TOTAL HYDROCARBON DESTRUCTION EFFICIENCY COMPLIANCE TEST PROGRAM

Prepared for:
Denso Manfacturing Athens
Regenerative Thermal Oxidizer
Athens, Tennessee

Prepared by:
Civil & Environmental Consultants Inc.
Knoxville, Tennessee

CEC Project
184-566

Test Date
October 30, 2018

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Test Report for the
Total Hydrocarbon Destruction Efficiency Compliance Test Program

REPORT CERTIFICATION

This report, testing details, and approach have been developed under the supervision (including review) of the persons named below. Results contained in this report relate only to the sources tested and the parameters included in the test program.

Civil & Environmental Consultants, Inc. (CEC) operates as an accredited air emission testing body (AETB) under a quality management system in conformance with ASTM D7036-04 (Reapproved 2011) "Standard Practice for Competence of Air Emission Testing Bodies". CEC has been issued accreditation certificate number 3913.01, expiration November 30, 2019, by the joint American Association for Laboratory Accreditation (A2LA) and the Stack Testing Accreditation Council (STAC).

Date 12/12/2018 Signature [signature]

Michael Mowery, QSTI
Principal
Civil & Environmental Consultants, Inc.

Date 12/12/2018 Signature [signature]

Todd Gregg, QSTI
Senior Project Scientist
Civil & Environmental Consultants, Inc.

1.0 INTRODUCTION

Civil & Environmental Consultants, Inc. (CEC) was contracted by Denso Manufacturing Athens (Denso) to perform compliance testing on the two regenerative thermal oxidizers (RTO) used at the Denso facility located in Athens, TN. The compliance tests were performed on October 30, 2018.

The intent of the compliance testing determined the RTO destruction efficiency of total hydrocarbons (THC). This data will be used by Denso for their facility emissions reporting.

1.1 Project Contact Information

Location	Address	Contact
Test Facility	DENSO Manufacturing Athens 2400 DENSO Drive Athens, TN 37303	Mr. Eddie Franks Manager Safety Health and Environment Phone (423) 746-0000 Eddie_Franks@DENSO-Diam.com
Testing Company Representative	Civil & Environmental Consultants Inc. 2704 Cherokee Farm Way, Suite 101 Knoxville, Tennessee 37920	Mr. Todd Gregg Project Manager 865-977-9997 (Office) 865-250-9067 (Cell) tgregg@cecinc.com

2.0 TEST CONDITIONS AND TECHNICAL APPROACH

2.1 Test Conditions and Schedule

CEC completed three test runs for THC at the inlet and outlet of the South RTO. The North RTO was not tested due to a malfunction the morning of the test date. Denso will continue to report zero removal efficiency (RE) from the North RTO for their emissions calculations.

2.2 Sample Locations

The inlet sampling location was a duct leading to the RTO and the outlet sampling location was a vertical stack attached to the RTO. Samples were collected by accessing the test port at each location.

2.3 Technical Approach

The methodologies that were utilized for data collection are presented and summarized in Table 2-1. The sampling procedures included in the technical approach were selected to accurately determine the RE of the RTO. The selected methodologies were consistent with those recommended and referenced in Title 40 of the Code of Federal Regulations Part 60 (40 CFR Part 60), Appendix A.

Table 2-1
Reference Method Test Procedures

Parameter	40CFR Part 60 EPA Test Method	Comments
Thermal Oxidizers		
Exhaust Gas Flow Rate	M1, M2	Exhaust only. Inlet flow measured by DMAT process equipment.
Exhaust Gas Moisture Content	M4	Inlet & Exhaust
O_2 / CO_2	M3	For gas composition
THC (as propane)	M25A	Inlet & Exhaust

3.0 TESTING EMISSION RESULTS

During the compliance test program, CEC performed three inlet and outlet THC tests on the South RTO. Table 3-1 summarizes the test results:

Table 3-1
Test Results Summary

Parameters	Run 1	Run 2	Run 3
Date	10/30/2018	10/30/2018	10/30/2018
Test Time	10:20-11:30	14:00-15:00	15:25-16:25
THC inlet	496.52	378.25	332.71
THC outlet	53.46	52.32	19.48
Destruction efficiency (%)	93.79	92.62	96.39
Temperature (°F)	1477	1482	1489

No problems were encountered with the CEC testing equipment during the test program and no operational issues were reported to CEC by Denso during the test runs.

3.1 EPA Method 25A, Determination of Total Hydrocarbon Emissions

The Method 25A sampling and measurement system meets the requirements for measuring the THC concentrations as set forth by the USEPA. In particular, it meets the requirements of USEPA Reference Method 25A, "Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer," 40CFR60, Appendix A. This method applies to the measurement of total gaseous organic concentration of hydrocarbons. With this method, gas samples were extracted from the inlet and outlet of the RTO locations through heated Teflon® sample lines connected directly to the analyzers.

The flame ionization detectors (FIDs) used during this program were JUM Model 109-A High-Temperature Total Hydrocarbon Analyzers. They are highly sensitive FIDs that provide a direct reading of total organic vapor concentrations with linear ranges of 0-100, 1000, 10,000, and 100,000 ppm by volume. The instruments were calibrated using nitrogen zero and propane in nitrogen certified standards. The calibrations were performed before and after each test run. Sample time and location were logged simultaneously on a data logger.

Because the RE is calculated on a comparative basis, there is not a requirement to speciate individual volatile organics present in the gas streams. The performance demonstration tests were performed by measuring the concentration of THC at the inlet and exhaust of the thermal oxidizer simultaneously.

The sampling was performed by extracting a sample of the gas stream from the inlet and exhaust of the RTO and transporting the sample gas through a heated Teflon sample line to the THC CEMs located in a thermally controlled sampling trailer. A continuous sample was extracted and measured for a 60 minute period. A total of three test runs were completed. The concentrations measured by the THC CEMs were recorded on an electronic datalogger.

During each test run the thermal oxidizer exhaust gas flow rate was measured with a calibrated S-type pitot tube according to procedures in 40 CFR Part 60, Appendix A, Methods 1 and 2. Due to the physical construction of the inlet to the thermal oxidizer being a very short distance in between disturbances, it was not be feasible to measure the gas flow rate using a pitot tube. The thermal oxidizer inlet gas flow rate was measured by DMAT facility personnel utilizing the installed flow monitor.

In order to calculate the emission concentrations on a dry basis, the moisture content of the inlet and exhaust gas streams was measured by 40 CFR Part 60, Appendix A, Method 4 regulations.

The removal efficiency of the thermal oxidizer was determined by calculating the mass rate of THC inlet and exhaust using the THC ppmvd concentrations (reported as propane) along with the measured gas flow rates using the following equations;

$$E_i = K_2 \left(\sum_{j=1}^{n} C_{ij} M_{ij} \right) Q_i$$

$$E_o = K_2 \left(\sum_{j=1}^{n} C_{oj} M_{oj} \right) Q_o$$

Where:
C_{ij}, C_{oj} = Concentration of sample component of the gas stream at the inlet and exhaust of the control device, respectively, dry basis, parts per million by volume.
E_i, E_o = Mass rate of THC at the inlet and exhaust of the control device, respectively, dry basis, kilogram per hour.
M_{ij}, M_{oj} = Molecular weight of the sample component j of the gas stream at the inlet and exhaust of the control device, respectively, gram/gram-mole. (MW of 44.96 is used for THC as propane).
Q_i, Q_o = Flow rate of the gas stream at the inlet and exhaust of the control device, respectively, dry standard cubic feet per minute.
K_2 = Constant, 2.494 x 10^{-6} (parts per million)$^{-1}$ (gram-mole per standard cubic meter) (kilogram/gram) minute/hour), where standard temperature (gram-mole per standard cubic meter) is 20 °C.

The percent reduction in THC was calculated using the following equation;

$$R = \frac{E_i - E_o}{E_i}(100)$$

Where:
R = Control efficiency of control device, percent.
E_i = Mass rate of THC (minus methane and ethane) at the inlet to the control device, kilograms THC per hour. E_o = Mass rate of THC (minus methane and ethane) at the exhaust of the control device, kilograms THC per hour.

3.2 Description of Sampling Location

The main stack is 32 inches in diameter, exiting approximately 35 feet above grade and is located at the northwest end of the facility. The sample ports are at approximately 5 feet below the exit of the stack, and approximately 15 feet above the fan exhaust entrance to the stack.

Access to the stack, for all gaseous CEM reference method sampling, was through a shared sample line. A filtered stainless steel probe was used to extract the gas sample from the stack. A heated, 3/8 inch Teflon® line transported the sample from the point of extraction to the non-contact gas conditioning chiller system. The moisture was condensed and removed from the gas stream, while the pollutant passed through to the gaseous analyzers. Just prior to the entrance of the gas conditioner, a separate heated line was used to extract a slipstream from the main heated line that connected directly to the inlet of the THC CEM. The analyzers were located in a temperature-controlled sampling trailer to minimize thermal effects on the calibration of the instruments. Figure 1 is a schematic of the CEM sampling system.

Each reference method CEM was connected to an electronic datalogger for collection of data. One-minute averages of each reference method CEM were recorded throughout the compliance test period. A copy of the test data recorded by the datalogger is provided in Appendix of this report.

