg. Concentration: 3.040 PPM

**Second Triad Analysis**

**Calibration Curve**

Concentration = A + Bx + Cx2 + Dx3 + Ex4
r = 0.999998155
Constants: A = -0.0106566
B = 3.80809E-05 C = 0
D = 0 E = 0

APPROVED BY: ROBERT LESNIAK

AIR LIQUIDE Air Liquide America Specialty Gases LLC Scott™

# RATA CLASS

*Guaranteed +/- 1% Accuracy*

1290 COMBERMERE STREET, TROY, MI 48083 Phone: 248-589-2950 Fax: 248-589-2134

## CERTIFICATE OF ACCURACY: EPA Protocol Gas

**Assay Laboratory - PGVP Vendor ID: A22013**
AIR LIQUIDE AMERICA SPECIALTY GASES LLC
1290 COMBERMERE STREET
TROY, MI 48083

P.O. No.:
Document # : 52235725-002
Folio #:AH095

**Customer**
AIR HYGIENE
MIKE SCOTT
1600 WEST TACOMA ST
BROKEN ARROW OK 74012
US

## ANALYTICAL INFORMATION Gas Type : CO2,O2,BALN

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1. EPA/600/R-12/531; May 2012. Do not use this standard if pressure is less than 100 psig.

**Cylinder Number:** EB0000359 **Certification Date:** 30Sep2013 **Exp. Date:** 01Oct2021
**Cylinder Pressure:** 2000 PSIG **Batch No:** TRO0093578

| COMPONENT | CERTIFIED CONCENTRATION (Moles) | ACCURACY (ABSOLUTE / RELATIVE) |
|---|---|---|
| OXYGEN | 21.1 % | 0.08 % / 0.4 % |
| CARBON DIOXIDE | 18.5 % | 0.2 % / 0.8 % |
| NITROGEN | BALANCE | |

## TRACEABILITY

**REFERENCE STANDARD**

| COMPONENT | CONCENTRATION | UNCERTAINTY | CYLINDER | TYPE/SRM SAMPLE | EXP. DATE |
|---|---|---|---|---|---|
| OXYGEN | 23.2000 % | 0.0900 % | K024582 | NTRM 2350 | 04Jan2018 |
| CARBON DIOXIDE | 23.0400 % | 0.1200 % | K026052 | NTRM 2300 | 17Aug2016 |

## ANALYTICAL METHOD

**1st Analysis: 30Sep2013**

| COMPONENT | INSTRUMENT | ANALYTICAL/PRINCIPLE | CALIBRATED | CONCENTRATION |
|---|---|---|---|---|
| OXYGEN | CAI/110P/V03018 | PARAMAGNETIC | 30Sep2013 | 21.10 % |
| CARBON DIOXIDE | PIR/2000/609015 | NDIR | 09Sep2013 | 18.50 % |

**Special Notes:** AH095 LIST ITEM AH095 ON CERTS AND TAGS

APPROVED BY: _____
JEFF CROTEAU

AIR LIQUIDE Air Liquide America Specialty Gases LLC Scott™

# RATA CLASS

*Guaranteed +/- 1% Accuracy*

1290 COMBERMERE STREET, TROY, MI 48083 Phone: 248-589-2950 Fax: 248-589-2134

## CERTIFICATE OF ACCURACY: EPA Protocol Gas

**Assay Laboratory - PGVP Vendor ID: A22013**
AIR LIQUIDE AMERICA SPECIALTY GASES LLC
1290 COMBERMERE STREET
TROY, MI 48083

P.O. No.:
Document # : 52235725-001
Folio #:AH094

**Customer**
AIR HYGIENE
MIKE SCOTT
1600 WEST TACOMA ST
BROKEN ARROW OK 74012
US

## ANALYTICAL INFORMATION Gas Type : CO2,O2,BALN

This certification was performed according to EPA Traceability Protocol For Assay & Certification of Gaseous Calibration Standards; Procedure G-1. EPA/600/R-12/531; May 2012. Do not use this standard if pressure is less than 100 psig.

**Cylinder Number:** ALM015644
**Cylinder Pressure:** 2000 PSIG
**Certification Date:** 30Sep2013
**Exp. Date:** 01Oct2021
**Batch No:** TRO0093273

| COMPONENT | CERTIFIED CONCENTRATION (Moles) | ACCURACY (ABSOLUTE / RELATIVE) |
|---|---|---|
| OXYGEN | 12.0 % | 0.05 % / 0.4 % |
| CARBON DIOXIDE | 9.42 % | 0.1 % / 1.0 % |
| NITROGEN | BALANCE | |

## TRACEABILITY

REFERENCE STANDARD

| COMPONENT | CONCENTRATION | UNCERTAINTY | CYLINDER | TYPE/SRM SAMPLE | EXP. DATE |
|---|---|---|---|---|---|
| OXYGEN | 23.2000 % | 0.0900 % | K024582 | NTRM 2350 | 04Jan2018 |
| CARBON DIOXIDE | 23.0400 % | 0.1200 % | K026052 | NTRM 2300 | 17Aug2016 |

## ANALYTICAL METHOD

1st Analysis: 30Sep2013

| COMPONENT | INSTRUMENT | ANALYTICAL/PRINCIPLE | CALIBRATED | CONCENTRATION |
|---|---|---|---|---|
| OXYGEN | CAI/110P/V03018 | PARAMAGNETIC | 30Sep2013 | 12.00 % |
| CARBON DIOXIDE | PIR/2000/609015 | NDIR | 09Sep2013 | 9.420 % |

**Special Notes:** AH094 LIST ITEM AH094 ON CERTS AND TAGS

APPROVED BY: _____
JEFF CROTEAU

# APPENDIX D

# QUALITY ASSURANCE AND QUALITY CONTROL DATA

# QA/QC PROGRAM

Air Hygiene ensures the quality and validity of its emission measurement and reporting procedures through a rigorous quality assurance (QA) program. The program is developed and administered by an internal QA team and encompasses five major areas:

1. QA reviews of reports, laboratory work, and field testing
2. Equipment calibration and maintenance
3. Chain-of-custody
4. Training
5. Knowledge of current test methods

Each of these areas is discussed individually below.

## QA Reviews

Air Hygiene's review procedure includes review of each source test report, along with laboratory and fieldwork, by the QA Team. The most important review is the one that takes place before a test program begins. The QA Team works closely with technical division personnel to prepare and review test protocols. Test protocol review includes selection of appropriate test procedures, evaluation of interferences or other restrictions that might preclude use of standard test procedures, and evaluation and/or development of alternate procedures.

## Equipment Calibration and Maintenance

The equipment used to conduct the emission measurements is maintained according to the manufacturer's instructions to ensure proper operation. In addition to the maintenance program, calibrations are carried out on each measurement device according to the schedule outlined by the Environmental Protection Agency. Quality control checks are also conducted in the field for each test program.

## Chain-of-Custody

Air Hygiene maintains full chain-of-custody documentation on all samples and data sheets. In addition to normal documentation of changes between field sample custodians, laboratory personnel, and field test personnel, Air Hygiene documents every individual who handles any test component in the field (e.g., probe wash, impinger loading and recovery, filter loading and recovery, etc.). Samples were stored in a locked area to which only Air Hygiene personnel have access. Field data sheets are secured at Air Hygiene's offices upon return from the field.

## Training

Personnel's training is essential to ensure quality testing. Air Hygiene has formal and informal training programs, which include:

1. Attendance at EPA-sponsored training courses
2. Enrollment in EPA correspondence courses
3 A requirement for all technicians to read and understand Air Hygiene's QA manual
4. In-house training and QA meetings on a regular basis
5. Maintenance of training records

## Knowledge of Current Test Methods

With the constant updating of standard test methods and the wide variety of emerging test procedures, it is essential that any qualified source tester keep abreast of new developments. Air Hygiene subscribes to services, which provide updates on EPA reference methods, rules, and regulations. Additionally, source test personnel regularly attend and present papers at testing and emission-related seminars and conferences. Air Hygiene personnel maintain membership in the Air and Waste Management Association and the American Industrial Hygiene Association.

## Reproduction and Distribution Policy

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# COMBUSTION TESTING QUALITY ASSURANCE ACTIVITIES

A number of quality assurance activities were undertaken before, during, and after this testing project. This section of the report combined with the documentation in Appendix C describes each of those activities.

Each instrument's response was checked and adjusted in the field prior to the collection of data via multi-point calibration. The instrument's linearity was checked by adjusting its zero and span responses to zero nitrogen and an upscale calibration gas in the range of the expected concentrations. The instrument response was then challenged with other calibration gases of known concentration and accepted as being linear if the response of the other calibration gases agreed within plus or minus two percent of the range of predicted values.

After each test run, the analyzers were checked for zero and span drift. This allowed each test run to be bracketed by calibrations and documents the precision of the data just collected. The criterion for acceptable data is that the instrument drift is no more than three percent of the full-scale response. The quality assurance worksheets in the following pages summarize all multipoint calibration checks and zero to span checks performed during the tests. These worksheets (as prepared from the data records of Appendix A) show that no drifts in excess of three percent occurred in the zero to span checks following each test run.

The sampling systems were leak checked by demonstrating that a vacuum greater than 10 in Hg could be held for at least one minute with a decline of less than one inch of Hg. A leak test was conducted after the sample system was set up and before the system was dismantled. This test was conducted to ensure that ambient air had not diluted the sample. Any leakage detected prior to the tests would be repaired and another leak check conducted before testing commenced. No leaks were found during the pre or post-test leak checks.

The absence of leaks in the sampling system was also verified by a sampling system bias check. The sampling system's integrity was tested by comparing the responses of the analyzers to the calibration gases introduced via two paths. The first path was directly into the analyzer and the second path via the sample system at the sample probe. Any difference in the instrument responses by these two methods was attributed to sampling system bias or leakage. The criterion for acceptance is agreement within five percent of the span of the analyzer.

The control gases used to calibrate the instruments were analyzed and certified by the compressed gas vendors to plus or minus one percent accuracy for all gases. EPA Protocol No. 1 was used, where applicable to assign the concentration values traceable to the National Institute of Standards and Technology (NIST), Standard Reference Materials (SRM's). The gas calibration sheets as prepared by the vendor are contained in Appendix C.

Air Hygiene collected and reported the enclosed test data in accordance with the procedures and quality assurance activities described in this test report. Air Hygiene makes no warranty as to the suitability of the test methods. Air Hygiene also assumes no liability relating to the interpretation and use of the test data.

## INSTRUMENTAL ANALYSIS
## QUALITY ASSURANCE DATA

Date: March 10-13, 2014
Company: John Zink, Co LLC
Location: Tulsa, Oklahoma
Techs: MSL, ML,MM

### Sample System Leak Check

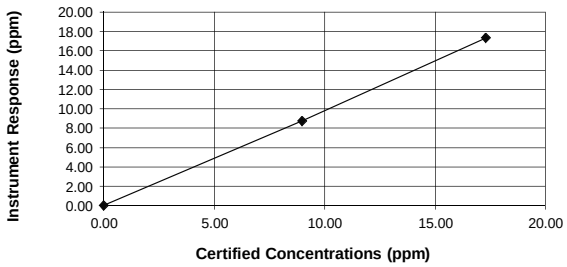
| Date | Sample System | Leak Rate (l/min) |
|---|---|---|
| March 10-13, 2014 | 1 | 0 |

jz-14-tulsa.ok-comp#1-ZTOF04X30PF-rpt

**Calibration Date:** March 11, 2014
**Client:** John Zink Co, LLC

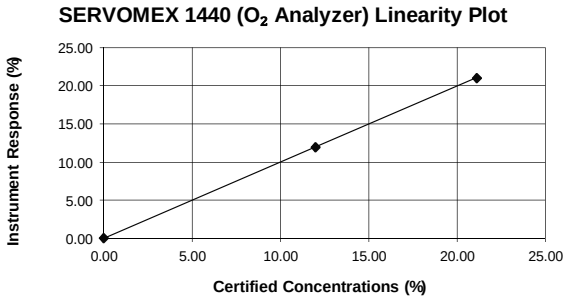
CO Span (ppm) = 17.30

| THERMO 48C (CO Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (ppm) | Instrument Response (ppm) | Calibration Error (%) | Absolute Conc. (ppm) | Pass or Fail (±2%, ≤0.5ppm) |
| 0.00 | 0.03 | 0.17 | 0.03 | YES (%) |
| 8.98 | 8.77 | -1.21 | 0.21 | YES (%) |
| 17.30 | 17.32 | 0.12 | 0.02 | YES (%) |
| Linearity = 1.001 | | | | |




$O_2$ Span (%) = 21.10

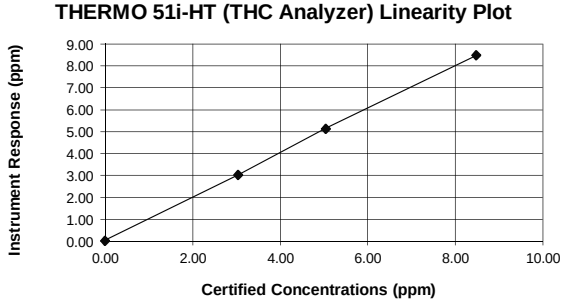
| SERVOMEX 1440 ($O_2$ Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (%) | Instrument Response (%) | Calibration Error (%) | Absolute Conc. (%) | Pass or Fail (±2%, ≤0.5%) |
| 0.00 | 0.04 | 0.19 | 0.04 | YES (%) |
| 12.00 | 12.01 | 0.05 | 0.01 | YES (%) |
| 21.10 | 21.07 | -0.14 | 0.03 | YES (%) |
| Linearity = 1.003 | | | | |




THC Range (ppm) = 10

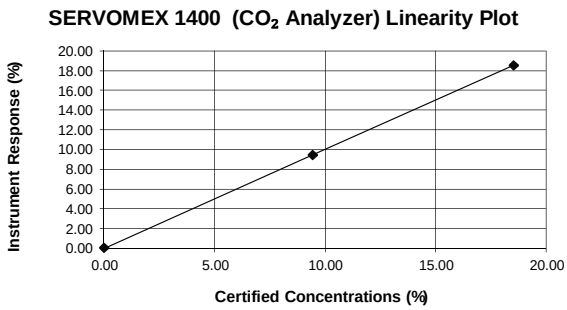
| THERMO 51i-HT (THC Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (ppm) | Instrument Response (ppm) | Calibration Error (%) | Estimated Point (ppm) | Pass or Fail (±2,5%)[1] |
| 0.00 | 0.04 | 0.40 | N/A | YES |
| 3.04 | 3.03 | -1.29 | 3.07 | YES |
| 5.04 | 5.15 | 1.74 | 5.06 | YES |
| 8.48 | 8.49 | 0.10 | N/A | YES |
| Linearity = 0.999 | | | | |

[1]-zero/high based on 2% of span,low/mid based on 5% of concentration




$CO_2$ Span (%) = 18.50

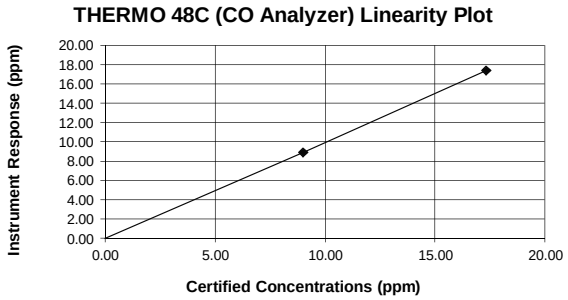
| SERVOMEX 1400 ($CO_2$ Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (%) | Instrument Response (%) | Calibration Error (%) | Absolute Conc. (%) | Pass or Fail (±2%, ≤0.5%) |
| 0.00 | 0.01 | 0.05 | 0.01 | YES (%) |
| 9.42 | 9.43 | 0.05 | 0.01 | YES (%) |
| 18.50 | 18.52 | 0.11 | 0.02 | YES (%) |
| Linearity = 0.999 | | | | |



**Calibration Date:** March 12, 2014
**Client:** John Zink Co, LLC

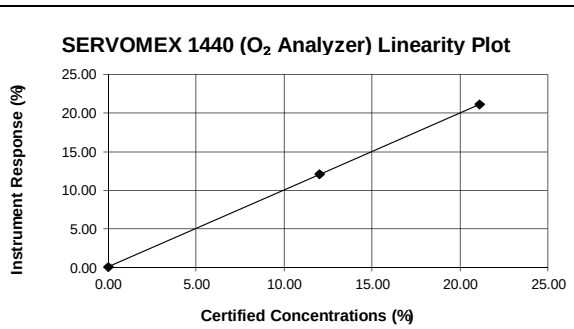
CO Span (ppm) = 17.30

| THERMO 48C (CO Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (ppm) | Instrument Response (ppm) | Calibration Error (%) | Absolute Conc. (ppm) | Pass or Fail (±2%, ≤0.5ppm) |
| 0.00 | -0.01 | -0.06 | 0.01 | YES (%) |
| 8.98 | 8.90 | -0.46 | 0.08 | YES (%) |
| 17.30 | 17.37 | 0.40 | 0.07 | YES (%) |
| Linearity = 0.996 | | | | |




O2 Span (%) = 21.10

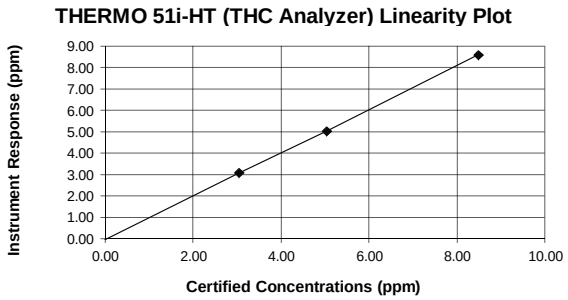
| SERVOMEX 1440 ($O_2$ Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (%) | Instrument Response (%) | Calibration Error (%) | Absolute Conc. (%) | Pass or Fail (±2%, ≤0.5%) |
| 0.00 | 0.08 | 0.38 | 0.08 | YES (%) |
| 12.00 | 12.06 | 0.28 | 0.06 | YES (%) |
| 21.10 | 21.13 | 0.14 | 0.03 | YES (%) |
| Linearity = 1.002 | | | | |




THC Range (ppm) = 10

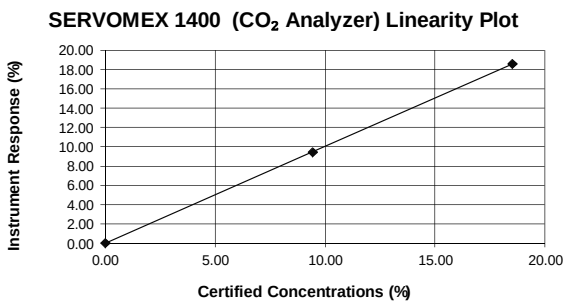
| THERMO 51i-HT (THC Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (ppm) | Instrument Response (ppm) | Calibration Error (%) | Estimated Point (ppm) | Pass or Fail (±2,5%)[1] |
| 0.00 | -0.03 | -0.30 | N/A | YES |
| 3.04 | 3.07 | 0.56 | 3.05 | YES |
| 5.04 | 5.02 | -1.22 | 5.08 | YES |
| 8.48 | 8.57 | 0.90 | N/A | YES |
| Linearity = 0.987 | | | | |

[1]-zero/high based on 2% of span,low/mid based on 5% of concentration




CO2 Span (%) = 18.50

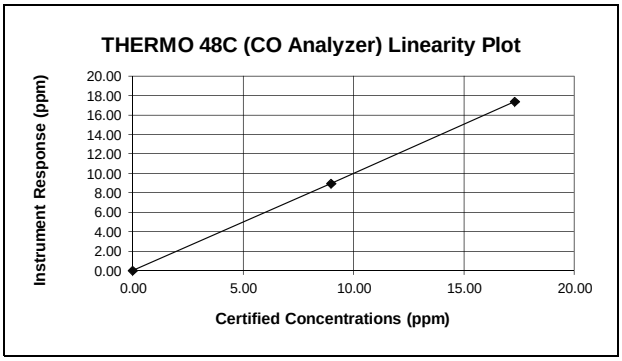
| SERVOMEX 1400 ($CO_2$ Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (%) | Instrument Response (%) | Calibration Error (%) | Absolute Conc. (%) | Pass or Fail (±2%, ≤0.5%) |
| 0.00 | 0.00 | 0.00 | 0.00 | YES (%) |
| 9.42 | 9.45 | 0.16 | 0.03 | YES (%) |
| 18.50 | 18.57 | 0.38 | 0.07 | YES (%) |
| Linearity = 0.996 | | | | |



**Calibration Date:** March 13, 2014
**Client:** John Zink Co, LLC

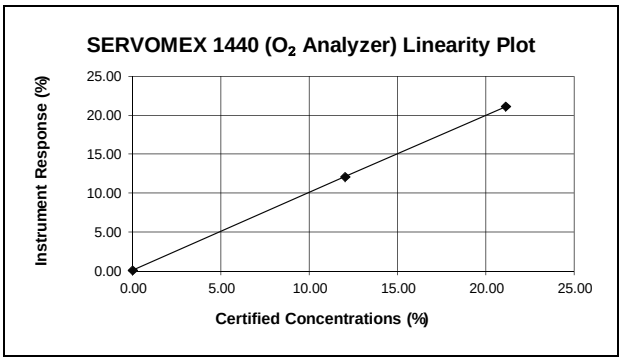
CO Span (ppm) = 17.30

| THERMO 48C (CO Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (ppm) | Instrument Response (ppm) | Calibration Error (%) | Absolute Conc. (ppm) | Pass or Fail (±2%, ≤0.5ppm) |
| 0.00 | 0.01 | 0.06 | 0.01 | YES (%) |
| 8.98 | 8.95 | -0.17 | 0.03 | YES (%) |
| 17.30 | 17.36 | 0.35 | 0.06 | YES (%) |
| Linearity = 0.997 | | | | |




O2 Span (%) = 21.10

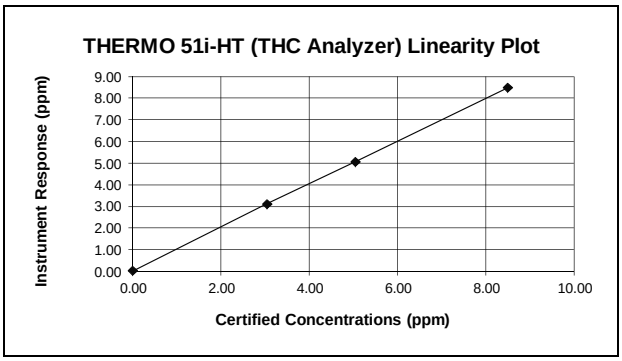
| SERVOMEX 1440 ($O_2$ Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (%) | Instrument Response (%) | Calibration Error (%) | Absolute Conc. (%) | Pass or Fail (±2%, ≤0.5%) |
| 0.00 | 0.09 | 0.43 | 0.09 | YES (%) |
| 12.00 | 12.09 | 0.43 | 0.09 | YES (%) |
| 21.10 | 21.09 | -0.05 | 0.01 | YES (%) |
| Linearity = 1.005 | | | | |




THC Range (ppm) = 10

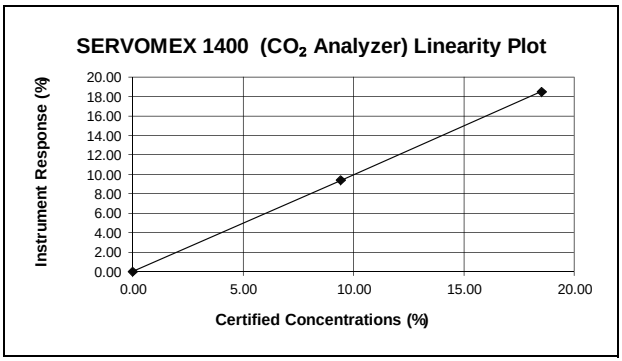
| THERMO 51i-HT (THC Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (ppm) | Instrument Response (ppm) | Calibration Error (%) | Estimated Point (ppm) | Pass or Fail (±2,5%)[1] |
| 0.00 | 0.03 | 0.30 | N/A | YES |
| 3.04 | 3.11 | 1.67 | 3.06 | YES |
| 5.04 | 5.07 | 0.35 | 5.05 | YES |
| 8.48 | 8.48 | 0.00 | N/A | YES |
| Linearity = 1.013 | | | | |