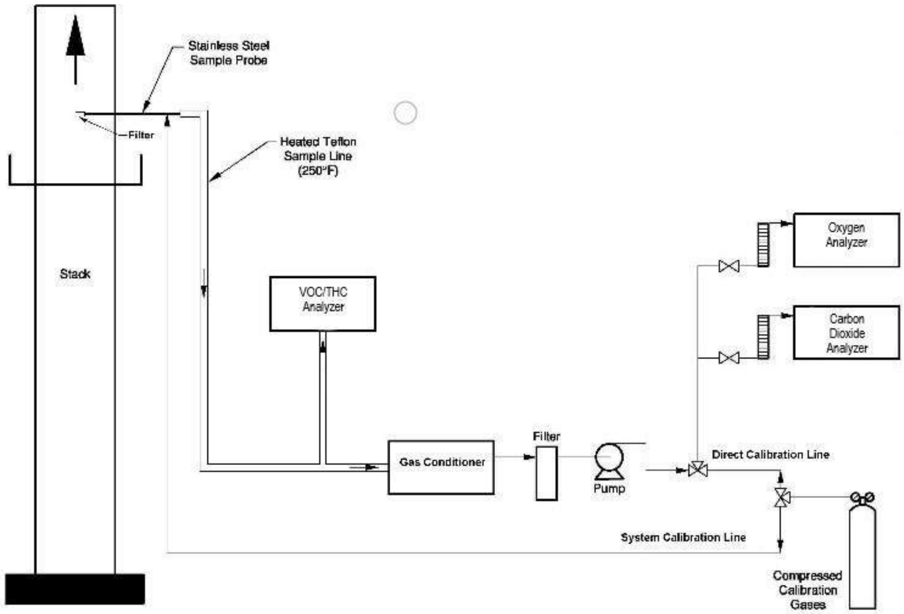

Figure 1. Schematic of THC Sampling System

3.3 Process Sampling

No process feed samples were acquired during the testing program. The plant data is located in Appendix A of this report.

3.4 Flow Characterization

3.4.1 Location of Traverse Points

To insure representative sampling of the velocity and volumetric flow rates, the cross section of the stack was divided into discreet sampling points according to the procedures described in 40 CFR 60, Appendix A, Method 1. The stack gas characteristics (i.e., flow, temp.) were measured at each of the traverse locations during each test run.

3.4.2 Velocity and Volumetric Flow Measurement

Velocity measurements were performed during each test run across each diameter of the stack to characterize the gas stream velocities and flow characteristics using the procedures outlined in 40 CFR, Part 60, Appendix A, Method 2, and Appendix B, Performance Specification 6. The velocity pressures were measured using an "S"-type pitot tube and a standard oil-filled inclined manometer.

3.4.3 Temperature Measurement

The temperature of the stack gas was recorded during each velocity traverse using a K-type thermocouple and dedicated digital temperature readout. The temperatures were recorded on the sampling data sheet for each traverse point location. The stack temperatures were arithmetically averaged and used to calculate the volumetric flow rates at standard and dry standard conditions.

3.4.4 Moisture Determination

The moisture content of the stack gas was determined using procedures outlined in 40 CFR 60, Appendix A, Reference Method 4. The Method 4 sampling was performed for every test run and a minimum of 21 standard cubic feet was collected for each moisture run. The moisture was determined for each sampling train by gravimetrically measuring the weight gain of the chilled impingers over the length of the sampling runs. Figure 2 is a schematic of the Method 4 sample train.

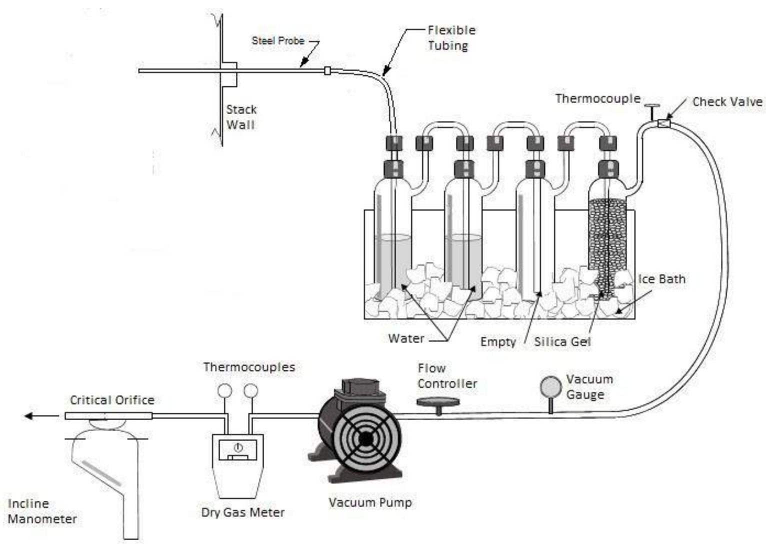

Figure 2. Schematic of Method 4 Sampling Train

3.5 Oxygen (O_2) Determination

The O_2 percent concentrations were sampled and determined using a Teledyne T-803 paramagnetic O_2 analyzer. The O_2 sampling conformed to procedures presented in 40 CFR 60, Appendix A, Method 3A.

3.6 Carbon Dioxide (CO2) Determination

The CO_2 concentrations were sampled and determined using a Teledyne T-803 dedicated non-dispersive infrared (NDIR) analyzer. The CO_2 sampling conformed to procedures presented in 40 CFR 60, Appendix A, Method 3A.

4.0 EQUIPMENT CALIBRATION

Proper equipment calibration is essential in maintaining the desired data quality level. All calibrations of the equipment to be used in the stack sampling conformed to the guidelines outlined in the EPA quality assurance handbook, Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods (EPA600/477027a). The following sections give a synopsis of the calibration procedures for the main components of the stack sampling systems.

4.1 CEM Calibration Procedures and Correction Factor Calculations

The reference method analyzers were calibrated with EPA-approved RATA Class calibration gases prior to the beginning of the test series, and after every test run. The initial calibration error checks were performed at the beginning of the test run series in accordance with the specific reference method applicable to the analyzer. After the successful completion of the initial calibration error check, a system bias check was performed.

Zero and mid-point calibration bias checks were performed prior to the beginning of the test runs. The bias check is a comparison of instrument response to gas introduced into the analyzer with gases routed throughout the entire sampling system. The maximum allowable system bias is 5% of the high-level calibration gas value. After the bias check was performed, the analyzers were not adjusted during the tests, unless an analyzer failed the drift check. No analyzers failed the drift check.

For the THC CEM, EPA Method 25A does not require a direct calibration. Instead, only the system calibration is performed on the THC CEM.

After each test run a drift check was performed on the analyzers, in the event that an analyzer failed the drift check, the test run completed prior to the drift check would be invalidated. None of the analyzers failed the drift check, so it was not necessary to eliminate any test runs. The drift checks were performed on each analyzer by introducing the mid-range calibration gas and the zero nitrogen. The maximum allowable calibration drift is 3% of the high-level calibration gas value. Calibration drift was determined by comparing the before run and after run values.

4.2 Stack Gas Flow Equipment Calibration Procedures

4.2.1 Dry Gas Meters/Critical Orifice

The dry gas meter and critical orifice in the control box used during the testing were calibrated against a primary wet test meter before and after the test in order to ensure accurate measurements of the sample gas volumes. The dry gas meter and critical orifice are normally housed as a set inside each control box and are calibrated as such.

The dry gas meter/critical orifice set was calibrated at preselected volume flow settings. For each of these flow rates, an accuracy ratio factor to the calibration standard (Y_i) was computed for the individual dry gas meter. A successful calibration for a particular dry gas meter would be achieved if each value of Y_i will be within 2 percent of the average value of Y_i ($Y_i = Y \pm 0.02Y$).

4.2.2 Thermocouples and Thermocouple Readouts

All thermocouples used during the stack sampling tests were calibrated to ensure accurate temperature measurements. All of the sensors utilized were type "K" thermocouples, which have a working range up to 2,500 ^oF. These sensors were used in the measurement of stack gas temperature and impinger temperature. The thermocouples were calibrated against an NIST traceable mercury-in-glass thermometer at multiple temperatures. In order to obtain the calibration data from each sensor, a single, recently calibrated thermocouple readout was used.

The thermocouple readouts used during the testing were calibrated using a thermocouple simulator. This calibration apparatus generates a voltage signal that mimics the signal an ideal "K" type thermocouple would exhibit at a particular temperature. The signal can be changed via a slide switch. The readouts were calibrated at preselected points across the range of the calibration device.

4.2.3 Barometer

The field barometer used during the tests was an NIST traceable electronic barometer. This barometer was calibrated at the factory and sealed, so no adjustments are required.

4.2.4 Analytical Balance

The field analytical balance was calibrated before the test with certified standard weights. The balance was adjusted for any deviation from the standard weights. In the field, periodic checks were made to insure data validity. This balance was used to measure the impinger weight changes due to moisture gain during the stack sampling (determination of stack moisture content).

4.2.5 Pitot Tubes

The S-type pitot tube used during the testing was calibrated by geometric consideration. The basis for the calibration is described in 40 CFR, Part 60, Appendix A, Method 2.

5.0 QUALITY ASSURANCE PROCEDURES

Quality assurance and quality control procedures were implemented throughout the sampling program. The reference test methods for the primary CEMs contain specific quality assurance and control requirements in the form of periodic calibration checks of the sampling system and the use of EPA approved RATA Class calibration gases. The calibration checks and system bias checks must be within strict allowable ranges in order for the instruments to pass ongoing calibrations. All the reference method CEMs were within their individual specific calibration and operating limits. All other test equipment (sample control boxes, dry gas meters, thermocouples, thermocouple readouts, pitot tubes) were calibrated in accordance with guidelines outlined in the EPA recommendations and requirements.

Field data sheets, emission monitor data sheets, calibration records and all calculations were checked and approved by CEC personnel experienced in performing these tests and acquiring the field data. Data and calculation procedures adhered to the CEC approved QA/QC guidelines for document and data review.

CEC recognizes the previously described reference methods to be very technical oriented and attempts to minimize all factors that can increase error by implementing its Quality Assurance Program into every segment of its testing activities.

Calculations were performed using verified Excel spreadsheets. An explanation of the nomenclature and calculations along with the complete test results are located in the Appendix of this report. Also appended are the calibration data and copies of the raw field data sheets. Analyzer interference data provided by the manufacturer is kept on file at CEC.

APPENDIX A

Process Data

Gregg, Todd

From: TAYLOR_CATES@denso-diam.com
Sent: Thursday, November 29, 2018 12:52 PM
To: Gregg, Todd
Cc: EDDIE_FRANKS@DENSO-diam.com
Subject: Re: Fw: Process Data

Hi Todd,

I apologize for the delay. I believe I have all of the information that you need below.

Run Time	Avg. TO Temp (F)	Avg. Flow (cfm)
r1	1477	14989
r2	1482	15112
r2	1489	15045

Thanks!!!

DENSO
Mrs. Taylor Cates
Specialist
Safety, Health, and Environment
DENSO Manufacturing Athens, TN INC.
Tel: (423)-746-0000 ext. 7543
Internal: 5010-7543

"AT WORK OR AT PLAY; LET SAFETY LEAD THE WAY!"

From: EDDIE FRANKS/DMTN
To: TAYLOR CATES/DMTN@NDAM
Cc: "Gregg, Todd" <tgregg@cecinc.com>
Date: 11/19/2018 11:48 AM
Subject: Fw: Process Data

Hey Taylor
Can you get with facilities and get Todd what he needs?
Let me know if you need any help.
Thanks, Eddie

Eddie Franks
Manager
Safety, Health and Environment
DENSO MANUFACTURING ATHENS TENNESSEE, INC
2400 Denso Drive
Athens, TN 37303
Tel: 423-746-0000 Ext. 7542
Cell: 901-652-8887

"AT WORK OR AT PLAY; LET SAFETY LEAD THE WAY"

CEM's Data

2018 Denso Athens Compliance
Run 1

	CEC Air Group THC in (ppmvw)	CEC Air Group THC out (ppmvw)	CEC Air Group THC in (ppmvd)	CEC Air Group THC out (ppmvd)	Denso Inlet Flow (cfm)	Denso Inlet Flow (dscfm)	CEC Air Group Outlet Flow (dscfm)	CEC Air Group THC in (lbs/hour)	CEC Air Group THC out (lbs/hour)	CEC Air Group RE (%)
10/30/2018 10:20	544.44	55.09	549.85	55.72	14,989	14,840	8,464	56.45	3.26	94.22%
10/30/2018 10:21	507.52	52.08	512.56	52.68	14,989	14,840	8,464	52.62	3.08	94.14%
10/30/2018 10:22	482.95	37.98	487.75	38.42	14,989	14,840	8,464	50.07	2.25	95.51%
10/30/2018 10:23	493.69	35.72	498.59	36.13	14,989	14,840	8,464	51.19	2.12	95.87%
10/30/2018 10:24	497.77	35.91	502.72	36.32	14,989	14,840	8,464	51.61	2.13	95.88%
10/30/2018 10:25	501.19	37.19	506.17	37.62	14,989	14,840	8,464	51.96	2.20	95.76%
10/30/2018 10:26	499.38	38.31	504.35	38.75	14,989	14,840	8,464	51.78	2.27	95.62%
10/30/2018 10:27	507.53	39.63	512.57	40.09	14,989	14,840	8,464	52.62	2.35	95.54%
10/30/2018 10:28	500.68	41.98	505.66	42.46	14,989	14,840	8,464	51.91	2.49	95.21%
10/30/2018 10:29	492.08	43.63	496.97	44.13	14,989	14,840	8,464	51.02	2.58	94.94%
10/30/2018 10:30	499.06	46.14	504.02	46.67	14,989	14,840	8,464	51.74	2.73	94.72%
10/30/2018 10:31	475.72	46.61	480.45	47.15	14,989	14,840	8,464	49.32	2.76	94.40%
10/30/2018 10:32	494.35	49.19	499.26	49.76	14,989	14,840	8,464	51.26	2.91	94.32%
10/30/2018 10:33	505.35	51.1	510.37	51.69	14,989	14,840	8,464	52.40	3.03	94.22%
10/30/2018 10:34	492.18	53.15	497.07	53.76	14,989	14,840	8,464	51.03	3.15	93.83%
10/30/2018 10:35	485.32	47.88	490.15	48.43	14,989	14,840	8,464	50.32	2.84	94.36%
10/30/2018 10:36	473.41	45.21	478.11	45.73	14,989	14,840	8,464	49.08	2.68	94.54%
10/30/2018 10:37	498.56	42.22	503.52	42.71	14,989	14,840	8,464	51.69	2.50	95.16%
10/30/2018 10:38	477.47	40.35	482.22	40.81	14,989	14,840	8,464	49.51	2.39	95.17%
10/30/2018 10:39	488.54	38.34	493.39	38.78	14,989	14,840	8,464	50.65	2.27	95.52%
10/30/2018 10:40	503.05	38.37	508.05	38.81	14,989	14,840	8,464	52.16	2.27	95.64%
10/30/2018 10:41	518.06	38.05	523.21	38.49	14,989	14,840	8,464	53.71	2.25	95.80%
10/30/2018 10:42	533.73	37.7	539.04	38.13	14,989	14,840	8,464	55.34	2.23	95.97%
10/30/2018 10:43	527.56	38.26	532.80	38.70	14,989	14,840	8,464	54.70	2.27	95.86%
10/30/2018 10:44	517.82	38.52	522.97	38.96	14,989	14,840	8,464	53.69	2.28	95.75%
10/30/2018 10:45	528.33	38.48	533.58	38.92	14,989	14,840	8,464	54.78	2.28	95.84%
10/30/2018 10:46	511.38	39.15	516.46	39.60	14,989	14,840	8,464	53.02	2.32	95.63%
10/30/2018 10:47	534.16	39.58	539.47	40.04	14,989	14,840	8,464	55.38	2.34	95.77%
10/30/2018 10:48	522.31	39.55	527.51	40.01	14,989	14,840	8,464	54.16	2.34	95.67%
10/30/2018 10:49	528.22	40.49	533.46	40.96	14,989	14,840	8,464	54.77	2.40	95.62%
10/30/2018 10:50	526.13	41.44	531.36	41.92	14,989	14,840	8,464	54.55	2.45	95.50%
10/30/2018 10:51	514.78	41.5	519.90	41.98	14,989	14,840	8,464	53.37	2.46	95.39%
10/30/2018 10:52	507.63	41.31	512.68	41.79	14,989	14,840	8,464	52.63	2.45	95.35%
10/30/2018 10:53	502.23	41.29	507.22	41.77	14,989	14,840	8,464	52.07	2.45	95.30%
10/30/2018 10:54	508.56	41.5	513.62	41.98	14,989	14,840	8,464	52.73	2.46	95.34%
10/30/2018 10:55	489.47	41.93	494.33	42.41	14,989	14,840	8,464	50.75	2.48	95.11%
10/30/2018 10:56	489.72	41.9	494.58	42.38	14,989	14,840	8,464	50.78	2.48	95.11%
10/30/2018 10:57	500.16	43.36	505.13	43.86	14,989	14,840	8,464	51.86	2.57	95.05%

2018 Denso Athens Compliance
Run 1

	CEC Air Group THC in (ppmvw)	CEC Air Group THC out (ppmvw)	CEC Air Group THC in (ppmvd)	CEC Air Group THC out (ppmvd)	Denso Inlet Flow (cfm)	Denso Inlet Flow (dscfm)	CEC Air Group Outlet Flow (dscfm)	CEC Air Group THC in (lbs/hour)	CEC Air Group THC out (lbs/hour)	CEC Air Group RE (%)
10/30/2018 10:58	502.58	45.09	507.57	45.61	14,989	14,840	8,464	52.11	2.67	94.87%
10/30/2018 10:59	512.30	47.26	517.39	47.80	14,989	14,840	8,464	53.12	2.80	94.73%
10/30/2018 11:00	487.14	48.6	491.98	49.16	14,989	14,840	8,464	50.51	2.88	94.30%
10/30/2018 11:01	474.02	49.78	478.73	50.35	14,989	14,840	8,464	49.15	2.95	94.00%
10/30/2018 11:02	474.88	50.88	479.60	51.47	14,989	14,840	8,464	49.24	3.01	93.88%
10/30/2018 11:03	480.84	51.98	485.62	52.58	14,989	14,840	8,464	49.86	3.08	93.82%
10/30/2018 11:04	469.03	52.11	473.69	52.71	14,989	14,840	8,464	48.63	3.09	93.65%
10/30/2018 11:05	471.34	52.06	476.03	52.66	14,989	14,840	8,464	48.87	3.08	93.69%
10/30/2018 11:06	487.39	54.14	492.23	54.76	14,989	14,840	8,464	50.53	3.21	93.65%
10/30/2018 11:07	476.55	55	481.29	55.63	14,989	14,840	8,464	49.41	3.26	93.41%
10/30/2018 11:08	463.61	55.91	468.22	56.55	14,989	14,840	8,464	48.07	3.31	93.11%
10/30/2018 11:09	491.42	57.21	496.30	57.87	14,989	14,840	8,464	50.95	3.39	93.35%
10/30/2018 11:10	473.64	59.82	478.34	60.51	14,989	14,840	8,464	49.11	3.54	92.79%
10/30/2018 11:11	494.86	61.72	499.77	62.43	14,989	14,840	8,464	51.31	3.66	92.88%
10/30/2018 11:12	486.45	65.6	491.28	66.36	14,989	14,840	8,464	50.44	3.89	92.30%
10/30/2018 11:13	491.76	69.27	496.65	70.07	14,989	14,840	8,464	50.99	4.10	91.95%
10/30/2018 11:14	480.50	69.76	485.27	70.56	14,989	14,840	8,464	49.82	4.13	91.71%
10/30/2018 11:15	476.31	72.1	481.05	72.93	14,989	14,840	8,464	49.39	4.27	91.35%
10/30/2018 11:16	474.66	75.75	479.38	76.62	14,989	14,840	8,464	49.21	4.49	90.88%
10/30/2018 11:17	478.99	78.18	483.75	79.08	14,989	14,840	8,464	49.66	4.63	90.68%
10/30/2018 11:18	483.14	78.57	487.94	79.47	14,989	14,840	8,464	50.09	4.65	90.71%
10/30/2018 11:19	483.27	81.06	488.08	81.99	14,989	14,840	8,464	50.11	4.80	90.42%
10/30/2018 11:20	475.73	83.23	480.46	84.19	14,989	14,840	8,464	49.33	4.93	90.01%
10/30/2018 11:21	468.30	84.88	472.95	85.86	14,989	14,840	8,464	48.55	5.03	89.65%
10/30/2018 11:22	469.72	84.17	474.39	85.14	14,989	14,840	8,464	48.70	4.99	89.76%
10/30/2018 11:23	467.96	83.36	472.61	84.32	14,989	14,840	8,464	48.52	4.94	89.82%
10/30/2018 11:24	459.81	81.93	464.38	82.87	14,989	14,840	8,464	47.67	4.85	89.82%
10/30/2018 11:25	440.89	80.97	445.27	81.90	14,989	14,840	8,464	45.71	4.80	89.51%
10/30/2018 11:26	452.36	78.42	456.85	79.32	14,989	14,840	8,464	46.90	4.64	90.10%
10/30/2018 11:27	455.49	76.82	460.02	77.70	14,989	14,840	8,464	47.23	4.55	90.37%
10/30/2018 11:28	437.65	60.95	442.00	61.65	14,989	14,840	8,464	45.38	3.61	92.04%
Averages	**491.64**	**52.85**	**496.52**	**53.46**	**14,989**	**14,840**	**8,464**	**50.97**	**3.13**	**93.79%**