[1]-zero/high based on 2% of span,low/mid based on 5% of concentration




CO2 Span (%) = 18.50

| SERVOMEX 1400 ($CO_2$ Analyzer) | | | | |
|---|---|---|---|---|
| Certified Concentration (%) | Instrument Response (%) | Calibration Error (%) | Absolute Conc. (%) | Pass or Fail (±2%, ≤0.5%) |
| 0.00 | 0.01 | 0.05 | 0.01 | YES (%) |
| 9.42 | 9.39 | -0.16 | 0.03 | YES (%) |
| 18.50 | 18.47 | -0.16 | 0.03 | YES (%) |
| Linearity = 1.002 | | | | |



| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 0-30-0 Load, Run - 4.0X30PF R1 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.87 | 1.04 | 0.11 | 5.91 |
| Corrected Average | 12.80 | 1.06 | 0.12 | 5.94 |
| Initial Zero | 0.07 | 0.01 | -0.01 | 0.04 |
| Final Zero | 0.01 | 0.05 | 0.01 | 0.01 |
| Avg. Zero | 0.04 | 0.03 | 0.00 | 0.03 |
| Initial UpScale | 12.11 | 8.78 | 3.14 | 9.40 |
| Final UpScale | 12.02 | 8.46 | 3.00 | 9.31 |
| Avg. UpScale | 12.07 | 8.62 | 3.07 | 9.36 |
| Sys Resp (Zero) | 0.04 | 0.03 | 0.04 | 0.01 |
| Sys Resp (Upscale) | 12.01 | 8.77 | 3.03 | 9.43 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.14% | -0.12% | -0.50% | 0.16% |
| Final Zero Bias | -0.14% | 0.12% | -0.30% | 0.00% |
| Zero Drift | 0.28% | 0.23% | 0.20% | 0.16% |
| Initial Upscale Bias | 0.47% | 0.06% | 1.10% | -0.16% |
| Final Upscale Bias | 0.05% | -1.79% | -0.30% | -0.65% |
| Upscale Drift | 0.43% | 1.85% | 1.40% | 0.49% |
| Alternative Specification Abs Diff: Initial Zero | 0.03 | 0.02 | -- | 0.03 |
| Alternative Specification Abs Diff: Final Zero | 0.03 | 0.02 | -- | 0.00 |
| Alternative Specification Abs Diff: Initial Upscale | 0.10 | 0.01 | -- | 0.03 |
| Alternative Specification Abs Diff: Final Upscale | 0.01 | 0.31 | -- | 0.12 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 0-30-0 Load, Run - 4.0X30PF R2 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.88 | 0.58 | 0.08 | 6.01 |
| Corrected Average | 12.87 | 0.50 | 0.06 | 6.09 |
| Initial Zero | 0.01 | 0.05 | 0.01 | 0.01 |
| Final Zero | 0.01 | 0.14 | 0.02 | 0.04 |
| Avg. Zero | 0.01 | 0.10 | 0.02 | 0.03 |
| Initial UpScale | 12.02 | 8.46 | 3.00 | 9.31 |
| Final UpScale | 12.00 | 8.88 | 2.94 | 9.23 |
| Avg. UpScale | 12.01 | 8.67 | 2.97 | 9.27 |
| Sys Resp (Zero) | 0.04 | 0.03 | 0.04 | 0.01 |
| Sys Resp (Upscale) | 12.01 | 8.77 | 3.03 | 9.43 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | -0.14% | 0.12% | -0.30% | 0.00% |
| Final Zero Bias | -0.14% | 0.64% | -0.20% | 0.16% |
| Zero Drift | 0.00% | 0.52% | 0.10% | 0.16% |
| Initial Upscale Bias | 0.05% | -1.79% | -0.30% | -0.65% |
| Final Upscale Bias | -0.05% | 0.64% | -0.90% | -1.08% |
| Upscale Drift | 0.09% | 2.43% | 0.60% | 0.43% |
| Alternative Specification Abs Diff: Initial Zero | 0.03 | 0.02 | -- | 0.00 |
| Alternative Specification Abs Diff: Final Zero | 0.03 | 0.11 | -- | 0.03 |
| Alternative Specification Abs Diff: Initial Upscale | 0.01 | 0.31 | -- | 0.12 |
| Alternative Specification Abs Diff: Final Upscale | 0.01 | 0.11 | -- | 0.20 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 0-30-0 Load, Run - 4.0X30PF R3 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.99 | 0.86 | 0.09 | 5.83 |
| Corrected Average | 12.98 | 0.76 | 0.06 | 5.93 |
| Initial Zero | 0.01 | 0.14 | 0.02 | 0.04 |
| Final Zero | 0.01 | 0.13 | 0.04 | 0.03 |
| Avg. Zero | 0.01 | 0.14 | 0.03 | 0.04 |
| Initial UpScale | 12.00 | 8.88 | 2.94 | 9.23 |
| Final UpScale | 12.01 | 8.49 | 2.96 | 9.28 |
| Avg. UpScale | 12.01 | 8.69 | 2.95 | 9.26 |
| Sys Resp (Zero) | 0.04 | 0.03 | 0.04 | 0.01 |
| Sys Resp (Upscale) | 12.01 | 8.77 | 3.03 | 9.43 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | -0.14% | 0.64% | -0.20% | 0.16% |
| Final Zero Bias | -0.14% | 0.58% | 0.00% | 0.11% |
| Zero Drift | 0.00% | 0.06% | 0.20% | 0.05% |
| Initial Upscale Bias | -0.05% | 0.64% | -0.90% | -1.08% |
| Final Upscale Bias | 0.00% | -1.62% | -0.70% | -0.81% |
| Upscale Drift | 0.05% | 2.25% | 0.20% | 0.27% |
| Alternative Specification Abs Diff: Initial Zero | 0.03 | 0.11 | -- | 0.03 |
| Alternative Specification Abs Diff: Final Zero | 0.03 | 0.10 | -- | 0.02 |
| Alternative Specification Abs Diff: Initial Upscale | 0.01 | 0.11 | -- | 0.20 |
| Alternative Specification Abs Diff: Final Upscale | 0.00 | 0.28 | -- | 0.15 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 30-70-30 Load, Run - 4.0X30PF R4 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.52 | 1.30 | 0.13 | 6.00 |
| Corrected Average | 12.51 | 1.17 | 0.15 | 6.03 |
| Initial Zero | 0.12 | 0.18 | -0.03 | 0.01 |
| Final Zero | 0.12 | 0.10 | -0.03 | 0.04 |
| Avg. Zero | 0.12 | 0.14 | -0.03 | 0.03 |
| Initial UpScale | 12.01 | 9.00 | 3.02 | 9.33 |
| Final UpScale | 12.02 | 9.03 | 3.07 | 9.38 |
| Avg. UpScale | 12.02 | 9.02 | 3.05 | 9.36 |
| Sys Resp (Zero) | 0.08 | -0.01 | -0.03 | 0.00 |
| Sys Resp (Upscale) | 12.06 | 8.90 | 3.07 | 9.45 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.19% | 1.10% | 0.00% | 0.05% |
| Final Zero Bias | 0.19% | 0.64% | 0.00% | 0.22% |
| Zero Drift | 0.00% | 0.46% | 0.00% | 0.16% |
| Initial Upscale Bias | -0.24% | 0.58% | -0.50% | -0.65% |
| Final Upscale Bias | -0.19% | 0.75% | 0.00% | -0.38% |
| Upscale Drift | 0.05% | 0.17% | 0.50% | 0.27% |
| Alternative Specification Abs Diff: Initial Zero | 0.04 | 0.19 | -- | 0.01 |
| Alternative Specification Abs Diff: Final Zero | 0.04 | 0.11 | -- | 0.04 |
| Alternative Specification Abs Diff: Initial Upscale | 0.05 | 0.10 | -- | 0.12 |
| Alternative Specification Abs Diff: Final Upscale | 0.04 | 0.13 | -- | 0.07 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 30-70-30 Load, Run - 4.0X30PF R5 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.92 | 1.13 | 0.04 | 6.08 |
| Corrected Average | 12.92 | 1.01 | 0.07 | 6.10 |
| Initial Zero | 0.12 | 0.10 | -0.03 | 0.04 |
| Final Zero | 0.10 | 0.16 | -0.02 | 0.05 |
| Avg. Zero | 0.11 | 0.13 | -0.03 | 0.05 |
| Initial UpScale | 12.02 | 9.03 | 3.07 | 9.38 |
| Final UpScale | 12.00 | 8.98 | 3.06 | 9.34 |
| Avg. UpScale | 12.01 | 9.01 | 3.07 | 9.36 |
| Sys Resp (Zero) | 0.08 | -0.01 | -0.03 | 0.00 |
| Sys Resp (Upscale) | 12.06 | 8.90 | 3.07 | 9.45 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.19% | 0.64% | 0.00% | 0.22% |
| Final Zero Bias | 0.09% | 0.98% | 0.10% | 0.27% |
| Zero Drift | 0.09% | 0.35% | 0.10% | 0.05% |
| Initial Upscale Bias | -0.19% | 0.75% | 0.00% | -0.38% |
| Final Upscale Bias | -0.28% | 0.46% | -0.10% | -0.59% |
| Upscale Drift | 0.09% | 0.29% | 0.10% | 0.22% |
| Alternative Specification Abs Diff: Initial Zero | 0.04 | 0.11 | -- | 0.04 |
| Alternative Specification Abs Diff: Final Zero | 0.02 | 0.17 | -- | 0.05 |
| Alternative Specification Abs Diff: Initial Upscale | 0.04 | 0.13 | -- | 0.07 |
| Alternative Specification Abs Diff: Final Upscale | 0.06 | 0.08 | -- | 0.11 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 30-70-30 Load, Run - 4.0X30PF R6 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.95 | 1.30 | 0.01 | 5.99 |
| Corrected Average | 12.96 | 1.20 | 0.06 | 5.99 |
| Initial Zero | 0.10 | 0.16 | -0.02 | 0.05 |
| Final Zero | 0.09 | 0.08 | -0.07 | 0.06 |
| Avg. Zero | 0.10 | 0.12 | -0.05 | 0.06 |
| Initial UpScale | 12.00 | 8.98 | 3.06 | 9.34 |
| Final UpScale | 11.99 | 8.94 | 3.03 | 9.44 |
| Avg. UpScale | 12.00 | 8.96 | 3.05 | 9.39 |
| Sys Resp (Zero) | 0.08 | -0.01 | -0.03 | 0.00 |
| Sys Resp (Upscale) | 12.06 | 8.90 | 3.07 | 9.45 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.09% | 0.98% | 0.10% | 0.27% |
| Final Zero Bias | 0.05% | 0.52% | -0.40% | 0.32% |
| Zero Drift | 0.05% | 0.46% | 0.50% | 0.05% |
| Initial Upscale Bias | -0.28% | 0.46% | -0.10% | -0.59% |
| Final Upscale Bias | -0.33% | 0.23% | -0.40% | -0.05% |
| Upscale Drift | 0.05% | 0.23% | 0.30% | 0.54% |
| Alternative Specification Abs Diff: Initial Zero | 0.02 | 0.17 | -- | 0.05 |
| Alternative Specification Abs Diff: Final Zero | 0.01 | 0.09 | -- | 0.06 |
| Alternative Specification Abs Diff: Initial Upscale | 0.06 | 0.08 | -- | 0.11 |
| Alternative Specification Abs Diff: Final Upscale | 0.07 | 0.04 | -- | 0.01 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 70-100-70 Load, Run - 4.0X30PF R7 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.97 | 0.10 | 0.01 | 6.13 |
| Corrected Average | 12.99 | 0.03 | 0.06 | 6.12 |
| Initial Zero | 0.09 | 0.08 | -0.07 | 0.06 |
| Final Zero | 0.09 | 0.06 | -0.03 | 0.05 |
| Avg. Zero | 0.09 | 0.07 | -0.05 | 0.06 |
| Initial UpScale | 11.99 | 8.94 | 3.03 | 9.44 |
| Final UpScale | 11.97 | 8.94 | 3.00 | 9.37 |
| Avg. UpScale | 11.98 | 8.94 | 3.02 | 9.41 |
| Sys Resp (Zero) | 0.08 | -0.01 | -0.03 | 0.00 |
| Sys Resp (Upscale) | 12.06 | 8.90 | 3.07 | 9.45 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.05% | 0.52% | -0.40% | 0.32% |
| Final Zero Bias | 0.05% | 0.40% | 0.00% | 0.27% |
| Zero Drift | 0.00% | 0.12% | 0.40% | 0.05% |
| Initial Upscale Bias | -0.33% | 0.23% | -0.40% | -0.05% |
| Final Upscale Bias | -0.43% | 0.23% | -0.70% | -0.43% |
| Upscale Drift | 0.09% | 0.00% | 0.30% | 0.38% |
| Alternative Specification Abs Diff: Initial Zero | 0.01 | 0.09 | -- | 0.06 |
| Alternative Specification Abs Diff: Final Zero | 0.01 | 0.07 | -- | 0.05 |
| Alternative Specification Abs Diff: Initial Upscale | 0.07 | 0.04 | -- | 0.01 |
| Alternative Specification Abs Diff: Final Upscale | 0.09 | 0.04 | -- | 0.08 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 70-100-70 Load, Run - 4.0X30PF R8 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.69 | 0.34 | -0.01 | 6.11 |
| Corrected Average | 12.73 | 0.29 | 0.02 | 6.10 |
| Initial Zero | 0.09 | 0.06 | -0.03 | 0.05 |
| Final Zero | 0.06 | 0.06 | -0.03 | 0.05 |
| Avg. Zero | 0.08 | 0.06 | -0.03 | 0.05 |
| Initial UpScale | 11.97 | 8.94 | 3.00 | 9.37 |
| Final UpScale | 11.98 | 8.87 | 2.95 | 9.45 |
| Avg. UpScale | 11.98 | 8.91 | 2.98 | 9.41 |
| Sys Resp (Zero) | 0.08 | -0.01 | -0.03 | 0.00 |
| Sys Resp (Upscale) | 12.06 | 8.90 | 3.07 | 9.45 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.05% | 0.40% | 0.00% | 0.27% |
| Final Zero Bias | -0.09% | 0.40% | 0.00% | 0.27% |
| Zero Drift | 0.14% | 0.00% | 0.00% | 0.00% |
| Initial Upscale Bias | -0.43% | 0.23% | -0.70% | -0.43% |
| Final Upscale Bias | -0.38% | -0.17% | -1.20% | 0.00% |
| Upscale Drift | 0.05% | 0.40% | 0.50% | 0.43% |
| Alternative Specification Abs Diff: Initial Zero | 0.01 | 0.07 | -- | 0.05 |
| Alternative Specification Abs Diff: Final Zero | 0.02 | 0.07 | -- | 0.05 |
| Alternative Specification Abs Diff: Initial Upscale | 0.09 | 0.04 | -- | 0.08 |
| Alternative Specification Abs Diff: Final Upscale | 0.08 | 0.03 | -- | 0.00 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

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| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 70-100-70 Load, Run - 4.0X30PF R9 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.90 | 0.53 | 0.11 | 6.01 |
| Corrected Average | 12.83 | 0.55 | 0.07 | 6.02 |
| Initial Zero | 0.11 | -0.07 | 0.04 | 0.02 |
| Final Zero | 0.12 | 0.04 | 0.03 | 0.06 |
| Avg. Zero | 0.12 | -0.02 | 0.04 | 0.04 |
| Initial UpScale | 12.13 | 8.93 | 3.12 | 9.37 |
| Final UpScale | 12.01 | 9.00 | 3.00 | 9.42 |
| Avg. UpScale | 12.07 | 8.97 | 3.06 | 9.40 |
| Sys Resp (Zero) | 0.09 | 0.01 | 0.03 | 0.01 |
| Sys Resp (Upscale) | 12.09 | 8.95 | 3.11 | 9.39 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.09% | -0.46% | 0.10% | 0.05% |
| Final Zero Bias | 0.14% | 0.17% | 0.00% | 0.27% |
| Zero Drift | 0.05% | 0.64% | 0.10% | 0.22% |
| Initial Upscale Bias | 0.19% | -0.12% | 0.10% | -0.11% |
| Final Upscale Bias | -0.38% | 0.29% | -1.10% | 0.16% |
| Upscale Drift | 0.57% | 0.40% | 1.20% | 0.27% |
| Alternative Specification Abs Diff: Initial Zero | 0.02 | 0.08 | -- | 0.01 |
| Alternative Specification Abs Diff: Final Zero | 0.03 | 0.03 | -- | 0.05 |
| Alternative Specification Abs Diff: Initial Upscale | 0.04 | 0.02 | -- | 0.02 |
| Alternative Specification Abs Diff: Final Upscale | 0.08 | 0.05 | -- | 0.03 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 90-100 Load, Run - 4.0X30PF R10 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.82 | 0.32 | 0.09 | 6.04 |
| Corrected Average | 12.84 | 0.26 | 0.06 | 6.01 |
| Initial Zero | 0.12 | 0.04 | 0.03 | 0.06 |
| Final Zero | 0.09 | 0.07 | 0.03 | 0.08 |
| Avg. Zero | 0.11 | 0.06 | 0.03 | 0.07 |
| Initial UpScale | 12.01 | 9.00 | 3.00 | 9.42 |
| Final UpScale | 11.97 | 9.11 | 3.05 | 9.44 |
| Avg. UpScale | 11.99 | 9.06 | 3.03 | 9.43 |
| Sys Resp (Zero) | 0.09 | 0.01 | 0.03 | 0.01 |
| Sys Resp (Upscale) | 12.09 | 8.95 | 3.11 | 9.39 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.14% | 0.17% | 0.00% | 0.27% |
| Final Zero Bias | 0.00% | 0.35% | 0.00% | 0.38% |
| Zero Drift | 0.14% | 0.17% | 0.00% | 0.11% |
| Initial Upscale Bias | -0.38% | 0.29% | -1.10% | 0.16% |
| Final Upscale Bias | -0.57% | 0.92% | -0.60% | 0.27% |
| Upscale Drift | 0.19% | 0.64% | 0.50% | 0.11% |
| Alternative Specification Abs Diff: Initial Zero | 0.03 | 0.03 | -- | 0.05 |
| Alternative Specification Abs Diff: Final Zero | 0.00 | 0.06 | -- | 0.07 |
| Alternative Specification Abs Diff: Initial Upscale | 0.08 | 0.05 | -- | 0.03 |
| Alternative Specification Abs Diff: Final Upscale | 0.12 | 0.16 | -- | 0.05 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

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| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 90-100 Load, Run - 4.0X30PF R11 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.60 | 0.05 | 0.08 | 6.19 |
| Corrected Average | 12.67 | 0.00 | 0.07 | 6.15 |
| Initial Zero | 0.09 | 0.07 | 0.03 | 0.08 |
| Final Zero | 0.05 | 0.19 | -0.02 | 0.09 |
| Avg. Zero | 0.07 | 0.13 | 0.01 | 0.09 |
| Initial UpScale | 11.97 | 9.11 | 3.05 | 9.44 |
| Final UpScale | 11.91 | 9.11 | 3.05 | 9.42 |
| Avg. UpScale | 11.94 | 9.11 | 3.05 | 9.43 |
| Sys Resp (Zero) | 0.09 | 0.01 | 0.03 | 0.01 |
| Sys Resp (Upscale) | 12.09 | 8.95 | 3.11 | 9.39 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | 0.00% | 0.35% | 0.00% | 0.38% |
| Final Zero Bias | -0.19% | 1.04% | -0.50% | 0.43% |
| Zero Drift | 0.19% | 0.69% | 0.50% | 0.05% |
| Initial Upscale Bias | -0.57% | 0.92% | -0.60% | 0.27% |
| Final Upscale Bias | -0.85% | 0.92% | -0.60% | 0.16% |
| Upscale Drift | 0.28% | 0.00% | 0.00% | 0.11% |
| Alternative Specification Abs Diff: Initial Zero | 0.00 | 0.06 | -- | 0.07 |
| Alternative Specification Abs Diff: Final Zero | 0.04 | 0.18 | -- | 0.08 |
| Alternative Specification Abs Diff: Initial Upscale | 0.12 | 0.16 | -- | 0.05 |
| Alternative Specification Abs Diff: Final Upscale | 0.18 | 0.16 | -- | 0.03 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

| DRIFT AND BIAS CHECK | | | | |
|---|---|---|---|---|
| 90-100 Load, Run - 4.0X30PF R12 | $O_2$ | CO | THC | $CO_2$ |
| Raw Average | 12.64 | 0.12 | 0.07 | 6.16 |
| Corrected Average | 12.70 | 0.02 | 0.10 | 6.16 |
| Initial Zero | 0.05 | 0.19 | -0.02 | 0.09 |
| Final Zero | 0.07 | 0.01 | -0.03 | 0.05 |
| Avg. Zero | 0.06 | 0.10 | -0.03 | 0.07 |
| Initial UpScale | 11.91 | 9.11 | 3.05 | 9.42 |
| Final UpScale | 11.99 | 9.01 | 3.04 | 9.33 |
| Avg. UpScale | 11.95 | 9.06 | 3.05 | 9.38 |
| Sys Resp (Zero) | 0.09 | 0.01 | 0.03 | 0.01 |
| Sys Resp (Upscale) | 12.09 | 8.95 | 3.11 | 9.39 |
| Upscale Cal Gas | 12.00 | 8.98 | 3.04 | 9.42 |
| Initial Zero Bias | -0.19% | 1.04% | -0.50% | 0.43% |
| Final Zero Bias | -0.09% | 0.00% | -0.60% | 0.22% |
| Zero Drift | 0.09% | 1.04% | 0.10% | 0.22% |
| Initial Upscale Bias | -0.85% | 0.92% | -0.60% | 0.16% |
| Final Upscale Bias | -0.47% | 0.35% | -0.70% | -0.32% |
| Upscale Drift | 0.38% | 0.58% | 0.10% | 0.49% |
| Alternative Specification Abs Diff: Initial Zero | 0.04 | 0.18 | -- | 0.08 |
| Alternative Specification Abs Diff: Final Zero | 0.02 | 0.00 | -- | 0.04 |
| Alternative Specification Abs Diff: Initial Upscale | 0.18 | 0.16 | -- | 0.03 |
| Alternative Specification Abs Diff: Final Upscale | 0.10 | 0.06 | -- | 0.06 |
| Calibration Span | 21.10 | 17.30 | 10.00 | 18.50 |
| 3% of Cal. Span (drift) | 0.63 | 0.52 | 0.30 | 0.56 |
| 5% of Cal. Span (bias) | 1.06 | 0.87 | 0.50 | 0.93 |

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APEX INSTRUMENTS SOURCE TESTING EQUIPMENT

Apex Instruments, Inc.
204 Technology Park Lane
Fuquay-Varina, NC 27526

# S-TYPE PITOT TUBE CALIBRATION SHEET

***Reference USEPA Reference Method 2 (40CFR60, App. A, Meth. 2)***

| | | | | |
|---|---|---|---|---|
| PITOT SERIAL# | 4174 | CALIBRATION DATE: | 11-Jan-13 | |
| PITOT TYPE: | S-Type | BAROMETRIC PRESSURE: | 29.88 | in Hg |
| STD. PITOT TYPE: | Ellipsoidal | STATIC PRESSURE | 1.4 | in $H_20$ |
| Cp(std): | 0.990 | BLOCKAGE %: | N/A | |
| PROBE SERIAL# | NICK | CORRECTION FACTOR: | 1.00 | |

| | SIDE "A" CALIBRATION | | | |
|---|---|---|---|---|
| RUN NO. | Δ Pstd in $H_2O$ | Δ Ps in $H_2O$ | Cp(s) | DEVIATION Cp(s) - avg.Cp(s) |
| 1 | 0.560 | 0.820 | 0.818 | 0.000 |
| 2 | 0.560 | 0.820 | 0.818 | 0.000 |
| 3 | 0.560 | 0.820 | 0.818 | 0.000 |
| | | *"A" AVERAGE* | 0.818 | 0.0000 (must be ≤ 0.01) |

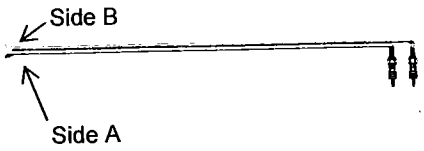
| | SIDE "B" CALIBRATION | | | |
|---|---|---|---|---|
| RUN NO. | Δ Pstd in $H_2O$ | Δ Ps in $H_2O$ | Cp(s) | DEVIATION Cp(s) - avg.Cp(s) |
| 1 | 0.560 | 0.815 | 0.821 | 0.000 |
| 2 | 0.560 | 0.815 | 0.821 | 0.000 |
| 3 | 0.560 | 0.815 | 0.821 | 0.000 |
| | | *"B" AVERAGE* | 0.821 | 0.0000 (must be ≤ 0.01) |

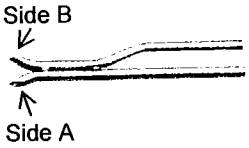
**ACCEPTANCE CRITERIA**

**AVERAGE** -0.0025 AVG. Cp (A) - AVG. Cp (B) must be ≤ 0.01

**If the Average <u>and</u> both Deviation Averages "A" & "B" are ≤ 0.01, then the OVERALL AVERAGE below may be used.**
*** If NOT, use the "A" Average <u>OR</u> "B" Average.**

**OVERALL AVERAGE** 0.8194




I certify that the above pitot tube was tested in accordance with the US EPA Method 2 standards.
See the Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 2, Item 4.

Print Name: Nick Allen

Signature: Nick Allen

Date 1.11.13

**WEATHER STATION CALIBRATION SHEET**
**Temperature, Barometric Pressure, and Relative Humidity Periodic Calibration**
**Air Hygiene Asset ID: samp-we-0021**

Filename: \\SERVER2\public\Shared\QAQC\Calibrations\Weather Stations\2013\[Weather Station Calibration_samp-we-0021.xlsm]100913
Make: Kestrel
Model #: 4000
Serial #: 686543

NIST ID 21470653
NIST S/N 21470653
Cal Due 10/9/2014

| ASTM Temp (deg F) | Thermo. (deg F) | ± deg F | ASTM Barometer (in. Hg) | Barometric (in. Hg) | ± in. Hg |
|---|---|---|---|---|---|
| 68.00 | 68.50 | 0.50 | 29.44 | 29.28 | 0.16 |

Sean Barnes — 10/09/13
(signature) (date)

| ASTM Temp (deg F) | Thermo. (deg F) | ± deg F | ASTM Barometer (in. Hg) | Barometric (in. Hg) | ± in. Hg |
|---|---|---|---|---|---|
| 68.00 | 68.40 | 0.40 | 29.44 | 29.27 | 0.17 |

Sean Barnes — 10/09/13
(signature) (date)

| ASTM Temp (deg F) | Thermo. (deg F) | ± deg F | ASTM Barometer (in. Hg) | Barometric (in. Hg) | ± in. Hg |
|---|---|---|---|---|---|
| 68.00 | 68.50 | 0.50 | 29.44 | 29.28 | 0.16 |

Sean Barnes — 10/09/13
(signature) (date)

| ASTM Temp (deg F) | Thermo. (deg F) | ± deg F | ASTM Barometer (in. Hg) | Barometric (in. Hg) | ± in. Hg |
|---|---|---|---|---|---|
| 68.00 | 68.60 | 0.60 | 29.44 | 29.28 | 0.16 |

Sean Barnes — 10/09/13
(signature) (date)

Note: Calibrated against NIST Traceable Barometer and Thermometer (SAMP-WE-0100).

Standard for Calibration of Individual Thermocouples

EMC, ALT-011: After each test run series, check the accuracy (and, hence, the calibration) of each thermocouple system at ambient temperature, or any other temperature, within the range specified by the manufacturer, using a reference thermometer (either ASTM reference thermometer or a thermometer that has been calibrated against an ASTM reference thermometer). The temperatures of the thermocouple and reference thermometers shall **agree to within ±2F**.

Standard of Calibration for Barometers

40 CFR Part 60, Appendix A, Method 5, Section:
6.0____Equipment and Supplies, 6.1____Sample Collection., 6.1.2____Barometer. Mercury, aneroid, or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in.).
10.0____Calibration and Standardization, 10.6____Barometer. Calibrate against a mercury barometer.

**METERING SYSTEM DRY GAS METER CALIBRATION SHEET**
**EPA Reference Method**
**Metering System Pre-Test Calibration**
**Air Hygiene Assett ID: samp-cp-0008**

Filename: N:\Shared\QAQC\Calibrations\PM-Equipment\M-5 Consoles\Calibration Sheet v4.1\Current\[SAMP-CP-0008 Calibration 3-3-14.xls]Original (5 point)

Make: Thermo Environmental
Model #: MST-C1
Serial #: 90706

Date: 03/03/14
Barometric Pressure: 29.92 (in. Hg)
Theoretical Critical Vacuum: 14.11 (in. Hg)

**DRY GAS METER READINGS**

| ΔH (in. H2O) | Time (min) | Volume Initial (ft³) | Volume Final (ft³) | Volume Total (ft³) | Initial Temperature Inlet (°F) | Initial Temperature Outlet (°F) |
|---|---|---|---|---|---|---|
| 0.26 | 17.00 | 831.020 | 836.670 | 5.650 | 75.0 | 69.0 |
| 0.55 | 12.00 | 836.670 | 842.380 | 5.710 | 75.0 | 70.0 |
| 1.10 | 10.00 | 842.380 | 848.800 | 6.420 | 76.0 | 71.0 |
| 2.00 | 10.00 | 848.800 | 857.520 | 8.720 | 78.0 | 71.0 |
| 3.50 | 10.00 | 857.520 | 868.930 | 11.410 | 79.0 | 72.0 |

| Final Temperature Inlet (°F) | Final Temperature Outlet (°F) | Orifice Serial# (number) | K' Orifice Coefficient (see above) | Actual Vacuum (in. Hg) | Ambient Temperature Initial (°F) | Ambient Temperature Final (°F) | Ambient Temperature Average (°F) |
|---|---|---|---|---|---|---|---|
| 75.0 | 70.0 | 40 | 0.2346 | 16.0 | 66.7 | 67.1 | 66.9 |
| 77.0 | 71.0 | 48 | 0.3355 | 16.0 | 67.1 | 67.8 | 67.5 |
| 77.0 | 71.0 | 55 | 0.4522 | 16.0 | 68.1 | 68.1 | 68.1 |
| 80.0 | 72.0 | 63 | 0.6118 | 16.0 | 68.1 | 68.7 | 68.4 |
| 80.0 | 72.0 | 73 | 0.8022 | 15.5 | 68.7 | 68.9 | 68.8 |

**RESULTS**

| DRY GAS METER VOLUME CORRECTED Vm(std) (ft³) | DRY GAS METER VOLUME CORRECTED Vm(std) (liters) | ORIFICE VOLUME CORRECTED Vcr(std) (ft³) | ORIFICE VOLUME CORRECTED Vcr(std) (liters) | ORIFICE VOLUME NOMINAL Vcr (ft³) |
|---|---|---|---|---|
| 5.606 | 158.77 | 5.198 | 147.2 | 5.190 |
| 5.659 | 160.27 | 5.245 | 148.5 | 5.242 |
| 6.365 | 180.27 | 5.888 | 166.7 | 5.891 |
| 8.641 | 244.70 | 7.963 | 225.5 | 7.972 |
| 11.337 | 321.07 | 10.438 | 295.6 | 10.458 |

| DRY GAS METER CALIBRATION FACTOR Y Variation (number) | DRY GAS METER CALIBRATION FACTOR Y Value (number) | ORIFICE CALIBRATION FACTOR ΔH@ Value (in. H2O) | ORIFICE CALIBRATION FACTOR ΔH@ Value (mm H2O) | ORIFICE CALIBRATION FACTOR ΔH@ Variation (in. H2O) |
|---|---|---|---|---|
| 0.003 | 0.927 | 1.560 | 39.61 | -0.141 |
| 0.003 | 0.927 | 1.612 | 40.94 | -0.089 |
| 0.001 | 0.925 | 1.775 | 45.08 | 0.074 |
| -0.003 | 0.922 | 1.762 | 44.76 | 0.062 |
| -0.004 | 0.921 | 1.794 | 45.56 | 0.093 |
| **AVERAGE:** | **0.924** | **1.700** | 43.19 | **PASSED** |

Notes:

For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter,acceptable tolerance of individual values from the average is +/- 0.02. For Orifice Calibration Factor dH@, the orifice differential pressure in inches of $H_20$ that equates to 0.75 cfm of air at 68 °F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is +/- 0.2. For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above. The Critical Orifice Coefficient, K', must be entered in English units, (ft)^3*(deg R)^0.5/((in.Hg)*(min)).

SIGNATURE: Craig McCarty

DATE: 03/03/14 03/03/14

## METERING SYSTEM THERMOCOUPLE CALIBRATION SHEET
### EPA Reference Method
### Metering System Pre-Test Calibration
### Air Hygiene Assett ID: samp-cp-0008

Filename: N:\Shared\QAQC\Calibrations\PM-Equipment\M-5 Consoles\Calibration Sheet v4.1\Current\[SAMP-CP-0008 Calibration 3-3-14.xls]Original (5 point)

Make: Thermo Environmental
Model #: MST-C1
Serial #: 90706

Date: 03/03/14
Barometric Pressure: 29.92 (in. Hg)
Temperature (ASTM cal): 69.40 (°F)

| Thermocouple | 100 (°F) | | 600 (°F) | | 1200 (°F) | |
|---|---|---|---|---|---|---|
| | Reading | % Error | Reading | % Error | Reading | % Error |
| Stack | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |
| Probe | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |
| Filter | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |
| Dryer | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |
| Aux. | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |

Note: Calibrated against an ALTEK Thermocouple Source Series 22, direct temperature output calibrated to ASTM and IPTS standards as outlined in ALTEK Data Sheet 22.

| Thermocouple | 69.40 (°F) | |
|---|---|---|
| | Reading | (±°F) |
| DGM In | 69.0 | 0.40 |
| DGM Out | 69.0 | 0.40 |

Note: Calibrated against ASTM Reference Thermometer.

SIGNATURE: Craig McCarty DATE: 03/03/14 03/03/14

Standard for Calibration of Console Thermocouple Systems

40 CFR, Part 60
Appendix A, Method 5
10.3.2 The temperature data recorded in the field shall be considered valid. If, during calibration, the absolute temperature measured with the sensor being calibrated and the reference sensor **agree within 1.5 percent**, the temperature data taken in the field shall be considered valid.

Standard for Calibration of Individual Thermocouples

EMC, ALT-011: After each test run series, check the accuracy (and, hence, the calibration) of each thermocouple system at ambient temperature, or any other temperature, within the range specified by the manufacturer, using a reference thermometer (either ASTM reference thermometer or a thermometer that has been calibrated against an ASTM reference thermometer). The temperatures of the thermocouple and reference thermometers shall **agree to within ±2°F**.

**PROBE (STACK), HOTBOX (FILTER), AND GOOSENECK (EXIT) THERMOCOUPLE CALIBRATION SHEET**
**EPA Reference Method**
**Metering System Pre-Test Calibration**

**Air Hygiene Assett ID(s):** **Probe:** samp-hp-0076 **Hotbox:** SAMP-BH-0001 **Gooseneck:** SAMP-AD-0039

Filename: N:\Shared\QAQC\Calibrations\PM-Equipment\M-5 Consoles\Calibration Sheet v4.1\Current\[SAMP-CP-0008 Calibration 3-3-14.xls]Original (5 point)

Barometric Pressure: 29.82

| Thermo-couples | | Temps (°F) | Signature | | Date | |
|---|---|---|---|---|---|---|
| Stack | Ref | 69.80 | Craig McCarty | | 03/03/14 | 03/03/14 |
| | Read | 70.00 | | | | |
| | ±°F | 0.20 | | | | |
| Filter | Ref | 69.80 | Craig McCarty | | 03/03/14 | 03/03/14 |
| | Read | 69.00 | | | | |
| | ±°F | 0.80 | | | | |
| Exit | Ref | 69.80 | Craig McCarty | | 03/03/14 | 03/03/14 |
| | Read | 70.00 | | | | |
| | ±°F | 0.20 | | | | |

Note: Calibrated against ASTM Reference Thermometer.

Standard for Calibration of Individual Thermocouples

EMC, ALT-011: After each test run series, check the accuracy (and, hence, the calibration) of each thermocouple system at ambient temperature, or any other temperature, within the range specified by the manufacturer, using a reference thermometer (either ASTM reference thermometer or a thermometer that has been calibrated against an ASTM reference thermometer). The temperatures of the thermocouple and reference thermometers shall **agree to within ±2°F**.

**METERING SYSTEM DRY GAS METER CALIBRATION SHEET**
**EPA Reference Method**
**Metering System Post-Test Calibration**
**Air Hygiene Assett ID: samp-cp-0008**

Filename: N:\Shared\QAQC\Calibrations\PM-Equipment\M-5 Consoles\Calibration Sheet v4.1\Current\[SAMP-CP-0008 Calibration 3-3-14.xls]3-19-14 (3 point)

Make: Thermo Environmental
Model #: MST-C1
Serial #: 90706

Date: 03/19/14
Barometric Pressure: 29.63 (in. Hg)
Theoretical Critical Vacuum: 13.98 (in. Hg)

**DRY GAS METER READINGS**

| ΔH (in. H2O) | Time (min) | Volume Initial (ft³) | Volume Final (ft³) | Volume Total (ft³) | Initial Temperature Inlet (°F) | Initial Temperature Outlet (°F) |
|---|---|---|---|---|---|---|
| 1.90 | 10.00 | 268.900 | 277.570 | 8.670 | 81.0 | 74.0 |
| 1.90 | 10.00 | 277.570 | 286.250 | 8.680 | 81.0 | 74.0 |
| 1.90 | 10.00 | 286.250 | 294.930 | 8.680 | 81.0 | 74.0 |

| Final Temperature Inlet (°F) | Final Temperature Outlet (°F) | Orifice Serial# (number) | K' Orifice Coefficient (see above) | Actual Vacuum (in. Hg) | Ambient Temperature Initial (°F) | Ambient Temperature Final (°F) | Ambient Temperature Average (°F) |
|---|---|---|---|---|---|---|---|
| 81.0 | 74.0 | 63 | 0.6100 | 16.0 | 71.9 | 71.9 | 71.9 |
| 81.0 | 74.0 | 63 | 0.6100 | 16.0 | 71.9 | 71.9 | 71.9 |
| 81.0 | 74.0 | 63 | 0.6100 | 16.0 | 71.9 | 71.9 | 71.9 |

**RESULTS**

| DRY GAS METER VOLUME CORRECTED Vm(std) (ft³) | DRY GAS METER VOLUME CORRECTED Vm(std) (liters) | ORIFICE VOLUME CORRECTED Vcr(std) (ft³) | ORIFICE VOLUME CORRECTED Vcr(std) (liters) | ORIFICE VOLUME NOMINAL Vcr (ft³) |
|---|---|---|---|---|
| 8.471 | 239.89 | 7.837 | 221.9 | 7.975 |
| 8.480 | 240.16 | 7.837 | 221.9 | 7.975 |
| 8.480 | 240.16 | 7.837 | 221.9 | 7.975 |

| DRY GAS METER CALIBRATION FACTOR Y Variation (number) | DRY GAS METER CALIBRATION FACTOR Y Value (number) | ORIFICE CALIBRATION FACTOR ΔH@ Value (in. H2O) | ORIFICE CALIBRATION FACTOR ΔH@ Value (mm H2O) | ORIFICE CALIBRATION FACTOR ΔH@ Variation (in. H2O) |
|---|---|---|---|---|
| 0.001 | 0.925 | 1.704 | 43.28 | 0.000 |
| 0.000 | 0.924 | 1.704 | 43.28 | 0.000 |
| 0.000 | 0.924 | 1.704 | 43.28 | 0.000 |
| **AVERAGE:** | **0.924** | **1.704** | 43.28 | **PASSED** |
| **LAST 5-PT:** | **0.924** | **1.700** | **PASSED** | 5-PT Date: |
| **% DIFF:** | **0.0%** | **0.2%** | | 03/03/14 |

40 CFR - CHAPTER I - PART 60
Appendix A, Method 5
10.3.2 Calibration After Use
After each field use, the calibration of the metering system shall be checked by performing three calibration runs at a single, intermediate orifice setting (based on the previous field test)....Calculate the average value of the DGM calibration factor. If the value has changed by more than 5 percent, recalibrate the meter over the full range of orifice settings, as detailed in Section 10.3.1.

10.3.3 Acceptable Variation in Calibration
If the DGM coefficient values obtained before and after a test series differ by more than 5 percent, the test series shall either be voided, or calculations for the test series shall be performed using whichever meter coefficient value (i.e., before or after) gives the lower value of total sample volume.

Notes: For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter,acceptable tolerance of individual values from the average is +/- 0.02. For Orifice Calibration Factor dH@, the orifice differential pressure in inches of $H_20$ that equates to 0.75 cfm of air at 68 °F and 29.92 inches of Hg, acceptable tolerance of individual values from the average is +/- 0.2. For valid test results, the Actual Vacuum should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above. The Critical Orifice Coefficient, K', must be entered in English units, (ft)^3*(deg R)^0.5/((in.Hg)*(min)).

SIGNATURE: Craig McCarty DATE: 03/19/14 03/19/14

**METERING SYSTEM THERMOCOUPLE CALIBRATION SHEET**
**EPA Reference Method**
**Metering System Post-Test Calibration**
**Air Hygiene Assett ID: samp-cp-0008**

Filename: N:\Shared\QAQC\Calibrations\PM-Equipment\M-5 Consoles\Calibration Sheet v4.1\Current\[SAMP-CP-0008 Calibration 3-3-14.xls]3-19-14 (3 point)

Make: Thermo Environmental
Model #: MST-C1
Serial #: 90706

Date: 03/19/14
Barometric Pressure: 29.63 (in. Hg)
Temperature (ASTM cal): 71.60 (°F)

| Thermocouple | 100 (°F) | | 600 (°F) | | 1200 (°F) | |
|---|---|---|---|---|---|---|
| | Reading | % Error | Reading | % Error | Reading | % Error |
| Stack | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |
| Probe | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |
| Filter | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |
| Dryer | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |
| Aux. | 101.00 | 0.50 | 601.00 | 0.17 | 1202.00 | 0.17 |

Note: Calibrated against an ALTEK Thermocouple Source Series 22, direct temperature output calibrated to ASTM and IPTS standards as outlined in ALTEK Data Sheet 22.

| Thermocouple | 71.60 (°F) | |
|---|---|---|
| | Reading | (±°F) |
| DGM In | 71.0 | 0.60 |
| DGM Out | 71.0 | 0.60 |

Note: Calibrated against ASTM Reference Thermometer.

SIGNATURE: Craig McCarty DATE: 03/19/14 03/19/14

Standard for Calibration of Console Thermocouple Systems

40 CFR, Part 60
Appendix A, Method 5
10.3.2 The temperature data recorded in the field shall be considered valid. If, during calibration, the absolute temperature measured with the sensor being calibrated and the reference sensor **agree within 1.5 percent**, the temperature data taken in the field shall be considered valid.

Standard for Calibration of Individual Thermocouples

EMC, ALT-011: After each test run series, check the accuracy (and, hence, the calibration) of each thermocouple system at ambient temperature, or any other temperature, within the range specified by the manufacturer, using a reference thermometer (either ASTM reference thermometer or a thermometer that has been calibrated against an ASTM reference thermometer). The temperatures of the thermocouple and reference thermometers shall **agree to within ±2°F**.

**PROBE (STACK), HOTBOX (FILTER), AND GOOSENECK (EXIT) THERMOCOUPLE CALIBRATION SHEET**
**EPA Reference Method**
**Metering System Post-Test Calibration**

**Air Hygiene Assett ID(s):** **Probe:** samp-hp-0033 **Hotbox:** samp-bh-0012 **Gooseneck:** samp-ad-0039

Filename: N:\Shared\QAQC\Calibrations\PM-Equipment\M-5 Consoles\Calibration Sheet v4.1\Current\[SAMP-CP-0008 Calibration 3-3-14.xls]3-19-14 (3 point)

Barometric Pressure: 29.63

| Thermo-couples | | Temps (°F) | Signature | | Date | |
|---|---|---|---|---|---|---|
| Stack | Ref | 71.60 | Craig McCarty | | 03/19/14 | 03/19/14 |
| | Read | 71.00 | | | | |
| | ±°F | 0.60 | | | | |
| Filter | Ref | 71.60 | Craig McCarty | | 03/19/14 | 03/19/14 |
| | Read | 71.00 | | | | |
| | ±°F | 0.60 | | | | |
| Exit | Ref | 71.60 | Craig McCarty | | 03/19/14 | 03/19/14 |
| | Read | 71.00 | | | | |
| | ±°F | 0.60 | | | | |

Note: Calibrated against ASTM Reference Thermometer.

Standard for Calibration of Individual Thermocouples

EMC, ALT-011: After each test run series, check the accuracy (and, hence, the calibration) of each thermocouple system at ambient temperature, or any other temperature, within the range specified by the manufacturer, using a reference thermometer (either ASTM reference thermometer or a thermometer that has been calibrated against an ASTM reference thermometer). The temperatures of the thermocouple and reference thermometers shall **agree to within ±2°F**.

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 LINE 2 TE

DATE: 2-26-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.1 | 145.9 | +/- 5°F |
| 100 | 100.1 | 95.5 | +/- 5°F |
| 32 | 32.0 | 27.1 | +/- 5°F |

Element passed: X Element. replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 L-2 PRESS

DATE: 3-7-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: PSI | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 25.0 | | | 25.1 | 8 (7.9 to 8.1) | | | |
| 50 | 50.0 | | | 50.1 | 12 (11.9 to 12.1) | | | |
| 75 | 75.0 | | | 75.1 | 16 (15.9 to 16.1) | | | |
| 100 | 98.0 | | | 98.2 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: NEW TRANS

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 2 dP

DATE: 2-26-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

+/- 1.5

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: IN/H2O | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0 | 0.05 | | 0.00 | 4 (3.9 to 4.1) | | | |
| 25 | 75.0 | 74.9 | | 74.87 | 8 (7.9 to 8.1) | | | |
| 50 | 150.0 | 149.9 | | 150.04 | 12 (11.9 to 12.1) | | | |
| 75 | 225.0 | 225 | | 225.2 | 16 (15.9 to 16.1) | | | |
| 100 | 298.0 | 298 | | 297.8 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 LINE 3 TE

DATE: 2-26-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.0 | 149.0 | +/- 5°F |
| 100 | 100.0 | 98.5 | +/- 5°F |
| 32 | 32.0 | 29.9 | +/- 5°F |

Element passed: X Element. replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 3 PRESS

DATE: 2-28-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: PSI | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 25.0 | | | 24.9 | 8 (7.9 to 8.1) | | | |
| 50 | 50.0 | | | 49.9 | 12 (11.9 to 12.1) | | | |
| 75 | 75.0 | | | 75.0 | 16 (15.9 to 16.1) | | | |
| 100 | 98.0 | | | 97.8 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal. X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 3 dP

DATE: 2-26-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: IN/H2O | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | 0.0 | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 75.0 | 75.0 | | 74.9 | 8 (7.9 to 8.1) | | | |
| 50 | 150.0 | 150.1 | | 149.8 | 12 (11.9 to 12.1) | | | |
| 75 | 225.0 | 225 | | 224.9 | 16 (15.9 to 16.1) | | | |
| 100 | 298.0 | 298 | | 297.8 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 LINE 4 TE

DATE: 2-26-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.1 | 149.4 | +/- 5°F |
| 100 | 100.0 | 99.0 | +/- 5°F |
| 32 | 31.9 | 30.9 | +/- 5°F |

Element passed: X Element replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 4 PRESS.

DATE: 3-7-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: PSI | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 25.0 | | | 25.2 | 8 (7.9 to 8.1) | | | |
| 50 | 50.0 | | | 50.2 | 12 (11.9 to 12.1) | | | |
| 75 | 75.0 | | | 75.2 | 16 (15.9 to 16.1) | | | |
| 100 | 98.0 | | | 98.2 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 4 dP

DATE: 2-26-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: IN/H2O | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | -0.1 | | 0.0 | 4 (3.9 to 4.1) | 0.1 | | 0.0 |
| 25 | 75.0 | 73.1 | | 73.1 | 8 (7.9 to 8.1) | 75.0 | | 75.2 |
| 50 | 150.0 | 146.3 | | 145.8 | 12 (11.9 to 12.1) | 150.5 | | 150.2 |
| 75 | 225.0 | 219 | | 218.4 | 16 (15.9 to 16.1) | 225 | | 224.9 |
| 100 | 298.0 | 290 | | 289.1 | 20 (19.9 to 20.1) | 298 | | 297.6 |

Trans. passed without cal: _____ Trans. passed with cal.: X Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 Aux. Stack TE (PREHEAT TEMP)

DATE: 3-4-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.0 | 152 | +/- 5°F |
| 100 | 100.0 | 102 | +/- 5°F |
| 32 | 32.0 | 35 | +/- 5°F |

Element passed: X Element. replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 FUEL TEMP TE (Enhanced Gas Temp)

DATE: 3-4-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.0 | 149 | +/- 5°F |
| 100 | 100.0 | 99 | +/- 5°F |
| 32 | 32.0 | 30 | +/- 5°F |

Element passed: X Element. replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 FUEL PRESSURE #2

DATE: 3-4-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: PSI | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | NA | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 20.0 | | | 20.0 | 8 (7.9 to 8.1) | | | |
| 50 | 40.0 | | | 40.0 | 12 (11.9 to 12.1) | | | |
| 75 | 60.0 | | | 60.1 | 16 (15.9 to 16.1) | | | |
| 100 | 78.9 | | | 78.9 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 LINE 2 TE

DATE: 3-21-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.0 | 150.3 | +/- 5°F |
| 100 | 100.0 | 99.4 | +/- 5°F |
| 32 | 32.0 | 31.3 | +/- 5°F |

Element passed: X Element. replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 2 dP

DATE: 1-4-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: IN/H2O +/- 1.5 | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | 0.0 | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 75.0 | 74.8 | | 74.8 | 8 (7.9 to 8.1) | | | |
| 50 | 150.0 | 149.5 | | 149.6 | 12 (11.9 to 12.1) | | | |
| 75 | 225.0 | 224 | | 224.9 | 16 (15.9 to 16.1) | | | |
| 100 | 298.0 | 297 | | 297.5 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 2 PRESS.

DATE: 4-4-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: PSI +/- .5 | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 25.0 | | | 25.1 | 8 (7.9 to 8.1) | | | |
| 50 | 50.0 | | | 50.1 | 12 (11.9 to 12.1) | | | |
| 75 | 75.0 | | | 75.2 | 16 (15.9 to 16.1) | | | |
| 100 | 98.0 | | | 98.2 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 LINE 3 TE

DATE: 3-21-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.0 | 153.3 | +/- 5°F |
| 100 | 100.0 | 103.0 | +/- 5°F |
| 32 | 32.0 | 34.6 | +/- 5°F |

Element passed: X Element. replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 3 dP

DATE: 4-4-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: IN/H2O | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | 0.0 | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 75.0 | 74.9 | | 74.6 | 8 (7.9 to 8.1) | | | |
| 50 | 150.0 | 149.9 | | 149.6 | 12 (11.9 to 12.1) | | | |
| 75 | 225.0 | 225 | | 224.4 | 16 (15.9 to 16.1) | | | |
| 100 | 298.0 | 298 | | 297.4 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 3 PRESS.

DATE: 4-4-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: PSI | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 25.0 | | | 25.1 | 8 (7.9 to 8.1) | | | |
| 50 | 50.0 | | | 49.6 | 12 (11.9 to 12.1) | | | |
| 75 | 75.0 | | | 74.7 | 16 (15.9 to 16.1) | | | |
| 100 | 98.0 | | | 97.8 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 LINE 4 TE

DATE: 3-21-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.0 | 153.3 | +/- 5°F |
| 100 | 100.0 | 103.0 | +/- 5°F |
| 32 | 32.0 | 35.0 | +/- 5°F |

Element passed: X Element replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 4 dP

DATE: 4-4-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: IN/H2O | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | 0.0 | | 0.3 | 4 (3.9 to 4.1) | | | |
| 25 | 75.0 | 75.0 | | 74.9 | 8 (7.9 to 8.1) | | | |
| 50 | 150.0 | 150.4 | | 15.3 | 12 (11.9 to 12.1) | | | |
| 75 | 225.0 | 225 | | 225.2 | 16 (15.9 to 16.1) | | | |
| 100 | 298.0 | 298 | | 297.2 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TRANSMITTER CALIBRATION RECORD

INSTRUMENT TAG: F-13 LINE 4 PRESS.