2018 Denso Athens Compliance
Run 2

	CEC Air Group THC in (ppmvw)	CEC Air Group THC out (ppmvw)	CEC Air Group THC in (ppmvd)	CEC Air Group THC out (ppmvd)	Denso Inlet Flow (cfm)	Denso Inlet Flow (dscfm)	CEC Air Group Outlet Flow (dscfm)	CEC Air Group THC in (lbs/hour)	CEC Air Group THC out (lbs/hour)	CEC Air Group RE (%)
10/30/2018 14:00	408.75	87.86	411.67	89.03	15,112	15,004	8,197	42.73	5.05	88.18%
10/30/2018 14:01	412.53	92.11	415.47	93.34	15,112	15,004	8,197	43.13	5.29	87.73%
10/30/2018 14:02	412.83	101.14	415.77	102.49	15,112	15,004	8,197	43.16	5.81	86.53%
10/30/2018 14:03	410.47	120.13	413.40	121.73	15,112	15,004	8,197	42.91	6.90	83.91%
10/30/2018 14:04	403.47	134.28	406.35	136.07	15,112	15,004	8,197	42.18	7.72	81.71%
10/30/2018 14:05	402.13	133.63	404.99	135.41	15,112	15,004	8,197	42.04	7.68	81.73%
10/30/2018 14:06	400.60	131.95	403.46	133.71	15,112	15,004	8,197	41.88	7.58	81.89%
10/30/2018 14:07	395.72	133.65	398.54	135.43	15,112	15,004	8,197	41.37	7.68	81.44%
10/30/2018 14:08	398.47	128.75	401.31	130.47	15,112	15,004	8,197	41.66	7.40	82.24%
10/30/2018 14:09	400.69	119.51	403.54	121.10	15,112	15,004	8,197	41.89	6.87	83.60%
10/30/2018 14:10	400.82	106.89	403.68	108.32	15,112	15,004	8,197	41.90	6.14	85.34%
10/30/2018 14:11	393.49	96.49	396.30	97.78	15,112	15,004	8,197	41.14	5.54	86.52%
10/30/2018 14:12	385.86	87.61	388.61	88.78	15,112	15,004	8,197	40.34	5.03	87.52%
10/30/2018 14:13	381.85	81.06	384.58	82.14	15,112	15,004	8,197	39.92	4.66	88.33%
10/30/2018 14:14	379.90	74.6	382.61	75.60	15,112	15,004	8,197	39.71	4.29	89.21%
10/30/2018 14:15	381.05	69.83	383.77	70.76	15,112	15,004	8,197	39.84	4.01	89.93%
10/30/2018 14:16	385.36	64.23	388.11	65.09	15,112	15,004	8,197	40.29	3.69	90.84%
10/30/2018 14:17	389.77	61.02	392.55	61.83	15,112	15,004	8,197	40.75	3.51	91.39%
10/30/2018 14:18	395.92	55.29	398.74	56.03	15,112	15,004	8,197	41.39	3.18	92.32%
10/30/2018 14:19	400.51	52.3	403.37	53.00	15,112	15,004	8,197	41.87	3.01	92.82%
10/30/2018 14:20	407.18	48.44	410.08	49.09	15,112	15,004	8,197	42.57	2.78	93.46%
10/30/2018 14:21	407.70	46.23	410.61	46.85	15,112	15,004	8,197	42.62	2.66	93.77%
10/30/2018 14:22	397.38	43.72	400.22	44.30	15,112	15,004	8,197	41.54	2.51	93.95%
10/30/2018 14:23	385.91	42.2	388.66	42.76	15,112	15,004	8,197	40.34	2.42	93.99%
10/30/2018 14:24	377.62	40.52	380.31	41.06	15,112	15,004	8,197	39.48	2.33	94.10%
10/30/2018 14:25	371.45	39.01	374.10	39.53	15,112	15,004	8,197	38.83	2.24	94.23%
10/30/2018 14:26	366.28	38.01	368.90	38.52	15,112	15,004	8,197	38.29	2.18	94.30%
10/30/2018 14:27	363.41	37.06	366.00	37.55	15,112	15,004	8,197	37.99	2.13	94.39%
10/30/2018 14:28	358.26	35.32	360.81	35.79	15,112	15,004	8,197	37.45	2.03	94.58%
10/30/2018 14:29	358.21	34.26	360.76	34.72	15,112	15,004	8,197	37.45	1.97	94.74%
10/30/2018 14:30	356.74	34.6	359.29	35.06	15,112	15,004	8,197	37.29	1.99	94.67%
10/30/2018 14:31	349.80	33.94	352.29	34.39	15,112	15,004	8,197	36.57	1.95	94.67%
10/30/2018 14:32	344.77	32.89	347.23	33.33	15,112	15,004	8,197	36.04	1.89	94.76%
10/30/2018 14:33	340.75	32.73	343.18	33.17	15,112	15,004	8,197	35.62	1.88	94.72%
10/30/2018 14:34	334.44	30.79	336.83	31.20	15,112	15,004	8,197	34.96	1.77	94.94%
10/30/2018 14:35	330.15	29.12	332.50	29.51	15,112	15,004	8,197	34.51	1.67	95.15%

2018 Denso Athens Compliance
Run 2

	CEC Air Group THC in (ppmvw)	CEC Air Group THC out (ppmvw)	CEC Air Group THC in (ppmvd)	CEC Air Group THC out (ppmvd)	Denso Inlet Flow (cfm)	Denso Inlet Flow (dscfm)	CEC Air Group Outlet Flow (dscfm)	CEC Air Group THC in (lbs/hour)	CEC Air Group THC out (lbs/hour)	CEC Air Group RE (%)
10/30/2018 14:36	337.16	27.86	339.57	28.23	15,112	15,004	8,197	35.25	1.60	95.46%
10/30/2018 14:37	350.29	26.53	352.79	26.88	15,112	15,004	8,197	36.62	1.52	95.84%
10/30/2018 14:38	361.26	25.6	363.84	25.94	15,112	15,004	8,197	37.77	1.47	96.10%
10/30/2018 14:39	372.36	24.63	375.02	24.96	15,112	15,004	8,197	38.93	1.42	96.36%
10/30/2018 14:40	377.32	23.91	380.01	24.23	15,112	15,004	8,197	39.44	1.37	96.52%
10/30/2018 14:41	381.13	23.13	383.85	23.44	15,112	15,004	8,197	39.84	1.33	96.66%
10/30/2018 14:42	385.88	22.53	388.63	22.83	15,112	15,004	8,197	40.34	1.29	96.79%
10/30/2018 14:43	384.81	21.92	387.56	22.21	15,112	15,004	8,197	40.23	1.26	96.87%
10/30/2018 14:44	387.49	21.28	390.25	21.56	15,112	15,004	8,197	40.51	1.22	96.98%
10/30/2018 14:45	392.46	20.99	395.26	21.27	15,112	15,004	8,197	41.03	1.21	97.06%
10/30/2018 14:46	391.79	20.89	394.59	21.17	15,112	15,004	8,197	40.96	1.20	97.07%
10/30/2018 14:47	383.77	20.68	386.51	20.96	15,112	15,004	8,197	40.12	1.19	97.04%
10/30/2018 14:48	376.73	20.85	379.42	21.13	15,112	15,004	8,197	39.38	1.20	96.96%
10/30/2018 14:49	371.77	21.36	374.42	21.64	15,112	15,004	8,197	38.86	1.23	96.84%
10/30/2018 14:50	368.89	21.86	371.53	22.15	15,112	15,004	8,197	38.56	1.26	96.74%
10/30/2018 14:51	363.64	22.62	366.23	22.92	15,112	15,004	8,197	38.01	1.30	96.58%
10/30/2018 14:52	361.73	23.65	364.31	23.97	15,112	15,004	8,197	37.82	1.36	96.41%
10/30/2018 14:53	362.96	23.8	365.55	24.12	15,112	15,004	8,197	37.94	1.37	96.40%
10/30/2018 14:54	360.49	23.72	363.06	24.04	15,112	15,004	8,197	37.68	1.36	96.38%
10/30/2018 14:55	351.14	24.16	353.64	24.48	15,112	15,004	8,197	36.71	1.39	96.22%
10/30/2018 14:56	342.98	25.05	345.43	25.38	15,112	15,004	8,197	35.85	1.44	95.99%
10/30/2018 14:57	336.11	25.7	338.51	26.04	15,112	15,004	8,197	35.14	1.48	95.80%
10/30/2018 14:58	325.86	26.56	328.19	26.91	15,112	15,004	8,197	34.07	1.53	95.52%
10/30/2018 14:59	315.66	27.16	317.91	27.52	15,112	15,004	8,197	33.00	1.56	95.27%
Averages	**375.57**	**51.63**	**378.25**	**52.32**	**15,112**	**15,004**	**8,197**	**39.26**	**2.97**	**92.62%**