DATE: 4-4-2014

PROCEDURE

1. Before performing any calibration, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.
2. If any value deviates from the expected value by more than 0.5% of span, perform calibration of the transmitter.
3. If calibration is performed, input all five test points into the transmitter and note down: process value from the transmitter display, milli-amp output values, and the value displayed in the data acquisition system in the appropriate columns.

| % of Span | Process Value | As Found | | | Acceptance Criteria (mA) | After Calibration | | |
|---|---|---|---|---|---|---|---|---|
| | Units: PSI | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value | | Process Value from Transmitter Display | Analog Output (mA) | Data Acquisition Process Value |
| 0 | 0.0 | | | 0.0 | 4 (3.9 to 4.1) | | | |
| 25 | 25.0 | | | 25.1 | 8 (7.9 to 8.1) | | | |
| 50 | 50.0 | | | 50.0 | 12 (11.9 to 12.1) | | | |
| 75 | 75.0 | | | 74.9 | 16 (15.9 to 16.1) | | | |
| 100 | 98.0 | | | 98.2 | 20 (19.9 to 20.1) | | | |

Trans. passed without cal: X Trans. passed with cal.: _____ Trans. replaced: _____

Calibration Performed by: CHARLES CROWN

Date next calibration is to be performed: _____

# TEMPERATURE ELEMENT VERIFICATION RECORD

INSTRUMENT TAG: F-13 FUEL TEMP TE

DATE: 4-4-2014

PROCEDURE

1. If element is connected to a transmitter, calibrate the transmitter first.
2. Insert element into test device, set test device to target temperature, allow temperature of test device to stabilize.
3. Note down the test device temperature in the appropriate column.
4. Note down the data acquisition value in the appropriate column.
5. If data acquisition value is outside the range of the acceptance criteria, replace the element.

| Target Temp. °F | Calibration Instrument Reading °F | Data Acquisition Value °F | Acceptance Criteria (mA) |
|---|---|---|---|
| 150 | 150.0 | 149 | +/- 5°F |
| 100 | 100.0 | 98 | +/- 5°F |
| 32 | 32.0 | 29 | +/- 5°F |

Element passed: X Element. replaced: _____

Verification Performed by: CHARLES CROWN

Date next verification is to be performed: _____

**SERIAL NUMBER 2014135** **04-22-2014**

**COMPONENT VALUES DETERMINED AT CALIBRATION**

**Integral Transducer**

| **PCB 100385** | **PCB 100389** |
|---|---|
| R5 825 | R10 2150 |
| R7 825 | |
| R8 88 | |
| R9 700 | |
| R15 5490 | |

FLOW SENSOR - 50 OHMS NI @ 75 deg F
TEMP SENSOR - 100 OHMS NI @ 75 deg F

**CALIBRATION POTENTIOMETERS**

TA 788 TC 646

**OPERATING RANGE**

| | **minimum** | **maximum** |
|---|---|---|
| FLOW | 0 | 4500 SCFH N2 |
| TEMPERATURE | 40 | 150 F |
| PRESSURE | 0 | 25 PSIG |

**COMMENTS --**

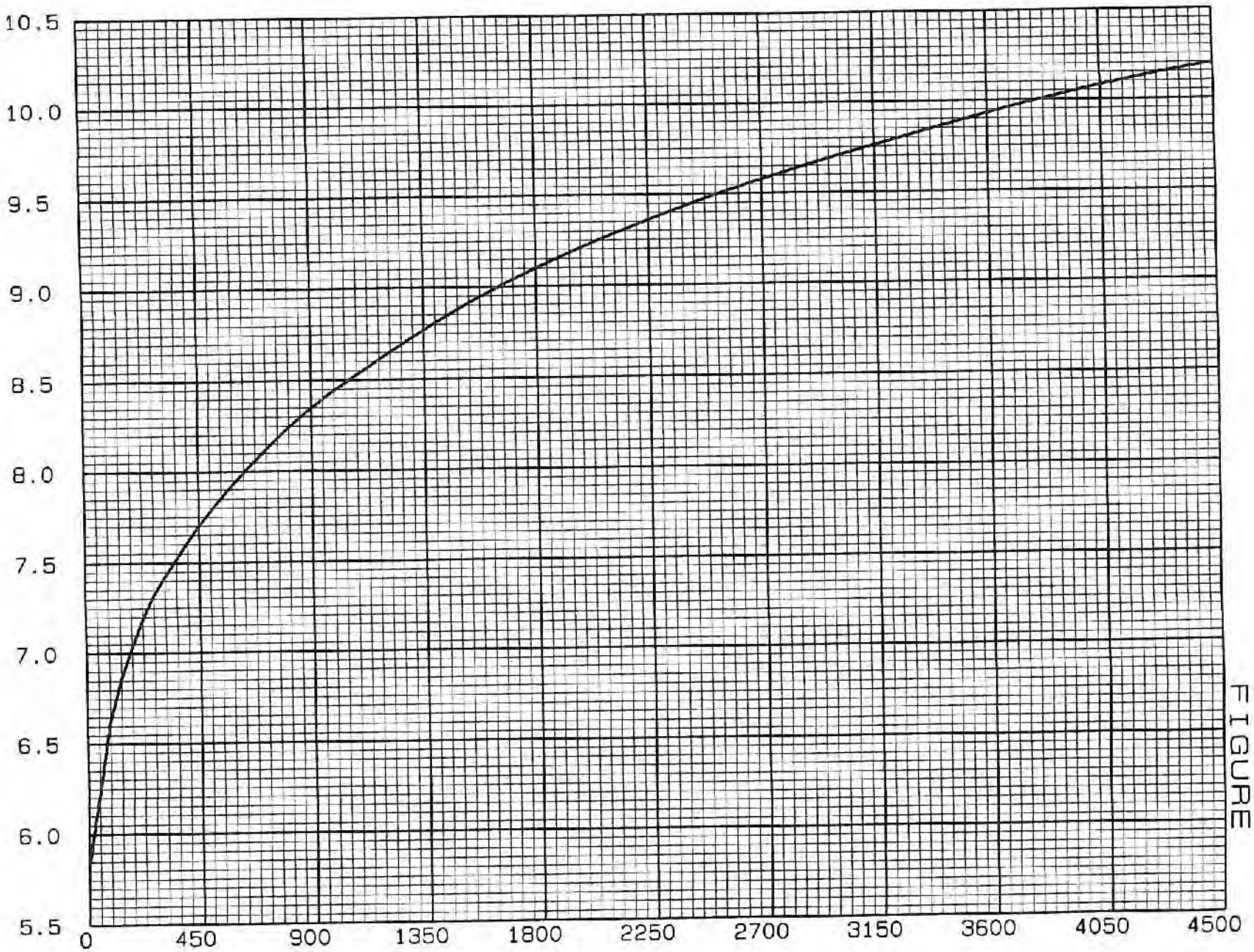
9500P
METER CALIBRATED FOR A 2" SCH 40 LINE

**METER OUTPUT SIGNAL CALIBRATION**

| **mA** | **SCFH N2** | **EXC Volts** |
|---|---|---|
| 4 | 0 | 5.830 |
| 4.32 | 90 | 6.630 |
| 4.64 | 180 | 7.035 |
| 4.96 | 270 | 7.318 |
| 5.28 | 360 | 7.520 |
| 5.6 | 450 | 7.700 |
| 7.2 | 900 | 8.350 |
| 8.8 | 1350 | 8.770 |
| 10.4 | 1800 | 9.100 |
| 12 | 2250 | 9.360 |
| 13.6 | 2700 | 9.580 |
| 15.2 | 3150 | 9.760 |
| 16.8 | 3600 | 9.930 |
| 18.4 | 4050 | 10.080 |
| 20 | 4500 | 10.200 |

**9500 EEPROM Setup Data**

| | |
|---|---|
| Maximum Calibrated Flow | 4500 |
| Flow FS at 20ma | 4500.0 |
| Flow Full Scale Displayed | 4500.0 |
| Totalizer Counts per/hour | 4500 |
| Totalizer Decimal Point | 0 |
| Zero Offset | 0 |
| Display Cutoff | 10% FS |
| Filter Time Constant | 1 Sec |




FIGURE

PAGE

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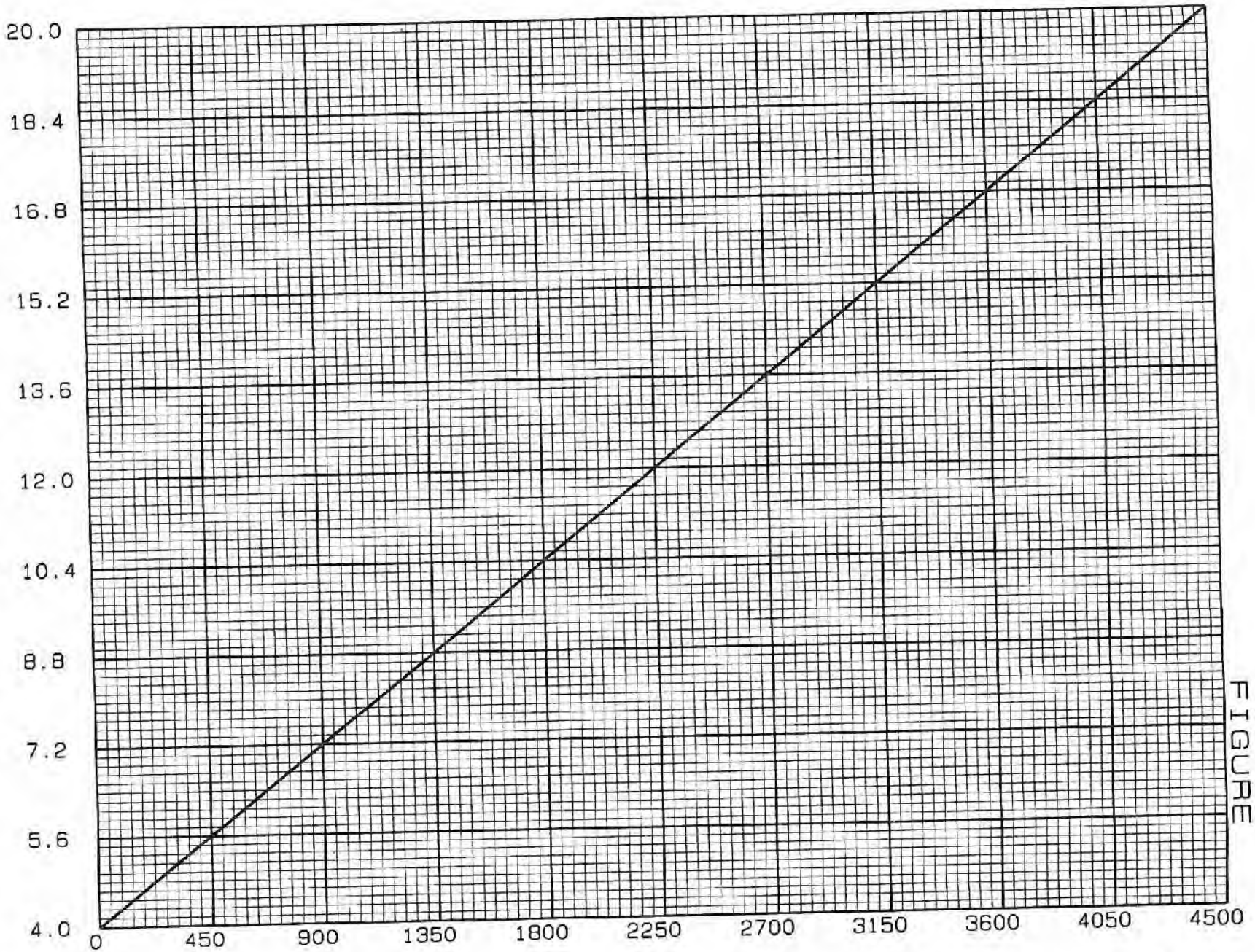
SCFH N2 2" SCH 40 LINE

S/N 2014135.0
04-22-2014




SCFH N2 2" SCH 40 LINE

S/N 2014135.C
04-22-2014

FIGURE

PAGE

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# Furnace #13 Data

Date 5/15/2014
Time 2:58:37 PM

FUELS

| | | | | | |
|---|---|---|---|---|---|
| Nitrogen | Line #1 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #2 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #3 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #4 | 100.00 | % Flow | 531 | scfh |

| | | |
|---|---|---|
| TIC Meter | 524 | scfh |
| Total Flow | 531 | scfh |
| Total LHV | 0.00 | Btu/scf |
| Total Heat Release | 0.000 | MMBtu/hr |

| | | |
|---|---|---|
| O2 (DRY) | 0.00 | %vd |
| O2 (WET) | 20.95 | |
| CO | 0.00 | ppmvd |
| NOx | 0.00 | ppmvd |

| CO Range | NOx Range | Point | Fuel |
|---|---|---|---|
| 5000 | 100 | 0.0 | ? |

Job: 0

Work Order: 8356920

## Furnace Information

| | | |
|---|---|---|
| Stack Temp: | 69 | °F |
| Furnace Temp: | 67 | °F |
| Radiant Furnace Temp: | 64 | °F |
| Pre-heated Air: | -240 | °F |
| Entrained Gas Temp: | 104 | °F |
| Orifice Gas Temp: | -240 | °F |
| Furnace Draft: | -0.02 | in.H2O |
| Burner dP: | 0.01 | in.H2O |
| Fuel Pressure 1: | 0.0 | psig |
| Fuel Pressure 2: | 0.0 | psig |
| H20 Flow: | 18.5 | gpm |
| Flame Length: | 0.0 | ft |
| Flame Width: | 0.0 | ft |
| Primary Air: | 0.0 | |

## Weather Conditions

| | | |
|---|---|---|
| Ambient Air Temp: | 56 | °F |
| Relative Humidity: | 50 | % |
| Wind Speed: | 5 | mph |
| Atmospheric Pressure: | 14.42 | psia |

Furnace 13 Comments

1.
2.
3.
4.
5.
6.
7.
8.
9.

| | Dp | Press | Temp. | LHV | Orifice Bore |
|---|---|---|---|---|---|
| Line 1 | 0.00 | 0.0 | 71.9 | 0.0 | 0.3450 |
| Line 2 | 0.00 | 67.4 | 92.7 | 0.0 | 0.1710 |
| Line 3 | 0.00 | 93.6 | 85.5 | 0.0 | 0.3400 |
| Line 4 | 29.96 | 80.0 | 141.4 | 0.0 | 0.2250 |

# Furnace #13 Data

Date 5/15/2014
Time 3:04:45 PM

FUELS

| | | | | | |
|---|---|---|---|---|---|
| Nitrogen | Line #1 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #2 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #3 | 100.00 | % Flow | 1299 | scfh |
| Nitrogen | Line #4 | 0.00 | % Flow | 0 | scfh |

| | | |
|---|---|---|
| TIC Meter | 1303 | scfh |
| Total Flow | 1299 | scfh |
| Total LHV | 0.00 | Btu/scf |
| Total Heat Release | 0.000 | MMBtu/hr |

| | | |
|---|---|---|
| O2 (DRY) | 0.00 | %vd |
| O2 (WET) | 20.92 | |
| CO | 0.00 | ppmvd |
| NOx | 0.00 | ppmvd |

Job: 0

Work Order: 8356920

| CO Range | NOx Range | Point | Fuel |
|---|---|---|---|
| 5000 | 100 | 0.0 | ? |

## Furnace Information

| | | |
|---|---|---|
| Stack Temp: | 69 | °F |
| Furnace Temp: | 67 | °F |
| Radiant Furnace Temp: | 64 | °F |
| Pre-heated Air: | -240 | °F |
| Entrained Gas Temp: | 109 | °F |
| Orifice Gas Temp: | -240 | °F |
| Furnace Draft: | -0.02 | in.H2O |
| Burner dP: | 0.02 | in.H2O |
| Fuel Pressure 1: | 0.0 | psig |
| Fuel Pressure 2: | 0.0 | psig |
| H20 Flow: | 18.4 | gpm |
| Flame Length: | 0.0 | ft |
| Flame Width: | 0.0 | ft |
| Primary Air: | 0.0 | |

## Weather Conditions

| | | |
|---|---|---|
| Ambient Air Temp: | 56 | °F |
| Relative Humidity: | 50 | % |
| Wind Speed: | 5 | mph |
| Atmospheric Pressure: | 14.42 | psia |

Furnace 13 Comments

1.
2.
3.
4.
5.
6.
7.
8.
9.

| | Dp | Press | Temp. | LHV | Orifice Bore |
|---|---|---|---|---|---|
| Line 1 | 0.00 | 0.0 | 71.4 | 0.0 | 0.3450 |
| Line 2 | 0.00 | 67.7 | 91.3 | 0.0 | 0.1710 |
| Line 3 | 36.26 | 60.2 | 86.8 | 0.0 | 0.3400 |
| Line 4 | 0.00 | 91.8 | 139.2 | 0.0 | 0.2250 |

# Furnace #13 Data

Date 5/15/2014
Time 3:50:46 PM

FUELS

| | | | | | |
|---|---|---|---|---|---|
| Nitrogen | Line #1 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #2 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #3 | 57.18 | % Flow | 1774 | scfh |
| Nitrogen | Line #4 | 42.82 | % Flow | 1328 | scfh |

| | | |
|---|---|---|
| TIC Meter | 3096 | scfh |
| Total Flow | 3102 | scfh |
| Total LHV | 0.00 | Btu/scf |
| Total Heat Release | 0.000 | MMBtu/hr |

| | | |
|---|---|---|
| O2 (DRY) | 0.00 | %vd |
| O2 (WET) | 20.96 | |
| CO | 0.00 | ppmvd |
| NOx | 0.00 | ppmvd |

| CO Range | NOx Range | Point | Fuel |
|---|---|---|---|
| 5000 | 100 | 0.0 | ? |

Job: 0

Work Order: 8356920

## Furnace Information

| | | |
|---|---|---|
| Stack Temp: | 67 | °F |
| Furnace Temp: | 64 | °F |
| Radiant Furnace Temp: | 63 | °F |
| Pre-heated Air: | -240 | °F |
| Entrained Gas Temp: | 99 | °F |
| Orifice Gas Temp: | -240 | °F |
| Furnace Draft: | -0.03 | in.H2O |
| Burner dP: | 0.03 | in.H2O |
| Fuel Pressure 1: | 0.1 | psig |
| Fuel Pressure 2: | 0.0 | psig |
| H20 Flow: | 19.7 | gpm |
| Flame Length: | 0.0 | ft |
| Flame Width: | 0.0 | ft |
| Primary Air: | 0.0 | |

## Weather Conditions

| | | |
|---|---|---|
| Ambient Air Temp: | 56 | °F |
| Relative Humidity: | 50 | % |
| Wind Speed: | 5 | mph |
| Atmospheric Pressure: | 14.42 | psia |

Furnace 13 Comments

1.
2.
3.
4.
5.
6.
7.
8.
9.

| | Dp | Press | Temp. | LHV | Orifice Bore |
|---|---|---|---|---|---|
| Line 1 | 0.00 | 0.0 | 64.6 | 0.0 | 0.3450 |
| Line 2 | 0.00 | 66.8 | 92.7 | 0.0 | 0.1710 |
| Line 3 | 67.77 | 59.7 | 77.4 | 0.0 | 0.3400 |
| Line 4 | 186.96 | 77.5 | 99.4 | 0.0 | 0.2250 |

# Furnace #13 Data

Date 5/15/2014
Time 3:26:53 PM

FUELS

| | | | | | |
|---|---|---|---|---|---|
| Nitrogen | Line #1 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #2 | 11.25 | % Flow | 463 | scfh |
| Nitrogen | Line #3 | 58.86 | % Flow | 2419 | scfh |
| Nitrogen | Line #4 | 29.89 | % Flow | 1228 | scfh |

| | | |
|---|---|---|
| TIC Meter | 4100 | scfh |
| Total Flow | 4110 | scfh |
| Total LHV | 0.00 | Btu/scf |
| Total Heat Release | 0.000 | MMBtu/hr |

| | | |
|---|---|---|
| O2 (DRY) | 0.00 | %vd |
| O2 (WET) | 20.96 | |
| CO | 0.00 | ppmvd |
| NOx | 0.00 | ppmvd |

Job: 0

Work Order: 8356920

| CO Range | NOx Range | Point | Fuel |
|---|---|---|---|
| 5000 | 100 | 0.0 | ? |

## Furnace Information

| | | |
|---|---|---|
| Stack Temp: | 69 | °F |
| Furnace Temp: | 67 | °F |
| Radiant Furnace Temp: | 65 | °F |
| Pre-heated Air: | -240 | °F |
| Entrained Gas Temp: | 121 | °F |
| Orifice Gas Temp: | -240 | °F |
| Furnace Draft: | -0.02 | in.H2O |
| Burner dP: | 0.01 | in.H2O |
| Fuel Pressure 1: | 0.1 | psig |
| Fuel Pressure 2: | 0.0 | psig |
| H20 Flow: | 19.6 | gpm |
| Flame Length: | 0.0 | ft |
| Flame Width: | 0.0 | ft |
| Primary Air: | 0.0 | |

## Weather Conditions

| | | |
|---|---|---|
| Ambient Air Temp: | 56 | °F |
| Relative Humidity: | 50 | % |
| Wind Speed: | 5 | mph |
| Atmospheric Pressure: | 14.42 | psia |

Furnace 13 Comments

1.
2.
3.
4.
5.
6.
7.
8.
9.

| | Dp | Press | Temp. | LHV | Orifice Bore |
|---|---|---|---|---|---|
| Line 1 | 0.00 | 0.0 | 70.1 | 0.0 | 0.3450 |
| Line 2 | 78.46 | 63.7 | 100.8 | 0.0 | 0.1710 |
| Line 3 | 133.11 | 57.9 | 79.6 | 0.0 | 0.3400 |
| Line 4 | 162.49 | 77.0 | 108.4 | 0.0 | 0.2250 |

# Furnace #13 Data

Date 5/15/2014
Time 3:29:35 PM

FUELS

| | | | | | |
|---|---|---|---|---|---|
| Nitrogen | Line #1 | 0.00 | % Flow | 0 | scfh |
| Nitrogen | Line #2 | 17.47 | % Flow | 769 | scfh |
| Nitrogen | Line #3 | 54.58 | % Flow | 2402 | scfh |
| Nitrogen | Line #4 | 27.96 | % Flow | 1230 | scfh |

| | | |
|---|---|---|
| TIC Meter | 4437 | scfh |
| Total Flow | 4400 | scfh |
| Total LHV | 0.00 | Btu/scf |
| Total Heat Release | 0.000 | MMBtu/hr |

| | | |
|---|---|---|
| O2 (DRY) | 0.00 | %vd |
| O2 (WET) | 20.96 | |
| CO | 0.00 | ppmvd |
| NOx | 0.00 | ppmvd |

Job: 0

Work Order: 8356920

| CO Range | NOx Range | Point | Fuel |
|---|---|---|---|
| 5000 | 100 | 0.0 | ? |

## Furnace Information

| | | |
|---|---|---|
| Stack Temp: | 68 | °F |
| Furnace Temp: | 67 | °F |
| Radiant Furnace Temp: | 65 | °F |
| Pre-heated Air: | -240 | °F |
| Entrained Gas Temp: | 117 | °F |
| Orifice Gas Temp: | -240 | °F |
| Furnace Draft: | -0.02 | in.H2O |
| Burner dP: | 0.02 | in.H2O |
| Fuel Pressure 1: | 0.1 | psig |
| Fuel Pressure 2: | 0.0 | psig |
| H20 Flow: | 19.5 | gpm |
| Flame Length: | 0.0 | ft |
| Flame Width: | 0.0 | ft |
| Primary Air: | 0.0 | |

## Weather Conditions

| | | |
|---|---|---|
| Ambient Air Temp: | 56 | °F |
| Relative Humidity: | 50 | % |
| Wind Speed: | 5 | mph |
| Atmospheric Pressure: | 14.42 | psia |

Furnace 13 Comments

1.
2.
3.
4.
5.
6.
7.
8.
9.

| | Dp | Press | Temp. | LHV | Orifice Bore |
|---|---|---|---|---|---|
| Line 1 | 0.00 | 0.0 | 69.6 | 0.0 | 0.3450 |
| Line 2 | 230.77 | 62.4 | 99.4 | 0.0 | 0.1710 |
| Line 3 | 132.53 | 57.6 | 79.2 | 0.0 | 0.3400 |
| Line 4 | 163.15 | 77.1 | 105.2 | 0.0 | 0.2250 |

Sample Date 11/18/2013 Truck/Trailer No.:

| Property | Result | Specification |
|---|---|---|
| Methane, PPM Wgt. | BDL | Note (1) |
| Ethane, PPM Wgt. | 8 | Note (1) |
| Ethylene, PPM Wgt. | 0.5 | 100 max. |
| Propane, Wgt. % | 0.34 | 0.5 max. |
| Propylene, Wgt. % | 99.66 | 99.5 min. |
| Total Saturated C4's, PPM Mole | BDL | Note (1) |
| Propadiene, PPM Wgt. | BDL | 5 max. |
| Methyl Acetylene, PPM Wgt. | BDL | 7 max. |
| Acetylene, PPM Wgt. | BDL | 3 max. |
| Total Butadienes, PPM Wgt. | BDL | 10 max. |
| Total Butenes, PPM Wgt. | BDL | 100 max. |
| 1-Butyne, PPM Wgt. | BDL | 7 max. |
| 2-Butyne, PPM Wgt. | BDL | 7 max. |
| Cyclopropane, PPM Wgt. | BDL | 1 max. |
| 3-Methyl 1-Butene, PPM Wgt. | BDL | 1 max. |
| Total > C5, PPM Wgt. | BDL | 20 max. |
| Carbon Monoxide, PPM Wgt. | BDL | 0.033 max. |
| Carbon Dioxide, PPM Wgt. | BDL | 2 max. |
| Carbonyl Sulfide, PPM Wgt. | BDL | 0.043 max. |
| Hydrogen Sulfide, PPM Wgt. | BDL | 1 max. |
| Total Sulfur, PPM Wgt. | BDL | 1 max. |
| Arsine, PPM Wgt. | BDL | 0.056 max. |
| Phosphine, PPM Wgt. | BDL | 0.1 max. |
| Methanol, PPM Wgt. | BDL | 4 max. |
| 2-Propanol, PPM Wgt. | BDL | 7 max. |
| Water, PPM Wgt. | 0.05 | 2 max. |
| Hydrogen, PPM Wgt. | BDL | 1 max. |
| Oxygen, PPM Wgt.* | BDL | 2 max. |
| Nitrogen, PPM Wgt. | BDL | Note (1) |
| Ammonia, PPM Wgt. | BDL | 0.2 max. |

Rail Car CS42500
Source Tank 5

by/for JEO
Robert D. Freeman
Laboratory Manager

Note (1) Total Non-Propane Inerts = 1000 Wt. ppm max.

Revised 09/09/13

# APPENDIX E

# FUEL ANALYSIS RECORDS

# LABORATORY REPORT

March 28, 2014

Min Lee
Air Hygiene, Incorporated
1600 West Tacoma Street
Broken Arrow, OK 74012

**RE: JZ-14-Tulsa.ok-comp#1 / 1**

Dear Min:

Enclosed are the results of the samples submitted to our laboratory on March 15, 2014. For your reference, these analyses have been assigned our service request number P1401040.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**ALS | Environmental**

Kelly Horiuchi
Laboratory Director

## CASE NARRATIVE

The samples were received intact under chain of custody on March 15, 2014 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Benzene Analysis

The samples were analyzed per ASTM D1945-03 for benzene using a gas chromatograph equipped with a flame ionization detector (FID). This procedure is described in laboratory SOP VOA-TO3C1C6. This method is not included on the laboratory's NELAP or AIHA-LAP scope of accreditation.

BTU and CHONS Analysis

The results for BTU and CHONS were generated according to ASTM D 3588-98. The following analyses were performed and used to calculate the BTU and CHONS results. This method is not included on the laboratory's NELAP, DoD-ELAP, or AIHA-LAP scope of accreditation.

C2 through C6 Hydrocarbon Analysis

The samples were analyzed according to ASTM D1945-03 for C2 through >C6 hydrocarbons using a gas chromatograph equipped with a flame ionization detector (FID). This method is not included on the laboratory's NELAP or AIHA-LAP scope of accreditation.

Fixed Gases Analysis

The samples were also analyzed for fixed gases (hydrogen, oxygen/argon, nitrogen, carbon monoxide, methane and carbon dioxide) according to ASTM D1945-03 (single injection) using a gas chromatograph equipped with a thermal conductivity detector (TCD). This method is not included on the laboratory's NELAP or AIHA-LAP scope of accreditation.

Hydrogen Sulfide Analysis

The samples were also analyzed for hydrogen sulfide per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD). This method is not included on the laboratory's NELAP, DoD-ELAP, or AIHA-LAP scope of accreditation.

## CASE NARRATIVE

Sulfur Analysis

The samples were also analyzed for twenty sulfur compounds per ASTM D 5504-08 using a gas chromatograph equipped with a sulfur chemiluminescence detector (SCD). All compounds with the exception of hydrogen sulfide and carbonyl sulfide are quantitated against the initial calibration curve for methyl mercaptan. This method is not included on the laboratory's NELAP, DoD-ELAP, or AIHA-LAP scope of accreditation.