2018 Denso Athens Compliance

Run 3

	CEC Air Group THC in (ppmvw)	CEC Air Group THC out (ppmvw)	CEC Air Group THC in (ppmvd)	CEC Air Group THC out (ppmvd)	Denso Inlet Flow (cfm)	Denso Inlet Flow (dscfm)	CEC Air Group Outlet Flow (dscfm)	CEC Air Group THC in (lbs/hour)	CEC Air Group THC out (lbs/hour)	CEC Air Group RE (%)
10/30/2018 15:25	336.14	24.04	339.11	24.39	15,045	14,912	9,185	34.98	1.55	95.57%
10/30/2018 15:26	337.07	23.72	340.05	24.07	15,045	14,912	9,185	35.08	1.53	95.64%
10/30/2018 15:27	341.02	23.15	344.04	23.49	15,045	14,912	9,185	35.49	1.49	95.79%
10/30/2018 15:28	342.09	21.84	345.12	22.16	15,045	14,912	9,185	35.60	1.41	96.04%
10/30/2018 15:29	340.38	21.85	343.39	22.17	15,045	14,912	9,185	35.42	1.41	96.02%
10/30/2018 15:30	345.77	21.74	348.82	22.06	15,045	14,912	9,185	35.99	1.40	96.10%
10/30/2018 15:31	351.79	21.43	354.90	21.75	15,045	14,912	9,185	36.61	1.38	96.23%
10/30/2018 15:32	356.48	21.04	359.63	21.35	15,045	14,912	9,185	37.10	1.36	96.34%
10/30/2018 15:33	359.37	20.29	362.55	20.59	15,045	14,912	9,185	37.40	1.31	96.50%
10/30/2018 15:34	361.87	20.02	365.07	20.31	15,045	14,912	9,185	37.66	1.29	96.57%
10/30/2018 15:35	363.42	20.07	366.63	20.37	15,045	14,912	9,185	37.82	1.29	96.58%
10/30/2018 15:36	360.32	19.84	363.50	20.13	15,045	14,912	9,185	37.50	1.28	96.59%
10/30/2018 15:37	356.07	19.96	359.21	20.25	15,045	14,912	9,185	37.06	1.29	96.53%
10/30/2018 15:38	345.60	19.71	348.65	20.00	15,045	14,912	9,185	35.97	1.27	96.47%
10/30/2018 15:39	341.24	19.47	344.26	19.76	15,045	14,912	9,185	35.51	1.26	96.47%
10/30/2018 15:40	336.07	19.32	339.04	19.60	15,045	14,912	9,185	34.98	1.25	96.44%
10/30/2018 15:41	332.88	19.04	335.82	19.32	15,045	14,912	9,185	34.64	1.23	96.46%
10/30/2018 15:42	331.00	19.01	333.93	19.29	15,045	14,912	9,185	34.45	1.23	96.44%
10/30/2018 15:43	325.11	19.1	327.99	19.38	15,045	14,912	9,185	33.84	1.23	96.36%
10/30/2018 15:44	325.41	18.78	328.28	19.06	15,045	14,912	9,185	33.87	1.21	96.42%
10/30/2018 15:45	323.19	18.61	326.05	18.88	15,045	14,912	9,185	33.64	1.20	96.43%
10/30/2018 15:46	322.06	18.76	324.90	19.04	15,045	14,912	9,185	33.52	1.21	96.39%
10/30/2018 15:47	330.57	18.69	333.49	18.97	15,045	14,912	9,185	34.40	1.21	96.50%
10/30/2018 15:48	336.64	18.71	339.62	18.99	15,045	14,912	9,185	35.04	1.21	96.56%
10/30/2018 15:49	341.30	18.67	344.31	18.94	15,045	14,912	9,185	35.52	1.20	96.61%
10/30/2018 15:50	346.94	18.74	350.00	19.02	15,045	14,912	9,185	36.11	1.21	96.65%
10/30/2018 15:51	346.48	18.62	349.54	18.89	15,045	14,912	9,185	36.06	1.20	96.67%
10/30/2018 15:52	349.74	18.48	352.83	18.75	15,045	14,912	9,185	36.40	1.19	96.73%
10/30/2018 15:53	348.61	18.61	351.69	18.88	15,045	14,912	9,185	36.28	1.20	96.69%
10/30/2018 15:54	346.89	18.31	349.95	18.58	15,045	14,912	9,185	36.10	1.18	96.73%
10/30/2018 15:55	342.69	18.37	345.72	18.64	15,045	14,912	9,185	35.67	1.18	96.68%
10/30/2018 15:56	338.81	18.46	341.80	18.73	15,045	14,912	9,185	35.26	1.19	96.62%
10/30/2018 15:57	333.75	18.53	336.69	18.80	15,045	14,912	9,185	34.73	1.19	96.56%
10/30/2018 15:58	330.44	18.37	333.36	18.64	15,045	14,912	9,185	34.39	1.18	96.56%
10/30/2018 15:59	327.74	18.29	330.64	18.56	15,045	14,912	9,185	34.11	1.18	96.54%
10/30/2018 16:00	322.52	18.33	325.37	18.60	15,045	14,912	9,185	33.57	1.18	96.48%

2018 Denso Athens Compliance
Run 3

	CEC Air Group THC in (ppmvw)	CEC Air Group THC out (ppmvw)	CEC Air Group THC in (ppmvd)	CEC Air Group THC out (ppmvd)	Denso Inlet Flow (cfm)	Denso Inlet Flow (dscfm)	CEC Air Group Outlet Flow (dscfm)	CEC Air Group THC in (lbs/hour)	CEC Air Group THC out (lbs/hour)	CEC Air Group RE (%)
10/30/2018 16:01	316.90	18.23	319.70	18.50	15,045	14,912	9,185	32.98	1.18	96.44%
10/30/2018 16:02	314.20	18.56	316.98	18.83	15,045	14,912	9,185	32.70	1.20	96.34%
10/30/2018 16:03	312.20	18.88	314.96	19.16	15,045	14,912	9,185	32.49	1.22	96.25%
10/30/2018 16:04	310.80	18.81	313.54	19.09	15,045	14,912	9,185	32.35	1.21	96.25%
10/30/2018 16:05	309.48	18.47	312.21	18.74	15,045	14,912	9,185	32.21	1.19	96.30%
10/30/2018 16:06	308.31	18.73	311.03	19.01	15,045	14,912	9,185	32.09	1.21	96.24%
10/30/2018 16:07	304.19	18.22	306.87	18.49	15,045	14,912	9,185	31.66	1.17	96.29%
10/30/2018 16:08	303.66	18.44	306.34	18.71	15,045	14,912	9,185	31.60	1.19	96.24%
10/30/2018 16:09	302.17	18.65	304.84	18.92	15,045	14,912	9,185	31.45	1.20	96.18%
10/30/2018 16:10	301.17	18.38	303.83	18.65	15,045	14,912	9,185	31.34	1.19	96.22%
10/30/2018 16:11	301.17	18.18	303.83	18.45	15,045	14,912	9,185	31.34	1.17	96.26%
10/30/2018 16:12	302.00	18.25	304.67	18.52	15,045	14,912	9,185	31.43	1.18	96.26%
10/30/2018 16:13	308.72	18.07	311.44	18.34	15,045	14,912	9,185	32.13	1.17	96.37%
10/30/2018 16:14	312.34	17.98	315.10	18.24	15,045	14,912	9,185	32.51	1.16	96.43%
10/30/2018 16:15	314.98	18.32	317.76	18.59	15,045	14,912	9,185	32.78	1.18	96.40%
10/30/2018 16:16	315.59	18.77	318.38	19.05	15,045	14,912	9,185	32.84	1.21	96.32%
10/30/2018 16:17	317.35	18.47	320.15	18.74	15,045	14,912	9,185	33.03	1.19	96.39%
10/30/2018 16:18	318.93	18.36	321.74	18.63	15,045	14,912	9,185	33.19	1.18	96.43%
10/30/2018 16:19	318.80	18.23	321.62	18.50	15,045	14,912	9,185	33.18	1.18	96.46%
10/30/2018 16:20	319.29	18.24	322.11	18.51	15,045	14,912	9,185	33.23	1.18	96.46%
10/30/2018 16:21	318.56	18.37	321.38	18.64	15,045	14,912	9,185	33.15	1.18	96.43%
10/30/2018 16:22	319.93	18.34	322.75	18.61	15,045	14,912	9,185	33.30	1.18	96.45%
10/30/2018 16:23	327.03	18.45	329.92	18.72	15,045	14,912	9,185	34.04	1.19	96.50%
10/30/2018 16:24	332.75	18.36	335.69	18.63	15,045	14,912	9,185	34.63	1.18	96.58%
Averages	**329.80**	**19.20**	**332.71**	**19.48**	**15,045**	**14,912**	**9,185**	**34.32**	**1.24**	**96.39%**

CEM Calibrations

CEM CALIBRATIONS

PROJECT NAME	Denso Athens
PROJECT NUMBER	184-566
DATE	October 30, 2018
RUN NUMBER	Run 1
START TIME	10:20 AM
STOP TIME	11:28 AM

ANALYZER	SPAN
THC	975
THC	50

		CALIBRATION ERROR			SYSTEM BIAS CHECK							
					PRETEST		POST TEST					
	GAS CYLINDER NUMBER	CAL. GAS VALUE (% or PPM)	ANALYZER RESPONSE (% or PPM)	CAL ERROR (% SPAN)	SYSTEM RESP.	SYS. BIAS (% SPAN)	SYSTEM RESP.	SYS. BIAS (% SPAN)	DRIFT (% SPAN)	IS CAL ERROR CHECK OK? (YES/NO)	IS POSTEST BIAS OK? (YES/NO)	IS SYSTEM DRIFT OK? (YES/NO)
THC zero	n/a	0.00	-0.03	0.00	1.24	-0.13	2.73	-0.28	-0.15	YES	YES	YES
THC low	EB0065494	233.70	227.15	0.67								
THC mid	CC89356	500.70	494.52	0.63	489.43	0.52	494.31	0.02	-0.50	YES	YES	YES
THC hi	EB0065408	975.00	973.31	0.17								
THC zero	n/a	0.00	0.03	-0.06	0.38	-0.70	0.81	-1.56	-0.86	YES	YES	YES
THC low	XC032387	10.02	9.98	0.08								
THC mid	XC021249	25.10	25.13	-0.06	25.20	-0.14	25.18	-0.10	0.04	YES	YES	YES
THC hi	CC400426	50.09	50.15	-0.12								

Calibration error = ((cal. gas value - analyzer resp) / analyzer span) * 100: allowable error ± 2 %, ± 5 % for THC

System Bias = ((analyzer resp - system resp) / analyzer span) * 100: allowable error ± 5 %

Drift = ((pretest sys resp - post test sys resp) / analyzer span) * 100: allowable error ± 3 %

Sys Bias (pre and post) must be performed on each run: To determine Drift.
Use zero gas and either mid or hi cal gas, choose cal gas closest to measured stack concentration.