*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.*

*Use of ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*

ALS Environmental – Simi Valley

Certifications, Accreditations, and Registrations

| Agency | Web Site | Number |
|---|---|---|
| AIHA | http://www.aihaaccreditedlabs.org | 101661 |
| Arizona DHS | http://www.azdhs.gov/lab/license/env.htm | AZ0694 |
| DoD ELAP | http://www.pjlabs.com/search-accredited-labs | L14-2 |
| Florida DOH (NELAP) | http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm | E871020 |
| Maine DHHS | http://www.maine.gov/dhhs/mecdc/environmental-health/water/dwp-services/labcert/labcert.htm | 2012039 |
| Minnesota DOH (NELAP) | http://www.health.state.mn.us/accreditation | 643428 |
| New Jersey DEP (NELAP) | http://www.nj.gov/dep/oqa/ | CA009 |
| New York DOH (NELAP) | http://www.wadsworth.org/labcert/elap/elap.html | 11221 |
| Oregon PHD (NELAP) | http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx | CA200007 |
| Pennsylvania DEP | http://www.depweb.state.pa.us/labs | 68-03307 (Registration) |
| Texas CEQ (NELAP) | http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html | T104704413-13-4 |
| Utah DOH (NELAP) | http://www.health.utah.gov/lab/labimp/certification/index.html | CA016272013-3 |
| Washington DOE | http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html | C946 |

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

# ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: Air Hygiene, Incorporated

Service Request: P1401040

Project ID: JZ-14-Tulsa.ok-comp#1 / 1

Date Received: 3/15/2014

Time Received: 10:10

| Client Sample ID | Lab Code | Matrix | Date Collected | Time Collected | Container ID | Pi1 (psig) | Pf1 (psig) | TO-3 Modified - C1C6+ Can | 3C Modified - Fxd Gases Can | ASTM D5504-01 - H2S Can | ASTM D5504-08 - Sulfur Can |
|---|---|---|---|---|---|---|---|---|---|---|---|
| JZ-0-30-0%-Can-4X30PF | P1401040-001 | Air | 3/11/2014 | 13:16 | SSC00180 | -0.54 | 3.82 | X | X | X | X |
| JZ-30-70-30%-Can-4X30PF | P1401040-002 | Air | 3/12/2014 | 12:24 | SSC00082 | 1.27 | 3.98 | X | X | X | X |
| JZ-70-100-70%-Can-4X30PF | P1401040-003 | Air | 3/13/2014 | 09:40 | SSC00037 | 2.72 | 3.91 | X | X | X | X |
| JZ-90-100%-Can-4X30PF | P1401040-004 | Air | 3/13/2014 | 15:15 | SSC00188 | 0.41 | 3.82 | X | X | X | X |

# Air - Chain of Custody Record & Analytical Service Request

Page _____ of _____

2655 Park Center Drive, Suite A
Simi Valley, California 93065
Phone (805) 526-7161
Fax (805) 526-7270

Requested Turnaround Time in Business Days (Surcharges) please circle
1 Day (100%) 2 Day (75%) 3 Day (50%) 4 Day (35%) 5 Day (25%) 10-Day-Standard

ALS Project No: P1401040

Company Name & Address (Reporting Information): John Zink, Inc

Project Name: JZ-14- Tulsa.ok -comp# 1

Project Number: 1

Project Manager: Min Sum Lee

P.O. # / Billing Information

Phone: 918-565-5379

Fax:

Email Address for Result Reporting: mlee@airhygiene.com A lab@airhygiene.com

Sampler (Print & Sign):

ALS Contact:

Analysis Method: See Quote or call

| Client Sample ID | Laboratory ID Number | Date Collected | Time Collected | Canister ID (Bar code # - AC, SC, etc.) | Flow Controller ID (Bar code # - FC #) | Canister Start Pressure "Hg | Canister End Pressure "Hg/psig | Sample Volume | Comments e.g. Actual Preservative or specific instructions |
|---|---|---|---|---|---|---|---|---|---|
| JZ-0-30-0%-can-4x30PF | 1-0.75 | 3/11/14 | 13:16:00 | SSC00180 | SOA-00162 | -30.00 | -0.05 | | |
| JZ-30-70-30%-can-4x30PF | 2+1.02 | 3/12/14 | 12:24:00 | SSC00082 | SOA-00068 | -30.00 | -0.02 | | |
| JZ-70-100-70%-can-4x30PF | 3+2.55 | 3/13/14 | 9:40:00 | SSC00037 | SOA-00121 | -30.00 | -0.02 | | |
| JZ-90-100%-can-4x30PF | 4+0.20 | 3/13/14 | 15:15:00 | SSC00188 | SOA00078 | -30.00 | 0.05 | | |

Report Tier Levels - please select
Tier I - Results (Default in not specified) _____
Tier II (Results + QC Summaries _____
Tier III (Results + QC & Calibration Summaries) _____
Tier IV (Date Validation Package) 10% Surcharge _____

EDD required YES / No
Type: _____ Units: _____

Chain of Custody Seal: (Circle)
INTACT BROKEN ABSENT

Project Requirements (MRLs, QAPP)

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Date: | Time: |
|---|---|---|---|---|---|
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | 3/14/14 | Time: 1010 |

Cooler / Blank Temperature _____°C

# ALS Environmental
## Sample Acceptance Check Form

Client: Air Hygiene, Incorporated  Work order: P1401040

Project: JZ-14-Tulsa.ok-comp#1 / 1

Sample(s) received on: 3/15/14  Date opened: 3/15/14  by: MZAMORA

***Note:*** This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

| | | Yes | No | N/A |
|---|---|---|---|---|
| 1 | Were **sample containers** properly marked with client sample ID? | ☒ | ☐ | ☐ |
| 2 | Container(s) **supplied by ALS**? | ☒ | ☐ | ☐ |
| 3 | Did **sample containers** arrive in good condition? | ☒ | ☐ | ☐ |
| 4 | Were **chain-of-custody** papers used and filled out? | ☒ | ☐ | ☐ |
| 5 | Did **sample container labels** and/or tags agree with custody papers? | ☒ | ☐ | ☐ |
| 6 | Was **sample volume** received adequate for analysis? | ☒ | ☐ | ☐ |
| 7 | Are samples within specified holding times? | ☒ | ☐ | ☐ |
| 8 | Was proper **temperature** (thermal preservation) of cooler at receipt adhered to? | ☐ | ☐ | ☒ |
| 9 | Was a **trip blank** received? | ☐ | ☒ | ☐ |
| 10 | Were **custody seals** on outside of cooler/Box? | ☐ | ☒ | ☐ |
| | Location of seal(s)? _____ Sealing Lid? | ☐ | ☐ | ☒ |
| | Were signature and date included? | ☐ | ☐ | ☒ |
| | Were seals intact? | ☐ | ☐ | ☒ |
| | Were custody seals on outside of sample container? | ☐ | ☒ | ☐ |
| | Location of seal(s)? _____ Sealing Lid? | ☐ | ☐ | ☒ |
| | Were signature and date included? | ☐ | ☐ | ☒ |
| | Were seals intact? | ☐ | ☐ | ☒ |
| 11 | Do containers have appropriate **preservation**, according to method/SOP or Client specified information? | ☐ | ☐ | ☒ |
| | Is there a client indication that the submitted samples are **pH** preserved? | ☐ | ☐ | ☒ |
| | Were **VOA vials** checked for presence/absence of air bubbles? | ☐ | ☐ | ☒ |
| | Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it? | ☐ | ☐ | ☒ |
| 12 | **Tubes:** Are the tubes capped and intact? | ☐ | ☐ | ☒ |
| | Do they contain moisture? | ☐ | ☐ | ☒ |
| 13 | **Badges:** Are the badges properly capped and intact? | ☐ | ☐ | ☒ |
| | Are dual bed badges separated and individually capped and intact? | ☐ | ☐ | ☒ |

| Lab Sample ID | Container Description | Required pH * | Received pH | Adjusted pH | VOA Headspace (Presence/Absence) | Receipt / Preservation Comments |
|---|---|---|---|---|---|---|
| P1401040-001.01 | 6.0 L Silonite Can | | | | | |
| P1401040-002.01 | 6.0 L Silonite Can | | | | | |
| P1401040-003.01 | 6.0 L Silonite Can | | | | | |
| P1401040-004.01 | 6.0 L Silonite Can | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

Explain any discrepancies: (include lab sample ID numbers): _____

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Project ID: P1401040

## Benzene

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC8/FID Date(s) Collected: 3/11 - 3/13/14
Analyst: Wade Henton Date Received: 3/15/14
Sampling Media: 6.0 L Silonite Canister(s) Date Analyzed: 3/26/14
Test Notes:

| **Client Sample ID** | ALS Sample ID | Canister Dilution Factor | Injection Volume ml(s) | **Result ppmV** | MRL ppmV | Data Qualifier |
|---|---|---|---|---|---|---|
| JZ-0-30-0%-Can-4X30PF | P1401040-001 | 1.31 | 0.050 | ND | 16 | |
| JZ-30-70-30%-Can-4X30PF | P1401040-002 | 1.17 | 0.050 | ND | 14 | |
| JZ-70-100-70%-Can-4X30PF | P1401040-003 | 1.07 | 0.050 | ND | 13 | |
| JZ-90-100%-Can-4X30PF | P1401040-004 | 1.23 | 0.050 | ND | 15 | |
| Method Blank | P140326-MB | 1.00 | 1.0 | ND | 0.60 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Lab Control Sample**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P140326-LCS

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC8/FID
Analyst: Wade Henton
Sampling Media: 6.0 L Silonite Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 3/26/14
Volume(s) Analyzed: NA ml(s)

| **Compound** | Spike Amount ppmV | **Result ppmV** | **% Recovery** | ALS Acceptance Limits | Data Qualifier |
|---|---|---|---|---|---|
| Benzene | 1,100 | **1,030** | **94** | 50-150 | |

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-0-30-0%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-001

Test Code: ASTM D3588-98
Analyst: Mike Conejo/Nalini Lall Date Collected: 3/11/14
Sample Type: 6.0 L Silonite Canister Date Received: 3/15/14
Test Notes:
Container ID: SSC00180

Initial Pressure (psig): -0.54 Final Pressure (psig): 3.82

Canister Dilution Factor: 1.31

| Components | Result Volume % | Result Weight % | Data Qualifier |
|---|---|---|---|
| Hydrogen | < 0.01 | < 0.01 | |
| Oxygen + Argon | **0.12** | **0.09** | |
| Nitrogen | **0.67** | **0.43** | |
| Carbon Monoxide | < 0.01 | < 0.01 | |
| Methane | < 0.01 | < 0.01 | |
| Carbon Dioxide | < 0.01 | < 0.01 | |
| Hydrogen Sulfide | < 0.01 | < 0.01 | |
| C2 as Ethane | < 0.01 | < 0.01 | |
| C3 as Propane | **99.15** | **99.38** | |
| C4 as n-Butane | < 0.01 | **0.01** | |
| C5 as n-Pentane | < 0.01 | < 0.01 | |
| C6 as n-Hexane | < 0.01 | < 0.01 | |
| > C6 as n-Hexane | **0.03** | **0.08** | |
| **TOTALS** | **99.99** | **99.99** | |

| Components | Mole % | Weight % |
|---|---|---|
| Carbon | **27.24** | **81.30** |
| Hydrogen | **72.62** | **18.19** |
| Oxygen + Argon | < 0.10 | < 0.10 |
| Nitrogen | **0.12** | **0.43** |
| Sulfur | < 0.10 | < 0.10 |

| | | |
|---|---|---|
| Specific Gravity (Air = 1) | | **1.5190** |
| Specific Volume | ft3/lb | **8.63** |
| Gross Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/ft3 | **2,540.8** |
| Net Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/ft3 | **2,337.6** |
| Gross Heating Value (Water Saturated at 0.25636 psia) | BTU/ft3 | **2,453.6** |
| Net Heating Value (Water Saturated at 0.25636 psia) | BTU/ft3 | **2,257.4** |
| Gross Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/lb | **21,916.1** |
| Net Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/lb | **20,163.7** |
| Compressibility Factor "Z" (60 F, 14.696 psia) | | **0.9828** |

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-30-70-30%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-002

Test Code: ASTM D3588-98
Analyst: Mike Conejo/Nalini Lall Date Collected: 3/12/14
Sample Type: 6.0 L Silonite Canister Date Received: 3/15/14
Test Notes:
Container ID: SSC00082

Initial Pressure (psig): 1.27 Final Pressure (psig): 3.98

Canister Dilution Factor: 1.17

| Components | Result Volume % | Result Weight % | Data Qualifier |
|---|---|---|---|
| Hydrogen | < 0.01 | < 0.01 | |
| Oxygen + Argon | **0.05** | **0.04** | |
| Nitrogen | **0.17** | **0.11** | |
| Carbon Monoxide | < 0.01 | < 0.01 | |
| Methane | < 0.01 | < 0.01 | |
| Carbon Dioxide | < 0.01 | < 0.01 | |
| Hydrogen Sulfide | < 0.01 | < 0.01 | |
| C2 as Ethane | < 0.01 | < 0.01 | |
| C3 as Propane | **99.73** | **99.77** | |
| C4 as n-Butane | < 0.01 | < 0.01 | |
| C5 as n-Pentane | < 0.01 | < 0.01 | |
| C6 as n-Hexane | < 0.01 | < 0.01 | |
| > C6 as n-Hexane | **0.02** | **0.06** | |
| **TOTALS** | **99.99** | **99.99** | |

| Components | Mole % | Weight % |
|---|---|---|
| Carbon | **27.26** | **81.60** |
| Hydrogen | **72.70** | **18.26** |
| Oxygen + Argon | < 0.10 | < 0.10 |
| Nitrogen | < 0.10 | **0.11** |
| Sulfur | < 0.10 | < 0.10 |

| | | |
|---|---|---|
| Specific Gravity (Air = 1) | | **1.5219** |
| Specific Volume | ft3/lb | **8.61** |
| Gross Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/ft3 | **2,555.5** |
| Net Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/ft3 | **2,351.1** |
| Gross Heating Value (Water Saturated at 0.25636 psia) | BTU/ft3 | **2,467.4** |
| Net Heating Value (Water Saturated at 0.25636 psia) | BTU/ft3 | **2,270.1** |
| Gross Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/lb | **22,001.7** |
| Net Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/lb | **20,242.4** |
| Compressibility Factor "Z" (60 F, 14.696 psia) | | **0.9827** |

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-70-100-70%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-003

Test Code: ASTM D3588-98
Analyst: Mike Conejo/Nalini Lall Date Collected: 3/13/14
Sample Type: 6.0 L Silonite Canister Date Received: 3/15/14
Test Notes:
Container ID: SSC00037

Initial Pressure (psig): 2.72 Final Pressure (psig): 3.91

Canister Dilution Factor: 1.07

| Components | Result Volume % | Result Weight % | Data Qualifier |
|---|---|---|---|
| Hydrogen | < 0.01 | < 0.01 | |
| Oxygen + Argon | **0.56** | **0.41** | |
| Nitrogen | **2.03** | **1.30** | |
| Carbon Monoxide | < 0.01 | < 0.01 | |
| Methane | < 0.01 | < 0.01 | |
| Carbon Dioxide | < 0.01 | < 0.01 | |
| Hydrogen Sulfide | < 0.01 | < 0.01 | |
| C2 as Ethane | < 0.01 | < 0.01 | |
| C3 as Propane | **97.36** | **98.18** | |
| C4 as n-Butane | < 0.01 | < 0.01 | |
| C5 as n-Pentane | < 0.01 | < 0.01 | |
| C6 as n-Hexane | < 0.01 | < 0.01 | |
| > C6 as n-Hexane | **0.04** | **0.09** | |
| **TOTALS** | **99.99** | **99.99** | |

| Components | Mole % | Weight % |
|---|---|---|
| Carbon | **27.14** | **80.32** |
| Hydrogen | **72.37** | **17.97** |
| Oxygen + Argon | **0.10** | **0.41** |
| Nitrogen | **0.38** | **1.30** |
| Sulfur | < 0.10 | < 0.10 |

| | | |
|---|---|---|
| Specific Gravity (Air = 1) | | **1.5097** |
| Specific Volume | ft3/lb | **8.68** |
| Gross Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/ft3 | **2,493.7** |
| Net Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/ft3 | **2,294.3** |
| Gross Heating Value (Water Saturated at 0.25636 psia) | BTU/ft3 | **2,409.5** |
| Net Heating Value (Water Saturated at 0.25636 psia) | BTU/ft3 | **2,216.8** |
| Gross Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/lb | **21,641.9** |
| Net Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/lb | **19,911.5** |
| Compressibility Factor "Z" (60 F, 14.696 psia) | | **0.9833** |

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-90-100%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-004

Test Code: ASTM D3588-98
Analyst: Mike Conejo/Nalini Lall Date Collected: 3/13/14
Sample Type: 6.0 L Silonite Canister Date Received: 3/15/14
Test Notes:
Container ID: SSC00188

Initial Pressure (psig): 0.41 Final Pressure (psig): 3.82

Canister Dilution Factor: 1.23

| Components | Result Volume % | Result Weight % | Data Qualifier |
|---|---|---|---|
| Hydrogen | < 0.01 | < 0.01 | |
| Oxygen + Argon | **0.05** | **0.04** | |
| Nitrogen | **0.30** | **0.19** | |
| Carbon Monoxide | < 0.01 | < 0.01 | |
| Methane | < 0.01 | < 0.01 | |
| Carbon Dioxide | < 0.01 | < 0.01 | |
| Hydrogen Sulfide | < 0.01 | < 0.01 | |
| C2 as Ethane | < 0.01 | < 0.01 | |
| C3 as Propane | **99.61** | **99.69** | |
| C4 as n-Butane | < 0.01 | < 0.01 | |
| C5 as n-Pentane | < 0.01 | < 0.01 | |
| C6 as n-Hexane | < 0.01 | < 0.01 | |
| > C6 as n-Hexane | **0.02** | **0.06** | |
| **TOTALS** | **99.99** | **99.99** | |

| Components | Mole % | Weight % |
|---|---|---|
| Carbon | **27.26** | **81.53** |
| Hydrogen | **72.68** | **18.24** |
| Oxygen + Argon | < 0.10 | < 0.10 |
| Nitrogen | < 0.10 | **0.19** |
| Sulfur | < 0.10 | < 0.10 |

| | | |
|---|---|---|
| Specific Gravity (Air = 1) | | **1.5211** |
| Specific Volume | ft3/lb | **8.61** |
| Gross Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/ft3 | **2,552.0** |
| Net Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/ft3 | **2,347.9** |
| Gross Heating Value (Water Saturated at 0.25636 psia) | BTU/ft3 | **2,464.2** |
| Net Heating Value (Water Saturated at 0.25636 psia) | BTU/ft3 | **2,267.1** |
| Gross Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/lb | **21,982.4** |
| Net Heating Value (Dry Gas @ 60 F, 14.696 psia) | BTU/lb | **20,224.7** |
| Compressibility Factor "Z" (60 F, 14.696 psia) | | **0.9827** |

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-0-30-0%-Can-4X30PF**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P1401040-001

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC8/FID
Analyst: Nalini Lall
Sampling Media: 6.0 L Silonite Canister
Test Notes:
Container ID: SSC00180

Date Collected: 3/11/14
Date Received: 3/15/14
Date Analyzed: 3/20/14
Volume(s) Analyzed: 0.050 ml(s)

Initial Pressure (psig): -0.54 Final Pressure (psig): 3.82

Canister Dilution Factor: 1.31

| **Compound** | **Result ppmV** | MRL ppmV | Data Qualifier |
|---|---|---|---|
| Methane | ND | 13 | |
| $C_2$ as Ethane | **52** | 13 | |
| $C_3$ as Propane | **990,000** | 13 | |
| $C_4$ as n-Butane | **90** | 13 | |
| $C_5$ as n-Pentane | ND | 13 | |
| $C_6$ as n-Hexane | ND | 13 | |
| $C_6$+ as n-Hexane | **320** | 26 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-30-70-30%-Can-4X30PF**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P1401040-002

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC8/FID
Analyst: Nalini Lall
Sampling Media: 6.0 L Silonite Canister
Test Notes:
Container ID: SSC00082

Date Collected: 3/12/14
Date Received: 3/15/14
Date Analyzed: 3/20/14
Volume(s) Analyzed: 0.050 ml(s)

Initial Pressure (psig): 1.27 Final Pressure (psig): 3.98

Canister Dilution Factor: 1.17

| **Compound** | **Result ppmV** | MRL ppmV | Data Qualifier |
|---|---|---|---|
| Methane | ND | 12 | |
| $C_2$ as Ethane | **62** | 12 | |
| $C_3$ as Propane | **1,000,000** | 12 | |
| $C_4$ as n-Butane | **64** | 12 | |
| $C_5$ as n-Pentane | ND | 12 | |
| $C_6$ as n-Hexane | ND | 12 | |
| $C_6$+ as n-Hexane | **230** | 23 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-70-100-70%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-003

Test Code: ASTM D1945-03 Date Collected: 3/13/14
Instrument ID: HP5890 II/GC8/FID Date Received: 3/15/14
Analyst: Nalini Lall Date Analyzed: 3/20/14
Sampling Media: 6.0 L Silonite Canister Volume(s) Analyzed: 0.050 ml(s)
Test Notes:
Container ID: SSC00037

Initial Pressure (psig): 2.72 Final Pressure (psig): 3.91

Canister Dilution Factor: 1.07

| **Compound** | **Result ppmV** | MRL ppmV | Data Qualifier |
|---|---|---|---|
| Methane | ND | 11 | |
| $C_2$ as Ethane | **39** | 11 | |
| $C_3$ as Propane | **970,000** | 11 | |
| $C_4$ as n-Butane | **66** | 11 | |
| $C_5$ as n-Pentane | ND | 11 | |
| $C_6$ as n-Hexane | ND | 11 | |
| $C_6$+ as n-Hexane | **360** | 21 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-90-100%-Can-4X30PF**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P1401040-004

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC8/FID
Analyst: Nalini Lall
Sampling Media: 6.0 L Silonite Canister
Test Notes:
Container ID: SSC00188

Date Collected: 3/13/14
Date Received: 3/15/14
Date Analyzed: 3/20/14
Volume(s) Analyzed: 0.050 ml(s)

Initial Pressure (psig): 0.41 Final Pressure (psig): 3.82

Canister Dilution Factor: 1.23

| **Compound** | **Result ppmV** | MRL ppmV | Data Qualifier |
|---|---|---|---|
| Methane | ND | 12 | |
| $C_2$ as Ethane | **36** | 12 | |
| $C_3$ as Propane | **1,000,000** | 12 | |
| $C_4$ as n-Butane | **66** | 12 | |
| $C_5$ as n-Pentane | ND | 12 | |
| $C_6$ as n-Hexane | ND | 12 | |
| $C_6$+ as n-Hexane | **220** | 25 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Method Blank**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P140320-MB

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC8/FID
Analyst: Nalini Lall
Sampling Media: 6.0 L Silonite Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 3/20/14
Volume(s) Analyzed: 1.0 ml(s)

| **Compound** | **Result ppmV** | MRL ppmV | Data Qualifier |
|---|---|---|---|
| Methane | ND | 0.50 | |
| $C_2$ as Ethane | ND | 0.50 | |
| $C_3$ as Propane | ND | 0.50 | |
| $C_4$ as n-Butane | ND | 0.50 | |
| $C_5$ as n-Pentane | ND | 0.50 | |
| $C_6$ as n-Hexane | ND | 0.50 | |
| $C_6$+ as n-Hexane | ND | 1.0 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Lab Control Sample**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P140320-LCS

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC8/FID
Analyst: Nalini Lall
Sampling Media: 6.0 L Silonite Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 3/20/14
Volume(s) Analyzed: NA ml(s)

| **Compound** | Spike Amount ppmV | **Result ppmV** | **% Recovery** | ALS Acceptance Limits | Data Qualifier |
|---|---|---|---|---|---|
| Methane | 1,020 | **1,060** | **104** | 83-120 | |
| Ethane | 1,010 | **1,070** | **106** | 85-122 | |
| Propane | 1,010 | **1,050** | **104** | 84-121 | |
| n-Butane | 1,010 | **995** | **99** | 79-114 | |
| n-Pentane | 1,010 | **1,040** | **103** | 80-121 | |
| n-Hexane | 1,020 | **1,010** | **99** | 73-121 | |

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-0-30-0%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-001

Test Code: ASTM D1945-03 Date Collected: 3/11/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/15/14
Analyst: Nalini Lall Date Analyzed: 3/18/14
Sample Type: 6.0 L Silonite Canister Volume(s) Analyzed: 0.10 ml(s)
Test Notes:
Container ID: SSC00180

Initial Pressure (psig): -0.54 Final Pressure (psig): 3.82

Canister Dilution Factor: 1.31

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 1333-74-0 | Hydrogen | ND | 0.13 | |
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **0.121** | 0.13 | **K** |
| 7727-37-9 | **Nitrogen** | **0.607** | 0.13 | |
| 630-08-0 | Carbon Monoxide | ND | 0.13 | |
| 124-38-9 | Carbon Dioxide | ND | 0.13 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

K = Analyte was detected above the method reporting limit prior to normalization.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-30-70-30%-Can-4X30PF**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P1401040-002

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC1/TCD
Analyst: Nalini Lall
Sample Type: 6.0 L Silonite Canister
Test Notes:
Container ID: SSC00082

Date Collected: 3/12/14
Date Received: 3/15/14
Date Analyzed: 3/18/14
Volume(s) Analyzed: 0.10 ml(s)

Initial Pressure (psig): 1.27 Final Pressure (psig): 3.98

Canister Dilution Factor: 1.17

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 1333-74-0 | Hydrogen | ND | 0.12 | |
| 7782-44-7 | Oxygen + | | | |
| 7440-37-1 | Argon | ND | 0.12 | |
| 7727-37-9 | **Nitrogen** | **0.166** | 0.12 | |
| 630-08-0 | Carbon Monoxide | ND | 0.12 | |
| 124-38-9 | Carbon Dioxide | ND | 0.12 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-70-100-70%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-003

Test Code: ASTM D1945-03 Date Collected: 3/13/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/15/14
Analyst: Nalini Lall Date Analyzed: 3/18/14
Sample Type: 6.0 L Silonite Canister Volume(s) Analyzed: 0.10 ml(s)
Test Notes:
Container ID: SSC00037

Initial Pressure (psig): 2.72 Final Pressure (psig): 3.91

Canister Dilution Factor: 1.07

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 1333-74-0 | Hydrogen | ND | 0.11 | |
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **0.557** | 0.11 | |
| 7727-37-9 | **Nitrogen** | **2.03** | 0.11 | |
| 630-08-0 | Carbon Monoxide | ND | 0.11 | |
| 124-38-9 | Carbon Dioxide | ND | 0.11 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-90-100%-Can-4X30PF**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P1401040-004