Drift must be performed every hour on THC

Calibration Error is performed only at start, unless allowable error parameters are exceeded.

CEM CALIBRATIONS

PROJECT NAME	Denso Athens
PROJECT NUMBER	184-566
DATE	October 30, 2018
RUN NUMBER	Run 2
START TIME	2:00 PM
STOP TIME	2:59 PM

ANALYZER	SPAN
THC	501
THC	50

	GAS CYLINDER NUMBER	CALIBRATION ERROR: CAL. GAS VALUE (% or PPM)	ANALYZER RESPONSE (% or PPM)	CAL ERROR (% SPAN)	SYSTEM BIAS CHECK: PRETEST SYSTEM RESP.	PRETEST SYS. BIAS (% SPAN)	POST TEST SYSTEM RESP.	POST TEST SYS. BIAS (% SPAN)	DRIFT (% SPAN)	IS CAL ERROR CHECK OK? (YES/NO)	IS PRETEST BIAS OK? (YES/NO)	IS POSTEST BIAS OK? (YES/NO)	IS SYSTEM DRIFT OK? (YES/NO)
THC zero	n/a	0.00	-0.03	0.01	2.73	-0.55	2.61	-0.53	0.02	YES	YES	YES	YES
THC low	CC400426	50.09	50.15	-0.01									
THC mid	EB0065494	233.70	227.15	1.31	233.33	-1.23	223.53	0.72	1.96	YES	YES	YES	YES
THC hi	CC89356	500.70	494.52	1.23									
THC zero	n/a	0.00	0.03	-0.06	0.81	-1.56	-0.20	0.46	2.02	YES	YES	YES	YES
THC low	XC032387	10.02	9.98	0.08									
THC mid	XC021249	25.10	25.13	-0.06	25.18	-0.10	24.96	0.34	0.44	YES	YES	YES	YES
THC hi	CC400426	50.09	50.15	-0.12									

Calibration error = ((cal. gas value - analyzer resp) / analyzer span) * 100: allowable error ± 2 %, ± 5 % for THC

System Bias = ((analyzer resp - system resp) / analyzer span) * 100: allowable error ± 5 %

Drift = ((pretest sys resp - post test sys resp) / analyzer span) * 100: allowable error ± 3 %

Sys Bias (pre and post) must be performed on each run: To determine Drift.
Use zero gas and either mid or hi cal gas, choose cal gas closest to measured stack concentration.

Drift must be performed every hour on THC

Calibration Error is performed only at start, unless allowable error parameters are exceeded.

CEM CALIBRATIONS

PROJECT NAME	Denso Athens
PROJECT NUMBER	184-566
DATE	October 30, 2018
RUN NUMBER	Run 3
START TIME	3:25 PM
STOP TIME	4:24 PM

ANALYZER	SPAN
THC	501
THC	50

	GAS CYLINDER NUMBER	CALIBRATION ERROR			SYSTEM BIAS CHECK					IS CAL ERROR CHECK OK? (YES/NO)	IS PRETEST BIAS OK? (YES/NO)	IS POSTEST BIAS OK? (YES/NO)	IS SYSTEM DRIFT OK? (YES/NO)
					PRETEST		POST TEST						
		CAL. GAS VALUE (% or PPM)	ANALYZER RESPONSE (% or PPM)	CAL ERROR (% SPAN)	SYSTEM RESP.	SYS. BIAS (% SPAN)	SYSTEM RESP.	SYS. BIAS (% SPAN)	DRIFT (% SPAN)				
THC zero	n/a	0.00	-0.03	0.01	2.61	-0.53	2.06	-0.42	0.11	YES	YES	YES	YES
THC low	CC400426	50.09	50.15	-0.01									
THC mid	EB0065494	233.70	227.15	1.31	223.53	0.72	219.61	1.51	0.78	YES	YES	YES	YES
THC hi	CC89356	500.70	494.52	1.23									
THC zero	n/a	0.00	0.03	-0.06	-0.20	0.46	-1.03	2.12	1.66	YES	YES	YES	YES
THC low	XC032387	10.02	9.98	0.08									
THC mid	XC021249	25.10	25.13	-0.06	24.96	0.34	24.59	1.08	0.74	YES	YES	YES	YES
THC hi	CC400426	50.09	50.15	-0.12									

Calibration error = ((cal. gas value - analyzer resp) / analyzer span) * 100: allowable error ± 2 %, ± 5 % for THC

System Bias = ((analyzer resp - system resp) / analyzer span) * 100: allowable error ± 5 %

Drift = ((pretest sys resp - post test sys resp) / analyzer span) * 100: allowable error ± 3 %

Sys Bias (pre and post) must be performed on each run: To determine Drift.
Use zero gas and either mid or hi cal gas, choose cal gas closest to measured stack concentration.

Drift must be performed every hour on THC

Calibration Error is performed only at start, unless allowable error parameters are exceeded.

Method 25A Calibration
Inlet Linearity Check

	Cal. Gas Value	Analyzer Response
High check	975.00	973.31
Zero check	0.00	-0.03

Slope	0.998297				
y-Intercept	-0.03			Cal Gas Value	5%
Predicted	233.272		TRUE	233.70	11.685
	499.818			500.70	25.035
Analyzer Response	227.15				
	494.52				
difference	6.1221				
	5.2975				
Cal ok?	Yes				
	Yes				

Method 25A Calibration
Outlet Linearity Check

	Cal. Gas Value	Analyzer Response
High check	50.09	50.15
Zero check	0	0.03

Slope	1.000599				
y-Intercept	0.03			**Cal Gas Value**	5%
Predicted	25.145		**TRUE**	25.10	1.255
	10.056			10.02	0.501
Analyzer Response	25.13				
	9.98				
difference	0.0150				
	0.0760				
Cal ok?	**Yes**				
	Yes				

Velocity Traverse Test Data

VELOCITY TRAVERSE CALCULATION SHEET

Client :	Denso Athens	Test I.D. :	Run 1	Console ID:	#2
Project Number :	184-566	Date:	10/30/218	Console ΔH@:	1.7556
Source :	South RTO Outlet	Test Team:	TC, RR	Console Y:	1.0067
				Pitot Tube ID:	PT-4-01

INPUT PARAMETERS

Stack Diameter:	32.00	inches
Barometric Pressure (Pb), in.Hg.:	29.87	in, Hg
Static Pressure:	0.11	in. H_2O
Avg. Percent CO2:	1.5	%
Avg. Percent O2:	19.8	%
Pitot Tube Coeffecent, (C_p):	0.840	
M4 Sample Volume :	44.160	Ft^3

CALCULATED INPUTS

Stack area, (A_s)	5.59	ft^2
Pressure in the stack, (P_s)	29.88	in Hg
Avg. Percent N2	78.7	%

Impinger Weights		
Initial	Final	Net Gain
777.1	779.3	2.2
709.9	710.8	0.9
600.6	601.0	0.4
868.9	876.6	7.7
2956.5	2967.7	11.2

Point No.	Delta P	√ΔP	ΔH	Stack Temp (F)	DGM Temp (F)
1	0.28	0.5292	1.50	68	50
2	0.29	0.5385		92	54
3	0.28	0.5292		138	58
4	0.24	0.4899		154	60
5	0.28	0.5292		87	62
6	0.29	0.5385		74	64
7	0.29	0.5385		69	
8	0.29	0.5385		68	
9	0.26	0.5099		77	
10	0.28	0.5292		91	
11	0.28	0.5292		119	
12	0.25	0.5000		137	
13	0.24	0.4899		115	
14	0.26	0.5099		88	
15	0.26	0.5099		77	
16	0.26	0.5099		73	
17		n/a			
16		n/a			
19		n/a			
20		n/a			
21		n/a			
22		n/a			
23		n/a			
24		n/a			
Average	**0.2706**	**0.5200**	**1.50**	**95.4**	**58.0**

MOISTURE CALCULATIONS

Volume of Water Collected

Vwstd = (Vl_c)(0.04707)

Vwstd = (11.2) * (0.04707)

Vwstd = 0.53 ft^3 0.527184

Volume of Gas Metered, Standard Conditions

Vmstd = 17.64*Vm*Y*(Pb+(ΔH / 13.6))/(Tm + 459.6)

Vmstd = (17.64) * (44.160) * (1.0067) * I17(29.87 + (1.50 / 13.6)) / (517.