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC1/TCD
Analyst: Nalini Lall
Sample Type: 6.0 L Silonite Canister
Test Notes:
Container ID: SSC00188

Date Collected: 3/13/14
Date Received: 3/15/14
Date Analyzed: 3/18/14
Volume(s) Analyzed: 0.10 ml(s)

Initial Pressure (psig): 0.41 Final Pressure (psig): 3.82

Canister Dilution Factor: 1.23

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 1333-74-0 | Hydrogen | ND | 0.12 | |
| 7782-44-7 | Oxygen + | | | |
| 7440-37-1 | Argon | ND | 0.12 | |
| 7727-37-9 | **Nitrogen** | **0.302** | 0.12 | |
| 630-08-0 | Carbon Monoxide | ND | 0.12 | |
| 124-38-9 | Carbon Dioxide | ND | 0.12 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Method Blank**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P140318-MB

Test Code: ASTM D1945-03
Instrument ID: HP5890 II/GC1/TCD
Analyst: Nalini Lall
Sample Type: 6.0 L Silonite Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 3/18/14
Volume(s) Analyzed: 0.10 ml(s)

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 1333-74-0 | Hydrogen | ND | 0.10 | |
| 7782-44-7 | Oxygen + | | | |
| 7440-37-1 | Argon | ND | 0.10 | |
| 7727-37-9 | Nitrogen | ND | 0.10 | |
| 630-08-0 | Carbon Monoxide | ND | 0.10 | |
| 124-38-9 | Carbon Dioxide | ND | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Lab Control Sample** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P140318-LCS

Test Code: ASTM D1945-03 Date Collected: NA
Instrument ID: HP5890 II/GC1/TCD Date Received: NA
Analyst: Nalini Lall Date Analyzed: 3/18/14
Sample Type: 6.0 L Silonite Canister Volume(s) Analyzed: NA ml(s)
Test Notes:

| **CAS #** | **Compound** | Spike Amount ppmV | **Result ppmV** | **% Recovery** | ALS Acceptance Limits | Data Qualifier |
|---|---|---|---|---|---|---|
| 1333-74-0 | Hydrogen | 40,000 | **36,700** | **92** | 84-110 | |
| 7782-44-7 | Oxygen + | | | | | |
| 7440-37-1 | Argon | 50,000 | **50,600** | **101** | 88-114 | |
| 7727-37-9 | Nitrogen | 50,000 | **51,500** | **103** | 88-114 | |
| 630-08-0 | Carbon Monoxide | 50,000 | **49,900** | **100** | 88-113 | |
| 124-38-9 | Carbon Dioxide | 50,000 | **49,400** | **99** | 84-109 | |

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-0-30-0%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-001

| | | | |
|---|---|---|---|
| Test Code: | ASTM D 5504-08 | Date Collected: | 3/11/14 |
| Instrument ID: | Agilent 6890A/GC13/SCD | Time Collected: | 13:16 |
| Analyst: | Mike Conejo | Date Received: | 3/15/14 |
| Sample Type: | 6.0 L Silonite Canister | Date Analyzed: | 3/18/14 |
| Test Notes: | | Time Analyzed: | 16:05 |
| Container ID: | SSC00180 | Volume(s) Analyzed: | 1.0 ml(s) |

Initial Pressure (psig): -0.54 Final Pressure (psig): 3.82

Canister Dilution Factor: 1.31

| CAS # | Compound | Result µg/m³ | MRL µg/m³ | Result ppbV | MRL ppbV | Data Qualifier |
|---|---|---|---|---|---|---|
| 7783-06-4 | Hydrogen Sulfide | ND | 9.1 | ND | 6.6 | |
| 463-58-1 | Carbonyl Sulfide | ND | 16 | ND | 6.6 | |
| 74-93-1 | Methyl Mercaptan | ND | 13 | ND | 6.6 | |
| 75-08-1 | Ethyl Mercaptan | ND | 17 | ND | 6.6 | |
| 75-18-3 | Dimethyl Sulfide | ND | 17 | ND | 6.6 | |
| 75-15-0 | Carbon Disulfide | ND | 10 | ND | 3.3 | |
| 75-33-2 | Isopropyl Mercaptan | ND | 20 | ND | 6.6 | |
| 75-66-1 | tert-Butyl Mercaptan | ND | 24 | ND | 6.6 | |
| 107-03-9 | n-Propyl Mercaptan | ND | 20 | ND | 6.6 | |
| 624-89-5 | Ethyl Methyl Sulfide | ND | 20 | ND | 6.6 | |
| 110-02-1 | Thiophene | ND | 23 | ND | 6.6 | |
| 513-44-0 | Isobutyl Mercaptan | ND | 24 | ND | 6.6 | |
| 352-93-2 | Diethyl Sulfide | ND | 24 | ND | 6.6 | |
| 109-79-5 | n-Butyl Mercaptan | ND | 24 | ND | 6.6 | |
| 624-92-0 | Dimethyl Disulfide | ND | 13 | ND | 3.3 | |
| 616-44-4 | 3-Methylthiophene | ND | 26 | ND | 6.6 | |
| 110-01-0 | Tetrahydrothiophene | ND | 24 | ND | 6.6 | |
| 638-02-8 | 2,5-Dimethylthiophene | ND | 30 | ND | 6.6 | |
| 872-55-9 | 2-Ethylthiophene | ND | 30 | ND | 6.6 | |
| 110-81-6 | Diethyl Disulfide | ND | 16 | ND | 3.3 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-30-70-30%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-002

| | | | |
|---|---|---|---|
| Test Code: | ASTM D 5504-08 | Date Collected: | 3/12/14 |
| Instrument ID: | Agilent 6890A/GC13/SCD | Time Collected: | 12:24 |
| Analyst: | Mike Conejo | Date Received: | 3/15/14 |
| Sample Type: | 6.0 L Silonite Canister | Date Analyzed: | 3/18/14 |
| Test Notes: | | Time Analyzed: | 16:21 |
| Container ID: | SSC00082 | Volume(s) Analyzed: | 1.0 ml(s) |

Initial Pressure (psig): 1.27 Final Pressure (psig): 3.98

Canister Dilution Factor: 1.17

| CAS # | Compound | Result µg/m³ | MRL µg/m³ | Result ppbV | MRL ppbV | Data Qualifier |
|---|---|---|---|---|---|---|
| 7783-06-4 | Hydrogen Sulfide | ND | 8.2 | ND | 5.9 | |
| 463-58-1 | Carbonyl Sulfide | ND | 14 | ND | 5.9 | |
| 74-93-1 | Methyl Mercaptan | ND | 12 | ND | 5.9 | |
| 75-08-1 | Ethyl Mercaptan | ND | 15 | ND | 5.9 | |
| 75-18-3 | Dimethyl Sulfide | ND | 15 | ND | 5.9 | |
| 75-15-0 | Carbon Disulfide | ND | 9.1 | ND | 2.9 | |
| 75-33-2 | Isopropyl Mercaptan | ND | 18 | ND | 5.9 | |
| 75-66-1 | tert-Butyl Mercaptan | ND | 22 | ND | 5.9 | |
| 107-03-9 | n-Propyl Mercaptan | ND | 18 | ND | 5.9 | |
| 624-89-5 | Ethyl Methyl Sulfide | ND | 18 | ND | 5.9 | |
| 110-02-1 | Thiophene | ND | 20 | ND | 5.9 | |
| 513-44-0 | Isobutyl Mercaptan | ND | 22 | ND | 5.9 | |
| 352-93-2 | Diethyl Sulfide | ND | 22 | ND | 5.9 | |
| 109-79-5 | n-Butyl Mercaptan | ND | 22 | ND | 5.9 | |
| 624-92-0 | Dimethyl Disulfide | ND | 11 | ND | 2.9 | |
| 616-44-4 | 3-Methylthiophene | ND | 23 | ND | 5.9 | |
| 110-01-0 | Tetrahydrothiophene | ND | 21 | ND | 5.9 | |
| 638-02-8 | 2,5-Dimethylthiophene | ND | 27 | ND | 5.9 | |
| 872-55-9 | 2-Ethylthiophene | ND | 27 | ND | 5.9 | |
| 110-81-6 | Diethyl Disulfide | ND | 15 | ND | 2.9 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-70-100-70%-Can-4X30PF** ALS Project ID: P1401040
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1** ALS Sample ID: P1401040-003

| | | | |
|---|---|---|---|
| Test Code: | ASTM D 5504-08 | Date Collected: | 3/13/14 |
| Instrument ID: | Agilent 6890A/GC13/SCD | Time Collected: | 09:40 |
| Analyst: | Mike Conejo | Date Received: | 3/15/14 |
| Sample Type: | 6.0 L Silonite Canister | Date Analyzed: | 3/18/14 |
| Test Notes: | | Time Analyzed: | 16:42 |
| Container ID: | SSC00037 | Volume(s) Analyzed: | 1.0 ml(s) |

Initial Pressure (psig): 2.72 Final Pressure (psig): 3.91

Canister Dilution Factor: 1.07

| CAS # | Compound | Result µg/m³ | MRL µg/m³ | Result ppbV | MRL ppbV | Data Qualifier |
|---|---|---|---|---|---|---|
| 7783-06-4 | Hydrogen Sulfide | ND | 7.5 | ND | 5.4 | |
| 463-58-1 | Carbonyl Sulfide | ND | 13 | ND | 5.4 | |
| 74-93-1 | Methyl Mercaptan | ND | 11 | ND | 5.4 | |
| 75-08-1 | Ethyl Mercaptan | ND | 14 | ND | 5.4 | |
| 75-18-3 | Dimethyl Sulfide | ND | 14 | ND | 5.4 | |
| 75-15-0 | Carbon Disulfide | ND | 8.3 | ND | 2.7 | |
| 75-33-2 | Isopropyl Mercaptan | ND | 17 | ND | 5.4 | |
| 75-66-1 | tert-Butyl Mercaptan | ND | 20 | ND | 5.4 | |
| 107-03-9 | n-Propyl Mercaptan | ND | 17 | ND | 5.4 | |
| 624-89-5 | Ethyl Methyl Sulfide | ND | 17 | ND | 5.4 | |
| 110-02-1 | Thiophene | ND | 18 | ND | 5.4 | |
| 513-44-0 | Isobutyl Mercaptan | ND | 20 | ND | 5.4 | |
| 352-93-2 | Diethyl Sulfide | ND | 20 | ND | 5.4 | |
| 109-79-5 | n-Butyl Mercaptan | ND | 20 | ND | 5.4 | |
| 624-92-0 | Dimethyl Disulfide | ND | 10 | ND | 2.7 | |
| 616-44-4 | 3-Methylthiophene | ND | 21 | ND | 5.4 | |
| 110-01-0 | Tetrahydrothiophene | ND | 19 | ND | 5.4 | |
| 638-02-8 | 2,5-Dimethylthiophene | ND | 25 | ND | 5.4 | |
| 872-55-9 | 2-Ethylthiophene | ND | 25 | ND | 5.4 | |
| 110-81-6 | Diethyl Disulfide | ND | 13 | ND | 2.7 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **JZ-90-100%-Can-4X30PF**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P1401040-004

| | | | |
|---|---|---|---|
| Test Code: | ASTM D 5504-08 | Date Collected: | 3/13/14 |
| Instrument ID: | Agilent 7890A/GC22/SCD | Time Collected: | 15:15 |
| Analyst: | Mike Conejo | Date Received: | 3/15/14 |
| Sample Type: | 6.0 L Silonite Canister | Date Analyzed: | 3/18/14 |
| Test Notes: | | Time Analyzed: | 16:53 |
| Container ID: | SSC00188 | Volume(s) Analyzed: | 1.0 ml(s) |

Initial Pressure (psig): 0.41 Final Pressure (psig): 3.82

Canister Dilution Factor: 1.23

| CAS # | Compound | Result µg/m³ | MRL µg/m³ | Result ppbV | MRL ppbV | Data Qualifier |
|---|---|---|---|---|---|---|
| 7783-06-4 | Hydrogen Sulfide | ND | 8.6 | ND | 6.2 | |
| 463-58-1 | Carbonyl Sulfide | ND | 15 | ND | 6.2 | |
| 74-93-1 | Methyl Mercaptan | ND | 12 | ND | 6.2 | |
| 75-08-1 | Ethyl Mercaptan | ND | 16 | ND | 6.2 | |
| 75-18-3 | Dimethyl Sulfide | ND | 16 | ND | 6.2 | |
| 75-15-0 | Carbon Disulfide | ND | 9.6 | ND | 3.1 | |
| 75-33-2 | Isopropyl Mercaptan | ND | 19 | ND | 6.2 | |
| 75-66-1 | tert-Butyl Mercaptan | ND | 23 | ND | 6.2 | |
| 107-03-9 | n-Propyl Mercaptan | ND | 19 | ND | 6.2 | |
| 624-89-5 | Ethyl Methyl Sulfide | ND | 19 | ND | 6.2 | |
| 110-02-1 | Thiophene | ND | 21 | ND | 6.2 | |
| 513-44-0 | Isobutyl Mercaptan | ND | 23 | ND | 6.2 | |
| 352-93-2 | Diethyl Sulfide | ND | 23 | ND | 6.2 | |
| 109-79-5 | n-Butyl Mercaptan | ND | 23 | ND | 6.2 | |
| 624-92-0 | Dimethyl Disulfide | ND | 12 | ND | 3.1 | |
| 616-44-4 | 3-Methylthiophene | ND | 25 | ND | 6.2 | |
| 110-01-0 | Tetrahydrothiophene | ND | 22 | ND | 6.2 | |
| 638-02-8 | 2,5-Dimethylthiophene | ND | 28 | ND | 6.2 | |
| 872-55-9 | 2-Ethylthiophene | ND | 28 | ND | 6.2 | |
| 110-81-6 | Diethyl Disulfide | **39** | 15 | **7.8** | 3.1 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Method Blank**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P140318-MB

Test Code: ASTM D 5504-08
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Mike Conejo
Sample Type: 6.0 L Silonite Canister
Test Notes:

Date Collected: NA
Time Collected: NA
Date Received: NA
Date Analyzed: 3/18/14
Time Analyzed: 08:32
Volume(s) Analyzed: 1.0 ml(s)

| CAS # | Compound | Result µg/m³ | MRL µg/m³ | Result ppbV | MRL ppbV | Data Qualifier |
|---|---|---|---|---|---|---|
| 7783-06-4 | Hydrogen Sulfide | ND | 7.0 | ND | 5.0 | |
| 463-58-1 | Carbonyl Sulfide | ND | 12 | ND | 5.0 | |
| 74-93-1 | Methyl Mercaptan | ND | 9.8 | ND | 5.0 | |
| 75-08-1 | Ethyl Mercaptan | ND | 13 | ND | 5.0 | |
| 75-18-3 | Dimethyl Sulfide | ND | 13 | ND | 5.0 | |
| 75-15-0 | Carbon Disulfide | ND | 7.8 | ND | 2.5 | |
| 75-33-2 | Isopropyl Mercaptan | ND | 16 | ND | 5.0 | |
| 75-66-1 | tert-Butyl Mercaptan | ND | 18 | ND | 5.0 | |
| 107-03-9 | n-Propyl Mercaptan | ND | 16 | ND | 5.0 | |
| 624-89-5 | Ethyl Methyl Sulfide | ND | 16 | ND | 5.0 | |
| 110-02-1 | Thiophene | ND | 17 | ND | 5.0 | |
| 513-44-0 | Isobutyl Mercaptan | ND | 18 | ND | 5.0 | |
| 352-93-2 | Diethyl Sulfide | ND | 18 | ND | 5.0 | |
| 109-79-5 | n-Butyl Mercaptan | ND | 18 | ND | 5.0 | |
| 624-92-0 | Dimethyl Disulfide | ND | 9.6 | ND | 2.5 | |
| 616-44-4 | 3-Methylthiophene | ND | 20 | ND | 5.0 | |
| 110-01-0 | Tetrahydrothiophene | ND | 18 | ND | 5.0 | |
| 638-02-8 | 2,5-Dimethylthiophene | ND | 23 | ND | 5.0 | |
| 872-55-9 | 2-Ethylthiophene | ND | 23 | ND | 5.0 | |
| 110-81-6 | Diethyl Disulfide | ND | 12 | ND | 2.5 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Method Blank**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P140318-MB

Test Code: ASTM D 5504-08
Instrument ID: Agilent 7890A/GC22/SCD
Analyst: Mike Conejo
Sample Type: 6.0 L Silonite Canister
Test Notes:

Date Collected: NA
Time Collected: NA
Date Received: NA
Date Analyzed: 3/18/14
Time Analyzed: 08:32
Volume(s) Analyzed: 1.0 ml(s)

| CAS # | Compound | Result µg/m³ | MRL µg/m³ | Result ppbV | MRL ppbV | Data Qualifier |
|---|---|---|---|---|---|---|
| 7783-06-4 | Hydrogen Sulfide | ND | 7.0 | ND | 5.0 | |
| 463-58-1 | Carbonyl Sulfide | ND | 12 | ND | 5.0 | |
| 74-93-1 | Methyl Mercaptan | ND | 9.8 | ND | 5.0 | |
| 75-08-1 | Ethyl Mercaptan | ND | 13 | ND | 5.0 | |
| 75-18-3 | Dimethyl Sulfide | ND | 13 | ND | 5.0 | |
| 75-15-0 | Carbon Disulfide | ND | 7.8 | ND | 2.5 | |
| 75-33-2 | Isopropyl Mercaptan | ND | 16 | ND | 5.0 | |
| 75-66-1 | tert-Butyl Mercaptan | ND | 18 | ND | 5.0 | |
| 107-03-9 | n-Propyl Mercaptan | ND | 16 | ND | 5.0 | |
| 624-89-5 | Ethyl Methyl Sulfide | ND | 16 | ND | 5.0 | |
| 110-02-1 | Thiophene | ND | 17 | ND | 5.0 | |
| 513-44-0 | Isobutyl Mercaptan | ND | 18 | ND | 5.0 | |
| 352-93-2 | Diethyl Sulfide | ND | 18 | ND | 5.0 | |
| 109-79-5 | n-Butyl Mercaptan | ND | 18 | ND | 5.0 | |
| 624-92-0 | Dimethyl Disulfide | ND | 9.6 | ND | 2.5 | |
| 616-44-4 | 3-Methylthiophene | ND | 20 | ND | 5.0 | |
| 110-01-0 | Tetrahydrothiophene | ND | 18 | ND | 5.0 | |
| 638-02-8 | 2,5-Dimethylthiophene | ND | 23 | ND | 5.0 | |
| 872-55-9 | 2-Ethylthiophene | ND | 23 | ND | 5.0 | |
| 110-81-6 | Diethyl Disulfide | ND | 12 | ND | 2.5 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Lab Control Sample**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P140318-LCS

Test Code: ASTM D 5504-08
Instrument ID: Agilent 6890A/GC13/SCD
Analyst: Mike Conejo
Sample Type: 6.0 L Silonite Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 3/18/14
Volume(s) Analyzed: NA ml(s)

| **CAS #** | **Compound** | Spike Amount ppbV | **Result ppbV** | **% Recovery** | ALS Acceptance Limits | Data Qualifier |
|---|---|---|---|---|---|---|
| 7783-06-4 | Hydrogen Sulfide | 2,050 | **1,850** | **90** | 66-131 | |
| 463-58-1 | Carbonyl Sulfide | 2,020 | **1,780** | **88** | 64-131 | |
| 74-93-1 | Methyl Mercaptan | 1,890 | **1,990** | **105** | 68-160 | |

# ALS ENVIRONMENTAL

LABORATORY CONTROL SAMPLE SUMMARY



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Lab Control Sample**
**Client Project ID:** **JZ-14-Tulsa.ok-comp#1 / 1**

ALS Project ID: P1401040
ALS Sample ID: P140318-LCS

Test Code: ASTM D 5504-08
Instrument ID: Agilent 7890A/GC22/SCD
Analyst: Mike Conejo
Sample Type: 6.0 L Silonite Canister
Test Notes:

Date Collected: NA
Date Received: NA
Date Analyzed: 3/18/14
Volume(s) Analyzed: NA ml(s)

| **CAS #** | **Compound** | Spike Amount ppbV | **Result ppbV** | **% Recovery** | ALS Acceptance Limits | Data Qualifier |
|---|---|---|---|---|---|---|
| 7783-06-4 | Hydrogen Sulfide | 2,050 | **1,790** | **87** | 66-131 | |
| 463-58-1 | Carbonyl Sulfide | 2,020 | **1,930** | **96** | 64-131 | |
| 74-93-1 | Methyl Mercaptan | 1,890 | **2,140** | **113** | 68-160 | |

# APPENDIX F

# METHOD 3C RESULTS

# LABORATORY REPORT

March 26, 2014

Min Lee
Air Hygiene, Incorporated
1600 West Tacoma Street
Broken Arrow, OK 74012

**RE: jz-13-tulsa.ok-comp#1**

Dear Min:

Enclosed are the results of the samples submitted to our laboratory on March 12, 2014. For your reference, these analyses have been assigned our service request number P1400954.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**ALS | Environmental**

Kelly Horiuchi
Laboratory Director

Client: Air Hygiene, Incorporated Service Request No: P1400954
Project: jz-13-tulsa.ok-comp#1

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## CASE NARRATIVE

The samples were received intact under chain of custody on March 12, 2014 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Fixed Gases Analysis

The samples were analyzed for fixed gases (oxygen/argon, nitrogen, methane and carbon dioxide) according to EPA Method 3C (triplicate injection) using a gas chromatograph equipped with a thermal conductivity detector (TCD). This method is not included on the laboratory's NELAP or AIHA-LAP scope of accreditation.

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*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.*

*Use of ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*

ALS Environmental – Simi Valley

Certifications, Accreditations, and Registrations

| Agency | Web Site | Number |
|---|---|---|
| AIHA | http://www.aihaaccreditedlabs.org | 101661 |
| Arizona DHS | http://www.azdhs.gov/lab/license/env.htm | AZ0694 |
| DoD ELAP | http://www.pjlabs.com/search-accredited-labs | L11-203 |
| Florida DOH (NELAP) | http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm | E871020 |
| Maine DHHS | http://www.maine.gov/dhhs/mecdc/environmental-health/water/dwp-services/labcert/labcert.htm | 2012039 |
| Minnesota DOH (NELAP) | http://www.health.state.mn.us/accreditation | 494864 |
| New Jersey DEP (NELAP) | http://www.nj.gov/dep/oqa/ | CA009 |
| New York DOH (NELAP) | http://www.wadsworth.org/labcert/elap/elap.html | 11221 |
| Oregon PHD (NELAP) | http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx | CA200007 |
| Pennsylvania DEP | http://www.depweb.state.pa.us/labs | 68-03307 (Registration) |
| Texas CEQ (NELAP) | http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html | T104704413-13-4 |
| Utah DOH (NELAP) | http://www.health.utah.gov/lab/labimp/certification/index.html | CA016272013-3 |
| Washington DOE | http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html | C946 |

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

# ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: Air Hygiene, Incorporated

Service Request: P1400954

Project ID: jz-13-tulsa.ok-comp#1

Date Received: 3/12/2014

Time Received: 09:45

| Client Sample ID | Lab Code | Matrix | Date Collected | Time Collected | 3C Modified - Fxd Gases Bag 2X |
|---|---|---|---|---|---|
| R1-0-30-0%-4X30PF | P1400954-001 | Air | 3/11/14 | 00:00 | X |
| R2-0-30-0%-4X30PF | P1400954-003 | Air | 3/11/14 | 00:00 | X |
| R3-0-30-0%-4X30PF | P1400954-005 | Air | 3/11/14 | 00:00 | X |

P1400954

# SAMPLE DESCRIPTION AND CHAIN OF CUSTODY RECORD

Air Hygiene International, Inc.
1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
(888) 461-8778
www.airhygiene.com

| | | | |
|---|---|---|---|
| Project Number: | jz-13-tulsa.ok-comp#1 | Laboratory Analysis Requested: | RM 3C |
| Person Taking Samples: | MSL | Comments: Neglect Backup bag unless main bag is broken | |

| Sample Number | Location | Date | Volume | Analysis Method | | | |
|---|---|---|---|---|---|---|---|
| | | | | O2 | CO2 | Nitrogen | Methane-Ethane |
| R1-0-30-0%-4X30PF | John Zink Tulsa R&D Facility | 24-Oct | 10 | x | x | x | x |
| R1-0-30-0%-4X30PF-BACKUP | John Zink Tulsa R&D Facility | 24-Oct | 5 | x | x | x | x |
| R2-0-30-0%-4X30PF | John Zink Tulsa R&D Facility | 24-Oct | 10 | x | x | x | x |
| R2-0-30-0%-4X30PF-BACKUP | John Zink Tulsa R&D Facility | 24-Oct | 5 | x | x | x | x |
| R3-0-30-0%-4X30PF | John Zink Tulsa R&D Facility | 25-Oct | 10 | x | x | x | x |
| R3-0-30-0%-4X30PF-BACKUP | John Zink Tulsa R&D Facility | 25-Oct | 5 | x | x | x | x |

| | | | | | |
|---|---|---|---|---|---|
| Relinquished by: (Signature) | Date: 3/11/14 | Time: | Received by: (Signature) | Date: 3/12/14 | Time: 0945 |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Date: | Time: |

4-tulsa.ok-comp#1-coc

9H02954

# SAMPLE DESCRIPTION AND CHAIN OF CUSTODY RECORD

Air Hygiene International, Inc.
1900 W Tacoma Street
Broken Arrow, Oklahoma 74012
(918) 451-5778
www.airhygiene.com

| | | | |
|---|---|---|---|
| Project Number | R-13-Hancock-compl1 | Laboratory Analysis Requested | RM 25 |
| Person Taking Sample | MB | Comments: Number Darkep bag where cable bag is broken | |

| Sample Number | Location | Date Sampled | Volume | Analysis Method CO | CO2 | Nitrogen | Methane + Ethane |
|---|---|---|---|---|---|---|---|
| R1-0-30-09-4X30PF | John Zink Tulsa R&D Facility | 24-Oct | 10 | x | x | x | x |
| R1-0-30-09-4X30PF-duplicate | John Zink Tulsa R&D Facility | 24-Oct | 5 | x | x | x | x |
| R2-0-30-09-4X30PF | John Zink Tulsa R&D Facility | 24-Oct | 10 | x | x | x | x |
| R2-0-30-09-4X30PF-duplicate | John Zink Tulsa R&D Facility | 24-Oct | 5 | x | x | x | x |
| R3-0-30-09-4X30PF | John Zink Tulsa R&D Facility | 25-Oct | 10 | x | x | x | x |
| R3-0-30-09-4X30PF-duplicate | John Zink Tulsa R&D Facility | 25-Oct | 5 | x | x | x | x |

Signature of Sampler: 3/11/14 — Signature of Receiver: 3/11/14 — 0935

Signature of Sampler — Date — Time — Signature of Receiver — Date — Time

Hancock-compl1.doc

# ALS Environmental
## Sample Acceptance Check Form

Client: Air Hygiene, Incorporated  Work order: P1400954

Project: jz-13-tulsa.ok-comp#1

Sample(s) received on: 3/12/14  Date opened: 3/12/14  by: MZAMORA

***Note:*** This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

| | | Yes | No | N/A |
|---|---|---|---|---|
| 1 | Were **sample containers** properly marked with client sample ID? | ☒ | ☐ | ☐ |
| 2 | Container(s) **supplied by ALS**? | ☐ | ☒ | ☐ |
| 3 | Did **sample containers** arrive in good condition? | ☒ | ☐ | ☐ |
| 4 | Were **chain-of-custody** papers used and filled out? | ☒ | ☐ | ☐ |
| 5 | Did **sample container labels** and/or tags agree with custody papers? | ☒ | ☐ | ☐ |
| 6 | Was **sample volume** received adequate for analysis? | ☒ | ☐ | ☐ |
| 7 | Are samples within specified holding times? | ☒ | ☐ | ☐ |
| 8 | Was proper **temperature** (thermal preservation) of cooler at receipt adhered to? | ☐ | ☐ | ☒ |
| 9 | Was a **trip blank** received? | ☐ | ☒ | ☐ |
| 10 | Were **custody seals** on outside of cooler/Box? | ☐ | ☒ | ☐ |
| | Location of seal(s)? _____ Sealing Lid? | ☐ | ☐ | ☒ |
| | Were signature and date included? | ☐ | ☐ | ☒ |
| | Were seals intact? | ☐ | ☐ | ☒ |
| | Were custody seals on outside of sample container? | ☐ | ☒ | ☐ |
| | Location of seal(s)? _____ Sealing Lid? | ☐ | ☐ | ☒ |
| | Were signature and date included? | ☐ | ☐ | ☒ |
| | Were seals intact? | ☐ | ☐ | ☒ |
| 11 | Do containers have appropriate **preservation**, according to method/SOP or Client specified information? | ☐ | ☐ | ☒ |
| | Is there a client indication that the submitted samples are **pH** preserved? | ☐ | ☐ | ☒ |
| | Were **VOA vials** checked for presence/absence of air bubbles? | ☐ | ☐ | ☒ |
| | Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it? | ☐ | ☐ | ☒ |
| 12 | **Tubes:** Are the tubes capped and intact? | ☐ | ☐ | ☒ |
| | Do they contain moisture? | ☐ | ☐ | ☒ |
| 13 | **Badges:** Are the badges properly capped and intact? | ☐ | ☐ | ☒ |
| | Are dual bed badges separated and individually capped and intact? | ☐ | ☐ | ☒ |

| Lab Sample ID | Container Description | Required pH * | Received pH | Adjusted pH | VOA Headspace (Presence/Absence) | Receipt / Preservation Comments |
|---|---|---|---|---|---|---|
| P1400954-001.01 | 10 L Tedlar Bag | | | | | |
| P1400954-002.01 | 5.0 L Tedlar Bag | | | | | |
| P1400954-003.01 | 10 L Tedlar Bag | | | | | |
| P1400954-004.01 | 5.0 L Tedlar Bag | | | | | |
| P1400954-005.01 | 10 L Tedlar Bag | | | | | |
| P1400954-006.01 | 5.0 L Tedlar Bag | | | | | |
| | | | | | | |
| | | | | | | |

Explain any discrepancies: (include lab sample ID numbers):

Chain of Custody is missing time collected

Dates collected are listed incorrectly on the COC.

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R1-0-30-0%-4X30PF** ALS Project ID: P1400954
**Client Project ID:** **jz-13-tulsa.ok-comp#1** ALS Sample ID: P1400954-001

Test Code: EPA Method 3C Modified Date Collected: 3/11/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/12/14
Analyst: Nalini Lall Date Analyzed: 3/13/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.0** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **80.1** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.91** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R2-0-30-0%-4X30PF** ALS Project ID: P1400954
**Client Project ID:** **jz-13-tulsa.ok-comp#1** ALS Sample ID: P1400954-003

Test Code: EPA Method 3C Modified Date Collected: 3/11/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/12/14
Analyst: Nalini Lall Date Analyzed: 3/13/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.0** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **80.1** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.91** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R3-0-30-0%-4X30PF** ALS Project ID: P1400954
**Client Project ID:** **jz-13-tulsa.ok-comp#1** ALS Sample ID: P1400954-005

Test Code: EPA Method 3C Modified Date Collected: 3/11/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/12/14
Analyst: Nalini Lall Date Analyzed: 3/13/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.6** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **79.9** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.53** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Method Blank** ALS Project ID: P1400954
**Client Project ID:** **jz-13-tulsa.ok-comp#1** ALS Sample ID: P140313-MB

Test Code: EPA Method 3C Modified Date Collected: NA
Instrument ID: HP5890 II/GC1/TCD Date Received: NA
Analyst: Nalini Lall Date Analyzed: 3/13/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | Oxygen + | | | |
| 7440-37-1 | Argon | ND | 0.10 | |
| 7727-37-9 | Nitrogen | ND | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | Carbon Dioxide | ND | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# LABORATORY REPORT

March 26, 2014

Min Lee
Air Hygiene, Incorporated
1600 West Tacoma Street
Broken Arrow, OK 74012

**RE: jz-14-tulsa.ok-comp#1**

Dear Min:

Enclosed are the results of the samples submitted to our laboratory on March 13, 2014. For your reference, these analyses have been assigned our service request number P1400986.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**ALS | Environmental**

Kelly Horiuchi
Laboratory Director

Client: Air Hygiene, Incorporated Service Request No: P1400986
Project: jz-14-tulsa.ok-comp#1

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## CASE NARRATIVE

The samples were received intact under chain of custody on March 13, 2014 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Fixed Gases Analysis

The samples were analyzed for fixed gases (oxygen/argon, nitrogen, methane and carbon dioxide) according to EPA Method 3C (triplicate injection) using a gas chromatograph equipped with a thermal conductivity detector (TCD). This method is not included on the laboratory's NELAP or AIHA-LAP scope of accreditation.

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*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.*

*Use of ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*

ALS Environmental – Simi Valley

Certifications, Accreditations, and Registrations

| Agency | Web Site | Number |
|---|---|---|
| AIHA | http://www.aihaaccreditedlabs.org | 101661 |
| Arizona DHS | http://www.azdhs.gov/lab/license/env.htm | AZ0694 |
| DoD ELAP | http://www.pjlabs.com/search-accredited-labs | L11-203 |
| Florida DOH (NELAP) | http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm | E871020 |
| Maine DHHS | http://www.maine.gov/dhhs/mecdc/environmental-health/water/dwp-services/labcert/labcert.htm | 2012039 |
| Minnesota DOH (NELAP) | http://www.health.state.mn.us/accreditation | 494864 |
| New Jersey DEP (NELAP) | http://www.nj.gov/dep/oqa/ | CA009 |
| New York DOH (NELAP) | http://www.wadsworth.org/labcert/elap/elap.html | 11221 |
| Oregon PHD (NELAP) | http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx | CA200007 |
| Pennsylvania DEP | http://www.depweb.state.pa.us/labs | 68-03307 (Registration) |
| Texas CEQ (NELAP) | http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html | T104704413-13-4 |
| Utah DOH (NELAP) | http://www.health.utah.gov/lab/labimp/certification/index.html | CA016272013-3 |
| Washington DOE | http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html | C946 |

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

# ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: Air Hygiene, Incorporated
Project ID: jz-14-tulsa.ok-comp#1

Service Request: P1400986

Date Received: 3/13/2014
Time Received: 10:00

| Client Sample ID | Lab Code | Matrix | Date Collected | Time Collected | 3C Modified - Fxd Gases Bag 2X |
|---|---|---|---|---|---|
| R4-30-70-30%-4X30PF | P1400986-001 | Air | 3/12/2014 | 00:00 | X |
| R5-30-70-30%-4X30PF | P1400986-003 | Air | 3/12/2014 | 00:00 | X |
| R6-30-70-30%-4X30PF | P1400986-005 | Air | 3/12/2014 | 00:00 | X |
| R7-70-100-70%-4X30PF | P1400986-007 | Air | 3/12/2014 | 00:00 | X |
| R8-70-100-70%-4X30PF | P1400986-009 | Air | 3/12/2014 | 00:00 | X |

P1400986

# SAMPLE DESCRIPTION AND CHAIN OF CUSTODY RECORD

Air Hygiene International, Inc.
1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
(888) 461-8778
www.airhygiene.com

| | | | |
|---|---|---|---|
| Project Number: | jz-14-tulsa.ok-comp#1 | Laboratory Analysis Requested: | RM 3C |
| Person Taking Samples: | MSL | Comments:Do not analyze backup unless breakage | |

| | Sample Number | Location | Date | Volume | Analysis Method | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | O2 | CO2 | Nitrogen | Methane-Ethane |
| 1 | R4-30-70-30%-4X30PF | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 2 | R4-30-70-30%-4X30PF-Backup | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 3 | R5-30-70-30%-4X30PF | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 4 | R5-30-70-30%-4X30PF-Backup | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 5 | R6-30-70-30%-4X30PF | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 6 | R6-30-70-30%-4X30PF-Backup | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 7 | R7-70-100-70%-4X30PF | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 8 | R7-70-100-70%-4X30PF-Backup | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 9 | R8-70-100-70%-4X30PF | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |
| 10 | R8-70-100-70%-4X30PF-Backup | John Zink Tulsa R&D Facility | 12-Mar | 10 | x | x | x | x |

| | | | | | |
|---|---|---|---|---|---|
| Relinquished by: (Signature) | Date: 3/12/14 | Time: 17:40:00 | Received by: (Signature) | Date: 3/13/14 | Time: 1000 |
| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Date: | Time: |

4-tulsa.ok-comp#1-coc

# ALS Environmental
## Sample Acceptance Check Form

Client: Air Hygiene, Incorporated  Work order: P1400986

Project: jz-14-tulsa.ok-comp#1

Sample(s) received on: 3/13/14  Date opened: 3/13/14  by: MZAMORA

***Note:*** This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

| | | Yes | No | N/A |
|---|---|---|---|---|
| 1 | Were **sample containers** properly marked with client sample ID? | ☒ | ☐ | ☐ |
| 2 | Container(s) **supplied by ALS**? | ☒ | ☐ | ☐ |
| 3 | Did **sample containers** arrive in good condition? | ☒ | ☐ | ☐ |
| 4 | Were **chain-of-custody** papers used and filled out? | ☒ | ☐ | ☐ |
| 5 | Did **sample container labels** and/or tags agree with custody papers? | ☒ | ☐ | ☐ |
| 6 | Was **sample volume** received adequate for analysis? | ☒ | ☐ | ☐ |
| 7 | Are samples within specified holding times? | ☒ | ☐ | ☐ |
| 8 | Was proper **temperature** (thermal preservation) of cooler at receipt adhered to? | ☐ | ☐ | ☒ |
| 9 | Was a **trip blank** received? | ☐ | ☒ | ☐ |
| 10 | Were **custody seals** on outside of cooler/Box? | ☐ | ☒ | ☐ |
| | Location of seal(s)? _____ Sealing Lid? | ☐ | ☐ | ☒ |
| | Were signature and date included? | ☐ | ☐ | ☒ |
| | Were seals intact? | ☐ | ☐ | ☒ |
| | Were custody seals on outside of sample container? | ☐ | ☒ | ☐ |
| | Location of seal(s)? _____ Sealing Lid? | ☐ | ☐ | ☒ |
| | Were signature and date included? | ☐ | ☐ | ☒ |
| | Were seals intact? | ☐ | ☐ | ☒ |
| 11 | Do containers have appropriate **preservation**, according to method/SOP or Client specified information? | ☐ | ☐ | ☒ |
| | Is there a client indication that the submitted samples are **pH** preserved? | ☐ | ☐ | ☒ |
| | Were **VOA vials** checked for presence/absence of air bubbles? | ☐ | ☐ | ☒ |
| | Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it? | ☐ | ☐ | ☒ |
| 12 | **Tubes:** Are the tubes capped and intact? | ☐ | ☐ | ☒ |
| | Do they contain moisture? | ☐ | ☐ | ☒ |
| 13 | **Badges:** Are the badges properly capped and intact? | ☐ | ☐ | ☒ |
| | Are dual bed badges separated and individually capped and intact? | ☐ | ☐ | ☒ |

| Lab Sample ID | Container Description | Required pH * | Received pH | Adjusted pH | VOA Headspace (Presence/Absence) | Receipt / Preservation Comments |
|---|---|---|---|---|---|---|
| P1400986-001.01 | 10 L Tedlar Bag | | | | | |
| P1400986-002.01 | 10 L Tedlar Bag | | | | | |
| P1400986-003.01 | 10 L Tedlar Bag | | | | | |
| P1400986-004.01 | 10 L Tedlar Bag | | | | | |
| P1400986-005.01 | 10 L Tedlar Bag | | | | | |
| P1400986-006.01 | 10 L Tedlar Bag | | | | | |
| P1400986-007.01 | 10 L Tedlar Bag | | | | | |
| P1400986-008.01 | 10 L Tedlar Bag | | | | | |

Explain any discrepancies: (include lab sample ID numbers):

Chain of Custody is missing time collected

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

# ALS Environmental
## Sample Acceptance Check Form

Client: Air Hygiene, Incorporated  Work order: P1400986

Project: jz-14-tulsa.ok-comp#1

Sample(s) received on: 3/13/14  Date opened: 3/13/14  by: MZAMORA

| Lab Sample ID | Container Description | Required pH * | Received pH | Adjusted pH | VOA Headspace (Presence/Absence) | Receipt / Preservation Comments |
|---|---|---|---|---|---|---|
| P1400986-009.01 | 10 L Tedlar Bag | | | | | |
| P1400986-010.01 | 10 L Tedlar Bag | | | | | |

Explain any discrepancies: (include lab sample ID numbers):

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R4-30-70-30%-4X30PF** ALS Project ID: P1400986
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1400986-001

Test Code: EPA Method 3C Modified Date Collected: 3/12/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/13/14
Analyst: Nalini Lall Date Analyzed: 3/13/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.0** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **80.1** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.91** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R5-30-70-30%-4X30PF** ALS Project ID: P1400986
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1400986-003

Test Code: EPA Method 3C Modified Date Collected: 3/12/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/13/14
Analyst: Nalini Lall Date Analyzed: 3/13/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.0** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **80.1** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.91** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R6-30-70-30%-4X30PF** ALS Project ID: P1400986
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1400986-005

Test Code: EPA Method 3C Modified
Instrument ID: HP5890 II/GC1/TCD
Analyst: Nalini Lall
Sample Type: 10 L Tedlar Bag
Test Notes:

Date Collected: 3/12/14
Date Received: 3/13/14
Date Analyzed: 3/13/14
Volume(s) Analyzed: 0.10 ml(s)

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.6** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **79.9** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.53** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R7-70-100-70%-4X30PF** ALS Project ID: P1400986
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1400986-007

Test Code: EPA Method 3C Modified
Instrument ID: HP5890 II/GC1/TCD
Analyst: Nalini Lall
Sample Type: 10 L Tedlar Bag
Test Notes:

Date Collected: 3/12/14
Date Received: 3/13/14
Date Analyzed: 3/14/14
Volume(s) Analyzed: 0.10 ml(s)

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **15.4** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **79.3** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.25** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R8-70-100-70%-4X30PF** ALS Project ID: P1400986
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1400986-009

Test Code: EPA Method 3C Modified Date Collected: 3/12/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/13/14
Analyst: Nalini Lall Date Analyzed: 3/14/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.7** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **79.8** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.50** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Method Blank** ALS Project ID: P1400986
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P140313-MB

Test Code: EPA Method 3C Modified Date Collected: NA
Instrument ID: HP5890 II/GC1/TCD Date Received: NA
Analyst: Nalini Lall Date Analyzed: 3/13/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | Oxygen + | | | |
| 7440-37-1 | Argon | ND | 0.10 | |
| 7727-37-9 | Nitrogen | ND | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | Carbon Dioxide | ND | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Method Blank** ALS Project ID: P1400986
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P140314-MB

Test Code: EPA Method 3C Modified Date Collected: NA
Instrument ID: HP5890 II/GC1/TCD Date Received: NA
Analyst: Nalini Lall Date Analyzed: 3/14/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | Oxygen + | | | |
| 7440-37-1 | Argon | ND | 0.10 | |
| 7727-37-9 | Nitrogen | ND | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | Carbon Dioxide | ND | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# LABORATORY REPORT

March 28, 2014

Min Lee
Air Hygiene, Incorporated
1600 West Tacoma Street
Broken Arrow, OK 74012

**RE: jz-14-tulsa.ok-comp#1**

Dear Min:

Enclosed are the results of the samples submitted to our laboratory on March 14, 2014. For your reference, these analyses have been assigned our service request number P1401010.

All analyses were performed according to our laboratory's NELAP and DoD-ELAP-approved quality assurance program. The test results meet requirements of the current NELAP and DoD-ELAP standards, where applicable, and except as noted in the laboratory case narrative provided. For a specific list of NELAP and DoD-ELAP-accredited analytes, refer to the certifications section at www.alsglobal.com. Results are intended to be considered in their entirety and apply only to the samples analyzed and reported herein.

If you have any questions, please call me at (805) 526-7161.

Respectfully submitted,

**ALS | Environmental**

Kelly Horiuchi
Laboratory Director

Client: Air Hygiene, Incorporated Service Request No: P1401010
Project: jz-14-tulsa.ok-comp#1

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## CASE NARRATIVE

The sample were received intact under chain of custody on March 14, 2014 and were stored in accordance with the analytical method requirements. Please refer to the sample acceptance check form for additional information. The results reported herein are applicable only to the condition of the samples at the time of sample receipt.

Fixed Gases Analysis

The samples were analyzed for fixed gases (oxygen/argon, nitrogen, methane and carbon dioxide) according to EPA Method 3C (triplicate injection) using a gas chromatograph equipped with a thermal conductivity detector (TCD). This method is not included on the laboratory's NELAP or AIHA-LAP scope of accreditation.

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*The results of analyses are given in the attached laboratory report. All results are intended to be considered in their entirety, and ALS Environmental (ALS) is not responsible for utilization of less than the complete report.*

*Use of ALS Environmental (ALS)'s Name. Client shall not use ALS's name or trademark in any marketing or reporting materials, press releases or in any other manner ("Materials") whatsoever and shall not attribute to ALS any test result, tolerance or specification derived from ALS's data ("Attribution") without ALS's prior written consent, which may be withheld by ALS for any reason in its sole discretion. To request ALS's consent, Client shall provide copies of the proposed Materials or Attribution and describe in writing Client's proposed use of such Materials or Attribution. If ALS has not provided written approval of the Materials or Attribution within ten (10) days of receipt from Client, Client's request to use ALS's name or trademark in any Materials or Attribution shall be deemed denied. ALS may, in its discretion, reasonably charge Client for its time in reviewing Materials or Attribution requests. Client acknowledges and agrees that the unauthorized use of ALS's name or trademark may cause ALS to incur irreparable harm for which the recovery of money damages will be inadequate. Accordingly, Client acknowledges and agrees that a violation shall justify preliminary injunctive relief. For questions contact the laboratory.*

ALS Environmental – Simi Valley

Certifications, Accreditations, and Registrations

| Agency | Web Site | Number |
|---|---|---|
| AIHA | http://www.aihaaccreditedlabs.org | 101661 |
| Arizona DHS | http://www.azdhs.gov/lab/license/env.htm | AZ0694 |
| DoD ELAP | http://www.pjlabs.com/search-accredited-labs | L11-203 |
| Florida DOH (NELAP) | http://www.doh.state.fl.us/lab/EnvLabCert/WaterCert.htm | E871020 |
| Maine DHHS | http://www.maine.gov/dhhs/mecdc/environmental-health/water/dwp-services/labcert/labcert.htm | 2012039 |
| Minnesota DOH (NELAP) | http://www.health.state.mn.us/accreditation | 494864 |
| New Jersey DEP (NELAP) | http://www.nj.gov/dep/oqa/ | CA009 |
| New York DOH (NELAP) | http://www.wadsworth.org/labcert/elap/elap.html | 11221 |
| Oregon PHD (NELAP) | http://public.health.oregon.gov/LaboratoryServices/EnvironmentalLaboratoryAccreditation/Pages/index.aspx | CA200007 |
| Pennsylvania DEP | http://www.depweb.state.pa.us/labs | 68-03307 (Registration) |
| Texas CEQ (NELAP) | http://www.tceq.texas.gov/field/qa/env_lab_accreditation.html | T104704413-13-4 |
| Utah DOH (NELAP) | http://www.health.utah.gov/lab/labimp/certification/index.html | CA016272013-3 |
| Washington DOE | http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html | C946 |

Analyses were performed according to our laboratory's NELAP and DoD-ELAP approved quality assurance program. A complete listing of specific NELAP and DoD-ELAP certified analytes can be found in the certifications section at www.alsglobal.com, or at the accreditation body's website.

Each of the certifications listed above have an explicit Scope of Accreditation that applies to specific matrices/methods/analytes; therefore, please contact the laboratory for information corresponding to a particular certification.

# ALS ENVIRONMENTAL

DETAIL SUMMARY REPORT

Client: Air Hygiene, Incorporated

Service Request: P1401010

Project ID: jz-14-tulsa.ok-comp#1

Date Received: 3/14/2014

Time Received: 10:10

| Client Sample ID | Lab Code | Matrix | Date Collected | Time Collected | 3C Modified - Fxd Gases Bag 2X |
|---|---|---|---|---|---|
| R9-70-100-70%-4X30PF | P1401010-001 | Air | 3/13/2014 | 00:00 | X |
| R10-90-100%-4X30PF | P1401010-003 | Air | 3/13/2014 | 00:00 | X |
| R11-90-100%-4X30PF | P1401010-005 | Air | 3/13/2014 | 00:00 | X |
| R12-90-100%-4X30PF | P1401010-007 | Air | 3/13/2014 | 00:00 | X |

P1401010

# SAMPLE DESCRIPTION AND CHAIN OF CUSTODY RECORD

Air Hygiene International, Inc.
1600 W Tacoma Street
Broken Arrow, Oklahoma 74012
(888) 461-8778
www.airhygiene.com

| | | | |
|---|---|---|---|
| Project Number: | jz-14-tulsa.ok-comp#1 | Laboratory Analysis Requested: | RM 3C |
| Person Taking Samples: | MSL | Comments:Do not analyze backup unless breakage | |

| | Sample Number | Location | Date | Volume | Analysis Method | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | O2 | CO2 | Nitrogen | Methane-Ethane |
| 1 | R9-70-100-70%-4X30PF | John Zink Tulsa R&D Facility | 13-Mar | 10 | x | x | x | x |
| 2 | R9-70-100-70%-4X30PF-Back Up | John Zink Tulsa R&D Facility | 13-Mar | 10 | x | x | x | x |
| 3 | R10-90-100%-4X30PF | John Zink Tulsa R&D Facility | 13-Mar | 10 | x | x | x | x |
| 4 | R10-90-100%-4X30PF-Back Up | John Zink Tulsa R&D Facility | 13-Mar | 10 | x | x | x | x |
| 5 | R11-90-100%-4X30PF | John Zink Tulsa R&D Facility | 13-Mar | 10 | x | x | x | x |
| 6 | R11-90-100%-4X30PF-Back Up | John Zink Tulsa R&D Facility | 13-Mar | 10 | x | x | x | x |
| 7 | R12-90-100%-4X30PF | John Zink Tulsa R&D Facility | 13-Mar | 10 | x | x | x | x |
| 8 | R12-90-100%-4X30PF-Back Up | John Zink Tulsa R&D Facility | 13-Mar | 10 | x | x | x | x |

| Relinquished by: (Signature) | Date: | Time: | Received by: (Signature) | Date: | Time: |
|---|---|---|---|---|---|
| [signature] | 3/13/14 | 16:00 | [signature] | 3/14/14 | 1010 |
| | | | | | |

4-tulsa.ok-comp#1-coc

# ALS Environmental
## Sample Acceptance Check Form

Client: Air Hygiene, Incorporated  Work order: P1401010

Project: jz-14-tulsa.ok-comp#1

Sample(s) received on: 3/14/14  Date opened: 3/14/14  by: MZAMORA

***Note:*** This form is used for all samples received by ALS. The use of this form for custody seals is strictly meant to indicate presence/absence and not as an indication of compliance or nonconformity. Thermal preservation and pH will only be evaluated either at the request of the client and/or as required by the method/SOP.

| | | Yes | No | N/A |
|---|---|---|---|---|
| 1 | Were **sample containers** properly marked with client sample ID? | ☒ | ☐ | ☐ |
| 2 | Container(s) **supplied by ALS**? | ☐ | ☒ | ☐ |
| 3 | Did **sample containers** arrive in good condition? | ☐ | ☒ | ☐ |
| 4 | Were **chain-of-custody** papers used and filled out? | ☒ | ☐ | ☐ |
| 5 | Did **sample container labels** and/or tags agree with custody papers? | ☒ | ☐ | ☐ |
| 6 | Was **sample volume** received adequate for analysis? | ☒ | ☐ | ☐ |
| 7 | Are samples within specified holding times? | ☒ | ☐ | ☐ |
| 8 | Was proper **temperature** (thermal preservation) of cooler at receipt adhered to? | ☐ | ☐ | ☒ |
| 9 | Was a **trip blank** received? | ☐ | ☒ | ☐ |
| 10 | Were **custody seals** on outside of cooler/Box? | ☐ | ☒ | ☐ |
| | Location of seal(s)? _____ Sealing Lid? | ☐ | ☐ | ☒ |
| | Were signature and date included? | ☐ | ☐ | ☒ |
| | Were seals intact? | ☐ | ☐ | ☒ |
| | Were custody seals on outside of sample container? | ☐ | ☒ | ☐ |
| | Location of seal(s)? _____ Sealing Lid? | ☐ | ☐ | ☒ |
| | Were signature and date included? | ☐ | ☐ | ☒ |
| | Were seals intact? | ☐ | ☐ | ☒ |
| 11 | Do containers have appropriate **preservation**, according to method/SOP or Client specified information? | ☐ | ☐ | ☒ |
| | Is there a client indication that the submitted samples are **pH** preserved? | ☐ | ☐ | ☒ |
| | Were **VOA vials** checked for presence/absence of air bubbles? | ☐ | ☐ | ☒ |
| | Does the client/method/SOP require that the analyst check the sample pH and if necessary alter it? | ☐ | ☐ | ☒ |
| 12 | **Tubes:** Are the tubes capped and intact? | ☐ | ☐ | ☒ |
| | Do they contain moisture? | ☐ | ☐ | ☒ |
| 13 | **Badges:** Are the badges properly capped and intact? | ☐ | ☐ | ☒ |
| | Are dual bed badges separated and individually capped and intact? | ☐ | ☐ | ☒ |

| Lab Sample ID | Container Description | Required pH * | Received pH | Adjusted pH | VOA Headspace (Presence/Absence) | Receipt / Preservation Comments |
|---|---|---|---|---|---|---|
| P1401010-001.01 | 10 L Tedlar Bag | | | | | |
| P1401010-002.01 | 10 L Tedlar Bag | | | | | |
| P1401010-003.01 | 10 L Tedlar Bag | | | | | |
| P1401010-004.01 | 10 L Tedlar Bag | | | | | |
| P1401010-005.01 | 10 L Tedlar Bag | | | | | |
| P1401010-006.01 | 10 L Tedlar Bag | | | | | |
| P1401010-007.01 | 10 L Tedlar Bag | | | | | |
| P1401010-008.01 | 10 L Tedlar Bag | | | | | Received Tedlar bag flat |