Vmstd = 45.422 ft^3 45.27332814

Moisture Content

Bwo = Vwstd/(Vmstd + Vwstd)

Bwo = (0.53) / (45.27 + 0.53)

Bwo = 0.012 0.011510439

VELOCITY CALCULATIONS

Molecular Weight of the Dry Gas Stream

Md = (.44)(%CO_2) + (.32)(%O_2) + (.28)(%N_2)

Md = (0.44)*(1.50) + (0.32)*(19.80) + (0.28)*(78.70)

Md = 29.03 lb/lbmol 29.032

Molecular Weight of Stack Gas

Ms = (Md)(1 - Bwo) + 18(Bwo)

Ms = (29.03) * (1-0.012) + (18) * (0.012)

Ms = 28.91 lb/lbmol 28.91

Velocity of Stack Gas

Vs = 85.49 * 60 * Cp * $(\Delta P)^{0.5}$ * $[(Ts+460) / Ps / Ms]^{0.5}$

Vs = 85.49 * 60 *(0.84) * (0.5200) * sqrt {[(555.04) / (29.88) / (28.91)]}

Vs = 1,796.0 ft/min 1796.001422

Total Flow of Stack Gas

Qa = As * Vs

Qa = (5.5850) * (1,796.0)

Qa = 10,030.8 ACFM 10030.75574

Qs = Qa * 528 / Ts * Ps / 29.92

Qs = (10,030.8) * (528 / 555.0) * (29.88 / 29.92)

Qs = 9,528.8 SCFM 9528.761736

Qstd = Qs * (1 - Bwo)

Qstd = (9,528.8) * (1 - 0.012)

Qstd = 9,419.1 DSCFM 9419.081505

1686.481478

VELOCITY TRAVERSE TEST RESULTS

Stack Gas Temperature (°F)	95	Stack Velocity (ft/min)	1,796.0
Moisture Content (% Vol.)	1.15%	Gas Flow Rate (ACFM)	10,031
CO_2 (% Vol.)	1.5	Gas Flow Rate (SCFM)	9,529
O_2 (% Vol.)	19.8	Gas Flow Rate (DSCFM)	9,419

VELOCITY TRAVERSE CALCULATION SHEET

Client :	Denso Athens	Test I.D. :	Run 2	Console ID:	#2
Project Number :	184-566	Date:	10/30/218	Console ΔH@:	1.7556
Source :	South RTO Outlet	Test Team:	TC, RR	Console Y:	1.0067
				Pitot Tube ID:	PT-4-01

INPUT PARAMETERS

Stack Diameter:	32.00	inches
Barometric Pressure (Pb), in.Hg.:	29.87	in, Hg
Static Pressure:	0.11	in. H_2O
Avg. Percent CO2:	1.7	%
Avg. Percent O2:	19.7	%
Pitot Tube Coeffiecent, (C_p):	0.840	
M4 Sample Volume :	34.714	Ft^3

CALCULATED INPUTS

Stack area, (A_s)	5.59	ft^2
Pressure in the stack, (P_s)	29.88	in Hg
Avg. Percent N2	78.6	%

Impinger Weights		
Initial	Final	Net Gain
779.3	783.1	3.8
710.8	711.7	0.9
601.0	601.2	0.2
876.6	881.8	5.2
2967.7	2977.8	10.1

Point No.	Delta P	√ΔP	ΔH	Stack Temp (F)	DGM Temp (F)
1	0.19	0.4359	1.50	95	7
2	0.20	0.4472		97	72
3	0.19	0.4359		125	74
4	0.16	0.4000		155	76
5	0.15	0.3873		134	78
6	0.17	0.4123		98	79
7	0.16	0.4000		90	
8	0.16	0.4000		85	
9	0.16	0.4000		85	
10	0.19	0.4359		107	
11	0.17	0.4123		121	
12	0.15	0.3873		135	
13	0.17	0.4123		102	
14	0.19	0.4359		92	
15	0.20	0.4472		88	
16	0.21	0.4583		85	
17		n/a			
16		n/a			
19		n/a			
20		n/a			
21		n/a			
22		n/a			
23		n/a			
24		n/a			
Average	**0.1763**	**0.4192**	**1.50**	**105.9**	**64.3**

MOISTURE CALCULATIONS

Volume of Water Collected

Vwstd = $(Vl_0)(0.04707)$

Vwstd = (10.1) * (0.04707)

Vwstd = 0.48 ft^3 0.475407

Volume of Gas Metered, Standard Conditions

Vmstd = 17.64*Vm*Y*(Pb+(ΔH / 13.6))/(Tm + 459.6)

Vmstd = (17.64) * (34.714) * (1.0067) * I17(29.87 + (1.50 / 13.6)) / (523.9

Vmstd = 35.275 ft^3 35.15897893

Moisture Content

Bwo = Vwstd/(Vmstd + Vwstd)

Bwo = (0.48) / (35.16 + 0.48)

Bwo = 0.013 0.013341243

VELOCITY CALCULATIONS

Molecular Weight of the Dry Gas Stream

Md = $(.44)(\%CO_2) + (.32)(\%O_2) + (.28)(\%N_2)$

Md = (0.44)*(1.70) + (0.32)*(19.70) + (0.28)*(78.60)

Md = 29.06 lb/lbmol 29.06

Molecular Weight of Stack Gas

Ms = (Md)(1 - Bwo) + 18(Bwo)

Ms = (29.06) * (1-0.013) + (18) * (0.013)

Ms = 28.91 lb/lbmol 28.91

Velocity of Stack Gas

Vs = $85.49 * 60 * Cp * (\Delta P)^{0.5} * [(Ts+460) / Ps / Ms]^{0.5}$

Vs = 85.49 * 60 *(0.84) * (0.4192) * sqrt {[(565.48) / (29.88) / (28.91)]}

Vs = 1,461.5 ft/min 1461.477366

Total Flow of Stack Gas

Qa = As * Vs

Qa = (5.5850) * (1,461.5)

Qa = 8,162.4 ACFM 8162.42254

Qs = Qa * 528 / Ts * Ps / 29.92

Qs = (8,162.4) * (528 / 565.5) * (29.88 / 29.92)

Qs = 7,610.8 SCFM 7610.80864

Qstd = Qs * (1 - Bwo)

Qstd = (7,610.8) * (1 - 0.013)

Qstd = 7,509.3 DSCFM 7509.270992

1344.530933

VELOCITY TRAVERSE TEST RESULTS

Stack Gas Temperature (°F)	106	Stack Velocity (ft/min)	1,461.5
Moisture Content (% Vol.)	1.33%	Gas Flow Rate (ACFM)	8,162
CO_2 (% Vol.)	1.7	Gas Flow Rate (SCFM)	7,611
O_2 (% Vol.)	19.7	Gas Flow Rate (DSCFM)	7,509

VELOCITY TRAVERSE CALCULATION SHEET

Client :	Denso Athens	Test I.D. :	Run 3	Console ID:	#2
Project Number :	184-566	Date:	10/30/218	Console ΔH@:	1.7556
Source :	South RTO Outlet	Test Team:	TC, RR	Console Y:	1.0067
				Pitot Tube ID:	PT-4-01

INPUT PARAMETERS

Stack Diameter:	32.00	inches
Barometric Pressure (Pb), in.Hg.:	29.87	in, Hg
Static Pressure:	-0.05	in. H_2O
Avg. Percent CO2:	1.3	%
Avg. Percent O2:	20.3	%
Pitot Tube Coeffiecent, (C_p):	0.840	
M4 Sample Volume :	34.733	Ft^3

CALCULATED INPUTS

Stack area, (A_s)	5.59	ft^2
Pressure in the stack, (P_s)	29.87	in Hg
Avg. Percent N2	78.4	%

Impinger Weights		
Initial	Final	Net Gain
783.1	785.2	2.1
711.7	712.8	1.1
601.2	602.4	1.2
881.8	888.3	6.5
2977.8	2988.7	10.9

Point No.	Delta P	$\sqrt{\Delta P}$	ΔH	Stack Temp (F)	DGM Temp (F)
1	0.21	0.4583	1.50	88	75
2	0.24	0.4899		104	77
3	0.27	0.5196		133	77
4	0.25	0.5000		150	78
5	0.24	0.4899		127	78
6	0.27	0.5196		102	78
7	0.29	0.5385		97	
8	0.30	0.5477		92	
9	0.19	0.4359		99	
10	0.23	0.4796		107	
11	0.26	0.5099		141	
12	0.24	0.4899		160	
13	0.24	0.4899		133	
14	0.27	0.5196		114	
15	0.26	0.5099		101	
16	0.26	0.5099		98	
17		n/a			
16		n/a			
19		n/a			
20		n/a			
21		n/a			
22		n/a			
23		n/a			
24		n/a			
Average	**0.2513**	**0.5005**	**1.50**	**115.4**	**77.2**

MOISTURE CALCULATIONS

Volume of Water Collected

$Vwstd = (Vl_0)(0.04707)$

Vwstd = (10.9) * (0.04707)

Vwstd = 0.51 ft^3 0.513063

Volume of Gas Metered, Standard Conditions

Vmstd = 17.64*Vm*Y*(Pb+(ΔH / 13.6))/(Tm + 459.6)

Vmstd = (17.64) * (34.733) * (1.0067) * l17(29.87 + (1.50 / 13.6)) / (536.8

Vmstd = 34.450 ft^3 34.33716083

Moisture Content

Bwo = Vwstd/(Vmstd + Vwstd)

Bwo = (0.51) / (34.34 + 0.51)

Bwo = 0.015 0.014721943

VELOCITY CALCULATIONS

Molecular Weight of the Dry Gas Stream

$Md = (.44)(\%CO_2) + (.32)(\%O_2) + (.28)(\%N_2)$

Md = (0.44)*(1.30) + (0.32)*(20.30) + (0.28)*(78.40)

Md = 29.02 lb/lbmol 29.02

Molecular Weight of Stack Gas

Ms = (Md)(1 - Bwo) + 18(Bwo)

Ms = (29.02) * (1-0.015) + (18) * (0.015)

Ms = 28.86 lb/lbmol 28.86

Velocity of Stack Gas

$Vs = 85.49 * 60 * Cp * (\Delta P)^{0.5} * [(Ts+460) / Ps / Ms]^{0.5}$

Vs = 85.49 * 60 *(0.84) * (0.5005) * sqrt {[(574.98) / (29.87) / (28.86)]}

Vs = 1,761.4 ft/min 1761.401344

Total Flow of Stack Gas

Qa = As * Vs

Qa = (5.5850) * (1,761.4)

Qa = 9,837.5 ACFM 9837.512618

Qs = Qa * 528 / Ts * Ps / 29.92

Qs = (9,837.5) * (528 / 575.0) * (29.87 / 29.92)

Qs = 9,017.6 SCFM 9017.589038

Qstd = Qs * (1 - Bwo)