Explain any discrepancies: (include lab sample ID numbers):

Chain of Custody is missing time collected

RSK - MEEPP, HCL (pH<2); RSK - CO2, (pH 5-8); Sulfur (pH>4)

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R9-70-100-70%-4X30PF** ALS Project ID: P1401010
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1401010-001

Test Code: EPA Method 3C Modified Date Collected: 3/13/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/14/14
Analyst: Nalini Lall Date Analyzed: 3/14/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.3** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **79.9** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.73** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R10-90-100%-4X30PF** ALS Project ID: P1401010
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1401010-003

Test Code: EPA Method 3C Modified Date Collected: 3/13/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/14/14
Analyst: Nalini Lall Date Analyzed: 3/14/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **14.2** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **80.0** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **5.80** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R11-90-100%-4X30PF** ALS Project ID: P1401010
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1401010-005

Test Code: EPA Method 3C Modified Date Collected: 3/13/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/14/14
Analyst: Nalini Lall Date Analyzed: 3/14/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **13.9** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **80.0** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **6.08** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **R12-90-100%-4X30PF** ALS Project ID: P1401010
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P1401010-007

Test Code: EPA Method 3C Modified Date Collected: 3/13/14
Instrument ID: HP5890 II/GC1/TCD Date Received: 3/14/14
Analyst: Nalini Lall Date Analyzed: 3/14/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | **Oxygen +** | | | |
| 7440-37-1 | **Argon** | **13.9** | 0.10 | |
| 7727-37-9 | **Nitrogen** | **80.1** | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | **Carbon Dioxide** | **6.05** | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# ALS ENVIRONMENTAL

RESULTS OF ANALYSIS



**Client:** **Air Hygiene, Incorporated**
**Client Sample ID:** **Method Blank** ALS Project ID: P1401010
**Client Project ID:** **jz-14-tulsa.ok-comp#1** ALS Sample ID: P140314-MB

Test Code: EPA Method 3C Modified Date Collected: NA
Instrument ID: HP5890 II/GC1/TCD Date Received: NA
Analyst: Nalini Lall Date Analyzed: 3/14/14
Sample Type: 10 L Tedlar Bag Volume(s) Analyzed: 0.10 ml(s)
Test Notes:

| CAS # | Compound | Result %, v/v | MRL %, v/v | Data Qualifier |
|---|---|---|---|---|
| 7782-44-7 | Oxygen + | | | |
| 7440-37-1 | Argon | ND | 0.10 | |
| 7727-37-9 | Nitrogen | ND | 0.10 | |
| 74-82-8 | Methane | ND | 0.10 | |
| 124-38-9 | Carbon Dioxide | ND | 0.10 | |

ND = Compound was analyzed for, but not detected above the laboratory reporting limit.
MRL = Method Reporting Limit - The minimum quantity of a target analyte that can be confidently determined by the referenced method.

# APPENDIX G

# Field Data Sheets

# MULTI LOAD TEST - FIELD DATA SHEET

AIR HYGIENE

| | |
|---|---|
| Company: | John Zink Inc |
| Location: | John Zink Tulsa R&D Facility |
| Date: | 3/13/14 |
| Unit Make and Model: | 4X30PF |
| Unit Number: | |
| Serial Number: | |
| Data Recorded By: | |
| Tested With AHI Unit(s): | Truck(s): 132 Trailer(s): 210 |
| LDEQ Warmup/Cal Req: | On (Day/Time): 24hr 5min Cal (Day/Time): |

| CYLINDER SERIAL NUMBERS | | $O_2$ | NOx | CO | THC | $CO_2$ | $SO_2$ |
|---|---|---|---|---|---|---|---|
| | Low | | | | | | |
| | Mid | | | | | | |
| | High | | | | | | |

| $NO_2$ CONVERSION | | | |
|---|---|---|---|
| $NO_2$ Gas (ppm) | | NOx Reading (ppm) | |
| NO Reading (ppm) | | Cylinder Num | |

Stack Dia. = _____
Measured By: _____
Measured With: _____

| RUN INFORMATION | Low Load | | | Mid Load | | | Mid-High Load | | | High Load | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 70-100 % #3 | 70-100 % #1 | 70-100 % #2 | ___% #3 | ___% #2 | ___% #3 | ___% #1 | ___% #2 | ___% #3 | ___% #1 | ___% #2 | ___% #3 |
| Time Start (hh:mm:ss) | 8:40:04 | 10:27:04 | 12:50:04 | 14:05:04 | 15:45:23 | | | | | | | |
| Time Stop (hh:mm:ss) | 9:40:04 | 11:27:04 | 13:50:04 | 15:05:04 | 16:45:23 | | | | | | | |
| Rated MegaWatts (MW or hp) | | | | | | | | | | | | |
| Actual MegaWatts (MW or hp) | | | | | | | | | | | | |
| Barometric Pressure (in. Hg) | 30.19 | 30.20 | 30.15 | 30.09 | 29.93 | | | | | | | |
| Ambient Temperature (°F) | 57 | 63 | 66 | 71 | 83 | | | | | | | |
| Relative Humidity (%) | 34 | 28 | 17 | 14 | 19 | | | | | | | |
| Fuel Flow (lb/min) | | | | | | | | | | | | |
| Fuel Flow (SCF/hr)=(lb/min)*21.7 | | | | | | | | | | | | |
| Specific Humidity (gr/lb) | | | | | | | | | | | | |
| Specific Humidity (lb $H_2O$/lb air)=(gr/lb)/7000 | | | | | | | | | | | | |
| PCD (psi) | | | | | | | | | | | | |
| PCD (mm Hg)=(psi+14.24)*51.71493 | | | | | | | | | | | | |
| NOx Water Injection (gpm) | | | | | | | | | | | | |

| CALIBRATION | $O_2$ | | NOx | | CO | | THC | | $CO_2$ | | $SO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual |
| Zero Gas | 0 | 0.09 | | | 0 | 0.01 | 0 | 0.03 | 0 | 0.01 | | |
| Low Gas | | | | | | | 3.04 | 3.11 | | | | |
| Mid Gas | 12.00 | 12.09 | | | 8.98 | 8.95 | 5.04 | 5.07 | 9.42 | 9.39 | | |
| High Gas | 21.10 | 21.09 | | | 17.30 | 17.36 | 8.48 | 8.48 | 18.50 | 18.47 | | |

| BIAS | $O_2$ | | NOx | | CO | | THC | | $CO_2$ | | $SO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid |
| Initial Low Load Run #1 | 0.11 | 12.13 | | | -0.07 | 8.93 | 0.04 | 3.12 | 0.02 | 9.37 | | |
| Load 1 Run #1 / Load 1 Run #2 | 0.12 | 12.09 | | | 0.04 | 9.00 | 0.03 | 3.00 | 0.06 | 9.42 | | |
| Load 1 Run #2 / Load 1 Run #3 | 0.09 | 11.97 | | | 0.07 | 8.94 | 0.03 | 3.04 | 0.08 | 9.44 | | |
| Load 1 Run #3 / Load 2 Run #1 | 0.05 | 11.91 | | | 0.19 | 9.11 | -0.02 | 3.05 | 0.09 | 9.42 | | |
| Load 2 Run #1 / Load 2 Run #2 | 0.07 | 11.99 | | | 0.01 | 9.01 | -0.03 | 3.04 | 0.05 | 9.33 | | |
| Load 2 Run #2 / Load 2 Run #3 | | | | | | | | | | | | |
| Load 2 Run #3 / Load 3 Run #1 | | | | | | | | | | | | |
| Load 3 Run #1 / Load 3 Run #2 | | | | | | | | | | | | |
| Load 3 Run #2 / Load 3 Run #3 | | | | | | | | | | | | |
| Load 3 Run #3 / Load 4 Run #1 | | | | | | | | | | | | |
| Load 4 Run #1 / Load 4 Run #2 | | | | | | | | | | | | |
| Load 4 Run #2 / Load 4 Run #3 | | | | | | | | | | | | |
| Load 4 Run #3 Final | | | | | | | | | | | | |
| Bias Gas Actual Conc. | | | | | | | | | | | | |

# AIR HYGIENE

## MULTI LOAD TEST - FIELD DATA SHEET

| | |
|---|---|
| Company: | John Zink |
| Location: | J-7 R&D Facility |
| Date: | 3/12/24 |
| Unit Make and Model: | |
| Unit Number: | 4X30 PF |
| Serial Number: | |
| Data Recorded By: | |
| Tested With AHI Unit(s): | Truck(s): 132 Trailer(s): 210 |
| LDEQ Warmup/Cal Req: | On (Day/Time): 24hr Cal (Day/Time): |

| CYLINDER SERIAL NUMBERS | | $O_2$ | NOx | CO | THC | $CO_2$ | $SO_2$ |
|---|---|---|---|---|---|---|---|
| | Low | | | | | | |
| | Mid | | | | | | |
| | High | | | | | | |

| $NO_2$ CONVERSION | | | |
|---|---|---|---|
| $NO_2$ Gas (ppm) | | NOx Reading (ppm) | |
| NO Reading (ppm) | | Cylinder Num | |

Stack Dia. = _____
Measured By: _____
Measured With: _____

| RUN INFORMATION | Low Load | | | Mid Load | | | Mid-High Load | | | High Load | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30-70% #1 | 30-70% #2 | 30-70% #3 | 70-100% #1 | 70-100% #2 | % #3 | % #1 | % #2 | % #3 | % #1 | % #2 | % #3 |
| Time Start (hh:mm:ss) | 8:40:00 | 10:00:00 | 11:23:00 | 13:19:00 | 14:29:00 | 15:48:00 | 16:30:00 | | | | | |
| Time Stop (hh:mm:ss) | 9:40:00 | 11:00:00 | 12:23:00 | 14:19:00 | 15:29:00 | 16:48:00 | 17:30:00 | | | | | |
| Rated MegaWatts (MW or hp) | | | | | | | | | | | | |
| Actual MegaWatts (MW or hp) | | | | | | | | | | | | |
| Barometric Pressure (in. Hg) | 30.21 | 30.26 | 30.26 | 30.26 | 30.22 | 30.20 | 30.19 | | | | | |
| Ambient Temperature (°F) | 53 | 60 | 66 | 58 | 65 | 72 | 70 | | | | | |
| Relative Humidity (%) | 40 | 33 | 25 | 28 | 28 | 21 | 20 | | | | | |
| Fuel Flow (lb/min) | | | | | | | | | | | | |
| Fuel Flow (SCF/hr)=(lb/min)*21.7 | | | | | | | | | | | | |
| Specific Humidity (gr/lb) | | | | | | | | | | | | |
| Specific Humidity (lb $H_2O$/lb air)=(gr/lb)/7000 | | | | | | | | | | | | |
| PCD (psi) | | | | | | | | | | | | |
| PCD (mm Hg)=(psi+14.24)*51.71493 | | | | | | | | | | | | |
| NOx Water Injection (gpm) | | | | | | | | | | | | |

| CALIBRATION | $O_2$ | | NOx | | CO | | THC | | $CO_2$ | | $SO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual |
| Zero Gas | 0 | 0.08 | | | 0 | -0.01 | 0 | -0.03 | 0 | 0.50 | | |
| Low Gas | | | | | | | 3.04 | 3.07 | | | | |
| Mid Gas | 12.00 | 12.06 | | | 8.98 | 8.90 | 5.04 | 5.02 | 9.42 | 9.45 | | |
| High Gas | 21.10 | 21.13 | | | 17.30 | 17.37 | 8.48 | 8.57 | 18.50 | 18.57 | | |

| BIAS | $O_2$ | | NOx | | CO | | THC | | $CO_2$ | | $SO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid |
| Initial Low Load Run #1 | 0.12 | 12.01 | | | 0.18 | 9.00 | -0.03 | 3.02 | 0.01 | 9.33 | | |
| Load 1 Run #1 / Load 1 Run #2 | 0.12 | 12.02 | | | 0.10 | 9.03 | -0.04 | 3.04 | 0.04 | 9.38 | | |
| Load 1 Run #2 / Load 1 Run #3 | 0.10 | 12.00 | | | 0.16 | 8.98 | -0.02 | 3.06 | 0.05 | 9.34 | | |
| Load 1 Run #3 / Load 2 Run #1 | 0.09 | 11.99 | | | 0.08 | 8.94 | -0.07 | 3.03 | 0.06 | 9.44 | | |
| Load 2 Run #1 / Load 2 Run #2 | 0.09 | 11.97 | | | 0.13 | 8.94 | -0.08 | 3.00 | 0.07 | 9.37 | | |
| Load 2 Run #2 / Load 2 Run #3 | 0.06 | 11.98 | | | 0.06 | 8.87 | -0.03 | 2.95 | 0.05 | 9.45 | | |
| Load 2 Run #3 / Load 3 Run #1 | | | | | | | | | | | | |
| Load 3 Run #1 / Load 3 Run #2 | | | | | | | | | | | | |
| Load 3 Run #2 / Load 3 Run #3 | | | | | | | | | | | | |
| Load 3 Run #3 / Load 4 Run #1 | | | | | | | | | | | | |
| Load 4 Run #1 / Load 4 Run #2 | | | | | | | | | | | | |
| Load 4 Run #2 / Load 4 Run #3 | | | | | | | | | | | | |
| Load 4 Run #3 Final | | | | | | | | | | | | |
| Bias Gas Actual Conc. | | | | | | | | | | | | |

# AIR HYGIENE

## MULTI LOAD TEST - FIELD DATA SHEET

| | |
|---|---|
| Company: | John Zink |
| Location: | TZ RR Facility |
| Date: | 3/14/14 |
| Unit Make and Model: | |
| Unit Number: | 4x30PF |
| Serial Number: | |
| Data Recorded By: | MSL |
| Tested With AHI Unit(s): | Truck(s): 132 Trailer(s): 210 |
| LDEQ Warmup/Cal Req: | On (Day/Time): OVR 24hr Cal (Day/Time): |

| CYLINDER SERIAL NUMBERS | | $O_2$ | NOx | CO | THC | $CO_2$ | $SO_2$ |
|---|---|---|---|---|---|---|---|
| | Low | | | | | | |
| | Mid | | | | | | |
| | High | | | | | | |

| $NO_2$ CONVERSION | | | |
|---|---|---|---|
| $NO_2$ Gas (ppm) | | NOx Reading (ppm) | |
| NO Reading (ppm) | | Cylinder Num | |

Stack Dia. = _____
Measured By: _____
Measured With: _____

| RUN INFORMATION | Low Load | | | Mid Load | | | Mid-High Load | | | High Load | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ____% #1 | ____% #2 | ____% #3 | ____% #1 | ____% #2 | ____% #3 | ____% #1 | ____% #2 | ____% #3 | ____% #1 | ____% #2 | ____% #3 |
| Time Start (hh:mm:ss) | 13:16:00 | 15:27:00 | 16:48:00 | | | | | | | | | |
| Time Stop (hh:mm:ss) | 14:16:00 | 16:24:00 | 17:48:00 | | | | | | | | | |
| Rated MegaWatts (MW or hp) | | | | | | | | | | | | |
| Actual MegaWatts (MW or hp) | | | | | | | | | | | | |
| Barometric Pressure (in. Hg) | 29.49 | 29.41 | 29.40 | | | | | | | | | |
| Ambient Temperature (°F) | 83 | 87 | 84 | | | | | | | | | |
| Relative Humidity (%) | 32 | 26 | 28 | | | | | | | | | |
| Fuel Flow (lb/min) | | | | | | | | | | | | |
| Fuel Flow (SCF/hr)=(lb/min)*21.7 | | | | | | | | | | | | |
| Specific Humidity (gr/lb) | | | | | | | | | | | | |
| Specific Humidity (lb $H_2O$/lb air)=(gr/lb)/7000 | | | | | | | | | | | | |
| PCD (psi) | | | | | | | | | | | | |
| PCD (mm Hg)=(psi+14.24)*51.71493 | | | | | | | | | | | | |
| NOx Water Injection (gpm) | | | | | | | | | | | | |

| CALIBRATION | $O_2$ | | NOx | | CO | | THC | | $CO_2$ | | $SO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual | Conc. | Actual |
| Zero Gas | 0 | 0.04 | | | 0 | 0.03 | 0 | 0.04 | 0 | 0.01 | | |
| Low Gas | | | | | | | 3.04 | 3.03 | | | | |
| Mid Gas | 12.0 | 12.01 | | | 8.98 | 8.77 | 5.04 | 5.14 | 9.42 | 9.43 | | |
| High Gas | 21.1 | 21.07 | | | 17.3 | 17.32 | 8.43 | 8.49 | 18.5 | 18.52 | | |

| BIAS | $O_2$ | | NOx | | CO | | THC | | $CO_2$ | | $SO_2$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid | Zero | Mid |
| Initial Low Load Run #1 | 0.07 | 12.11 | | | 0.01 | 8.78 | -0.01 | 3.14 | 0.04 | 9.40 | | |
| Load 1 Run #1 / Load 1 Run #2 | 0.01 | 12.02 | | | 0.05 | 8.46 | 0.01 | 3.00 | 0.01 | 9.31 | | |
| Load 1 Run #2 / Load 1 Run #3 | 0.01 | 12.00 | | | 0.14 | 8.88 | 0.02 | 2.94 | 0.04 | 9.23 | | |
| Load 1 Run #3 / Load 2 Run #1 | 0.01 | 12.01 | | | 0.13 | 8.49 | 0.04 | 2.96 | 0.03 | 9.28 | | |
| Load 2 Run #1 / Load 2 Run #2 | | | | | | | | | | | | |
| Load 2 Run #2 / Load 2 Run #3 | | | | | | | | | | | | |
| Load 2 Run #3 / Load 3 Run #1 | | | | | | | | | | | | |
| Load 3 Run #1 / Load 3 Run #2 | | | | | | | | | | | | |
| Load 3 Run #2 / Load 3 Run #3 | | | | | | | | | | | | |
| Load 3 Run #3 / Load 4 Run #1 | | | | | | | | | | | | |
| Load 4 Run #1 / Load 4 Run #2 | | | | | | | | | | | | |
| Load 4 Run #2 / Load 4 Run #3 | | | | | | | | | | | | |
| Load 4 Run #3 Final | | | | | | | | | | | | |
| Bias Gas Actual Conc. | | | | | | | | | | | | |

| M4 | | Pre Run 1 | Post | | Pre Run 6 | Post |
|---|---|---|---|---|---|---|
| Run 1 Box Grey | 1. | 677.4 | 717.3 | 1 | 773.6 | 809.0 |
| | 2. | 716.1 | 730.7 | 2 | 700.1 | 709.4 |
| | 3. | 571.8 | 577.7 | 3 | 592.6 | 595.0 |
| | 4. | 848.8 | 862.4. | 4 | 804.4 | 812.3 |
| | | | | | Run 7 | |
| Box Run 2 ~~Blue~~ Grey | 1 | 694.7 | 735.1 | 1 | 794.6 | 835.0 |
| | 2 | 679.5 | 691.1 | 2 | 748.1 | 758.7 |
| | 3 | 589.0 | 591.6 | 3 | 578.9 | 581.6 |
| | 4 | 790.7 | 798.9 | 4 | 907.4 | 918.4 |
| | | | | | TP 13/11/12 | |
| Run 3 | 1 | 717.3 | ~~745.6~~ | | 739.1 | scales weren't balanced properly |
| | 2 | 730.7 | ~~729.4~~ | | 756.1 | |
| | 3 | 577.7 | ~~567.5~~ | | 579.3 | |
| | 4 | 862.4 | ~~850.8~~ | | 865.9 | |
| | | | | | ~~Run 8~~ | |
| Run 4 | 1 | 735.1 | 773.6 | 1 | ~~809.0~~ | |
| | 2 | 691.1 | 700.1 | 2 | ~~709.4~~ | |
| | 3 | 591.6 | 592.6 | 3 | ~~595.0~~ | |
| | 4 | 798.9 | 804.4 | 4 | ~~812.3~~ | |
| | | | | | Run 8 | |
| Run 5 | 1 | 739.1 | 794.6 | 1 | 835.0 | 875.3 |
| | 2 | 756.1 | 748.1 | 2 | 758.7 | 767.3 |
| | 3 | 579.3 | 578.9 | 3 | 581.6 | 582.9 |
| | 4 | 896.0 | 907.4 | 4 | 918.4 | 927.8 |

53 40%

| | Run 9 Pre | Post |
|---|---|---|
| 1 | 707.3 | 732.4 |
| 2 | 742.0 | 758.3 |
| 3 | 575.4 | 579.0 |
| 4 | 875.0 | 886.6 |
| | Run 10 | |
| 1 | 707.3 | 739.3 |
| 2 | 677.3 | 689.9 |
| 3 | 591.3 | 593.5 |
| 4 | 875.5 | 886.6 |
| | Run 11 | |
| 1 | 732.4 | 771.6 |
| 2 | 758.3 | 768.2 |
| 3 | 579.0 | 582.4 |
| 4 | 886.6 | 898.2 |
| | Run 12 | |
| 1 | 739.3 | 777.8 |
| 2 | 689.9 | 700.9 |
| 3 | 593.5 | 596.5 |
| 4 | 886.6 | 894.9 |

Canister pressure 3/11 4x30PF

0/30/0 Run 1-3

-30.0

-21.2

-10.8

-0.05

30/70/30 Run 4-6

-30.00

-19.3

-10.15

-0.02

70/100/70 Run 7-9

-30.0

-20.31

-10.2

-0.02

9/100 Run 10-12

-30.0

-19.5

-9.70

0.05

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**end of report**

# APPENDIX C

# MUNICIPLE AND COUNTY NOTIFICATION LETTERS

CERTIFIED MAIL # 7000 1670 0005 1026 4311

Shirley Township Supervisors
15480 Croghan Pike
Shirleysburg, PA 17260

Re: Municipal Notification
State Only Operating Permit
Sunoco Pipeline, L.P. Mount Union Station
Shirley Township, Huntingdon County

Dear Shirley Township Supervisors:

Pursuant to 25 Pa Code (for operating permit) (127.413), Sunoco Pipeline L.P. is hereby providing notice that we have submitted an application to the Pennsylvania Department of Environmental Protection (PADEP) for a State Only Operating Permit for a natural gas liquid pumping station known as Mount Union Station located in Shirley Township, Huntingdon County. The pumping station is part of a natural gas liquid pipeline project known as Mariner East that will deliver butane, propane, and ethane from the liquid-rich Marcellus Shale areas in western Pennsylvania to Marcus Hook, Pennsylvania, where it will be processed, stored, and distributed, to various domestic and waterborne markets. Pumping stations along the pipeline will use electric driven split case multistage centrifugal pumps to transport product through the pipeline. All pumping devices used to transport material will utilize electricity supplied by a public utility. A John Zink Company LLC 4' by 30' ZTOF production flare will be constructed at Mount Union Station as an air pollution control device. The flare is enclosed (i.e., no visible flame) and will be used to control fugitive emissions from potential pump seal leaks as well as emissions that will occur annually and biannually every fifth year associated with pipeline cleaning/maintenance activities known as pigging operations.

A 30-day comment period begins with the receipt of this letter. If you have any questions concerning this notice or the application you can contact me at 610-670-3284 or you can contact the PADEP, South-central Regional Office, Bureau of Air Quality Control at 909 Elmerton Avenue, Harrisburg, PA (717-705-4700).

Sincerely,

Matthew L. Gordon
Sunoco Pipeline, L.P.

CERTIFIED MAIL # 7014 0150 0002 0658 2917

Huntingdon County Commissioners
233 Penn Street
Huntingdon, PA 16652

Re: County Notification
State Only Operating Permit
Sunoco Pipeline, L.P. Mount Union Station
Penn Township, Huntingdon County

Dear Huntingdon County Commissioners:

Pursuant to 25 Pa Code (for operating permit) (127.413), Sunoco Pipeline L.P. is hereby providing notice that we have submitted an application to the Pennsylvania Department of Environmental Protection (PADEP) for a State Only Operating Permit for a natural gas liquid pumping station known as Mount Union Station located in Shirley Township, Huntingdon County. The pumping station is part of a natural gas liquid pipeline project known as Mariner East that will deliver butane, propane, and ethane from the liquid-rich Marcellus Shale areas in western Pennsylvania to Marcus Hook, Pennsylvania, where it will be processed, stored, and distributed, to various domestic and waterborne markets. Pumping stations along the pipeline will use electric driven split case multistage centrifugal pumps to transport product through the pipeline. All pumping devices used to transport material will utilize electricity supplied by a public utility. A John Zink Company LLC 4' by 30' ZTOF production flare will be constructed at Mount Union Station as an air pollution control device. The flare is enclosed (i.e., no visible flame) and will be used to control fugitive emissions from potential pump seal leaks as well as emissions that will occur annually and biannually every fifth year associated with pipeline cleaning/maintenance activities known as pigging operations.

A 30-day comment period begins with the receipt of this letter. If you have any questions concerning this notice or the application you can contact me at 610-670-3284 or you can contact the PADEP, South-central Regional Office, Bureau of Air Quality Control at 909 Elmerton Avenue, Harrisburg, PA (717-705-4700).

Sincerely,

Matthew L. Gordon
Sunoco Pipeline, L.P.