Qstd = (9,017.6) * (1 - 0.015)

Qstd = 8,884.8 DSCFM 8884.832609

1590.8245

VELOCITY TRAVERSE TEST RESULTS

Stack Gas Temperature (°F)	115	Stack Velocity (ft/min)	1,761.4
Moisture Content (% Vol.)	1.47%	Gas Flow Rate (ACFM)	9,838
CO_2 (% Vol.)	1.3	Gas Flow Rate (SCFM)	9,018
O_2 (% Vol.)	20.3	Gas Flow Rate (DSCFM)	8,885

GAS COMPOSITION TEST

Test Location	Denso Athens
Test Date:	10/30/2018
Project Number	184-566
Test Number	R1 Inlet

Note: Manual input only data marked in RED

INPUT PARAMETERS

Volume of water Collected, Vl_o (ml)	9.6	ml
Volume measured by dry gas meter (Vm), ft^3	42.85	ft^3
Delta H, in. H_2O	1.642	in. H_2O
Gamma	1.028	
Barometric Pressure (Pb), in. Hg.	29.87	in. Hg
Temperature of the meter box (Tm), °F	58.00	°F
Percent CO_2	0.9	%
Percent O_2	20.8	%
Percent CO	0.0	%
Percent N_2	78.3	%
Average Stack Temperature (T_s), °F	na	°F

Impinger Weights

	Initial	Final	Net Gain
	772.4	772.9	0.5
	741.6	742.4	0.8
	604.8	605.5	0.7
	866.8	874.4	7.6
Total	2985.6	2995.2	9.6

SAMPLING CALCULATIONS

Volume of Water Collected

Vwstd = (Vl0)(0.04707)

Vwstd = (9.6) * (0.04707)

Vwstd = 0.45 ft^3 0.451872

Volume of Gas Metered, Standard Conditions

Vmstd = 17.64*Vm*Y*(Pb+(ΔH / 13.6))/(Tm + 459.6)

Vmstd = ((17.65) * (42.85) * (29.87 + (1.6424/13.6)) * (1.0278) / (517.60)

Vmstd = 45.04 ft^3 45.01543253

Moisture Content

Bwo = Vwstd/(Vmstd + Vwstd)

Bwo = 0.45 / (45.02 + 0.45)

Bwo = 0.010 0.009938394

Molecular Weight of the Dry Gas Stream

Md = (.44)(%CO2) + (.32)(%O2) + (.28)(%CO +%N2)

Md = (0.44)*(0.90) + (0.32)*(20.80) + (0.28)*(78.30)

Md = 28.98 lb/lbmol 28.976

Molecular Weight of Stack Gas

Ms = (Md)(1-Bwo) + 18(Bwo)

Ms = (28.98) * (1-0.010) + (18) * (0.010)

Ms = 28.87 lb/lbmol 28.87

GAS COMPOSITION TEST RESULTS

Vol. Sampled at STP (ft^3)	45.02
Stack Gas Temperature (°F)	na
Moisture Content (% Vol)	0.99%
CO_2 Percent	0.9
O_2 Percent	20.8
CO Percent	0.0

GAS COMPOSITION TEST

Test Location	Denso Athens
Test Date:	10/30/2018
Project Number	184-566
Test Number	R2 Inlet

Note: Manual input only data marked in RED

INPUT PARAMETERS

Volume of water Collected, Vl_o (ml)	5.5	ml
Volume measured by dry gas meter (Vm), ft^3	33.77	ft^3
Delta H, in. H_2O	1.642	in. H_2O
Gamma	1.028	
Barometric Pressure (Pb), in. Hg.	29.87	in. Hg
Temperature of the meter box (Tm), °F	50.17	°F
Percent CO_2	0.9	%
Percent O_2	20.8	%
Percent CO	0.0	%
Percent N_2	78.3	%
Average Stack Temperature (T_s), °F	na	°F

Impinger Weights

	Initial	Final	Net Gain
	772.9	772.6	-0.3
	742.4	742.2	-0.2
	605.5	605.8	0.3
	874.4	880.1	5.7
Total	2995.2	3000.7	5.5

SAMPLING CALCULATIONS

Volume of Water Collected

Vwstd = (Vl0)(0.04707)

Vwstd = (5.5) * (0.04707)

Vwstd = 0.26 ft^3 0.258885

Volume of Gas Metered, Standard Conditions

Vmstd = 17.64*Vm*Y*(Pb+(ΔH / 13.6))/(Tm + 459.6)

Vmstd = ((17.65) * (33.77) * (29.87 + (1.6424/13.6)) * (1.0278) / (509.77)

Vmstd = 36.04 ft^3 36.02301679

Moisture Content

Bwo = Vwstd/(Vmstd + Vwstd)

Bwo = 0.26 / (36.02 + 0.26)

Bwo = 0.007 0.007135376

Molecular Weight of the Dry Gas Stream

Md = (.44)(%CO2) + (.32)(%O2) + (.28)(%CO +%N2)

Md = (0.44)*(0.90) + (0.32)*(20.80) + (0.28)*(78.30)

Md = 28.98 lb/lbmol 28.976

Molecular Weight of Stack Gas

Ms = (Md)(1-Bwo) + 18(Bwo)

Ms = (28.98) * (1-0.007) + (18) * (0.007)

Ms = 28.90 lb/lbmol 28.90

GAS COMPOSITION TEST RESULTS

Vol. Sampled at STP (ft^3)	36.02
Stack Gas Temperature (°F)	na
Moisture Content (% Vol)	0.71%
CO_2 Percent	0.9
O_2 Percent	20.8
CO Percent	0.0

GAS COMPOSITION TEST

Test Location	Denso Athens
Test Date:	10/30/2018
Project Number	184-566
Test Number	R3 Inlet

Note: Manual input only data marked in RED

INPUT PARAMETERS

Volume of water Collected, Vl_c (ml)	6.6	ml
Volume measured by dry gas meter (Vm), ft^3	34.18	ft^3
Delta H, in. H_2O	1.642	in. H_2O
Gamma	1.028	
Barometric Pressure (Pb), in. Hg.	29.87	in. Hg
Temperature of the meter box (Tm), °F	73.67	°F
Percent CO_2	1.0	%
Percent O_2	20.8	%
Percent CO	0.0	%
Percent N_2	78.2	%
Average Stack Temperature (T_s), °F	na	°F

Impinger Weights

	Initial	Final	Net Gain
	772.6	771.7	-0.9
	742.2	742.6	0.4
	605.8	606.7	0.9
	880.1	886.3	6.2
Total	3000.7	3007.3	6.6

SAMPLING CALCULATIONS

Volume of Water Collected

Vwstd = (Vl0)(0.04707)

Vwstd = (6.6) * (0.04707)

Vwstd = 0.31 ft^3 0.310662

Volume of Gas Metered, Standard Conditions

Vmstd = 17.64*Vm*Y*(Pb+(ΔH / 13.6))/(Tm + 459.6)

Vmstd = ((17.65) * (34.18) * (29.87 + (1.6424/13.6)) * (1.0278) / (533.27)

Vmstd = 34.87 ft^3 34.85259023

Moisture Content

Bwo = Vwstd/(Vmstd + Vwstd)

Bwo = 0.31 / (34.85 + 0.31)

Bwo = 0.009 0.008834848

Molecular Weight of the Dry Gas Stream

Md = (.44)(%CO2) + (.32)(%O2) + (.28)(%CO +%N2)

Md = (0.44)*(1.00) + (0.32)*(20.80) + (0.28)*(78.20)

Md = 28.99 lb/lbmol 28.992

Molecular Weight of Stack Gas

Ms = (Md)(1-Bwo) + 18(Bwo)

Ms = (28.99) * (1-0.009) + (18) * (0.009)

Ms = 28.89 lb/lbmol 28.89

GAS COMPOSITION TEST RESULTS

Vol. Sampled at STP (ft^3)	34.85
Stack Gas Temperature (°F)	na
Moisture Content (% Vol)	0.88%
CO_2 Percent	1.0
O_2 Percent	20.8
CO Percent	0.0

CEC

EPA M2/M4 DATA SHEET

Project Name: Denso Athens
Project No.: 184-556
Date: 10/30/2018

Test No.: 1
Location: Inlet
Personnel: R Raymond

Stack Dimensions: n/a
Barometric Pressure: 29.87 in. Hg
Static Pressure: ______ in. H_2O

South Unit Inlet

M2 Test Time : Start : ______ Stop : ______

VELOCITY TRAVERSE

TRAVERSE POINT	VELOCITY PRESSURE (ΔP)	STACK TEMP.
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
Average		

IMPINGER WEIGHTS

Impinger	Initial Wt.	Final Wt.	Total
1	772.4	772.9	
2	746.6	742.4	
3	604.8	605.5	
4	866.8	874.4	
Total			

PITOT LEAK CHECK (> 3")

INITIAL	(+) ✓ >3"	(-) ✓ >3"
FINAL	(+)	(-)

TRAIN LEAK CHECK (ft^3 @ in, Hg.)

INITIAL	0.0	@ 15"
FINAL	0.0	@ 7"

MOISTURE TRAIN

SAMPLING TIME Clock	Sample	DRY GAS METER	DGM TEMP.	LAST IMPINGER TEMP.	TRAIN VACUUM
1027	0	604.282	48	36	1.5
1037	10	612.82	54	38	1.5
1047	20	620.18	59	41	1.5
1057	30	626.47	61	42	1.5
1107	40	633.12	62	44	1.5
1117	50	640.12	64	46	1.5
1127	60	647.063			

M4 Sample Train I.D.: 1 O2%: 20.8 CO2%: .9
Control Console I.D.: 1 ΔH@: 1.6424 Y: 1.0278
Pitot Tube Type: S I.D. No.: ~~A4~~ Coefficient: ______
Manometer Type: Oil Incl. I.D. No.: ______
Thermometer Type: K I.D. No.: ______

NOTES: ______

EPA M2/M4 DATA SHEET

Project Name: Denso Athens
Project No.: 184-556
Date: 10-30-2018

Test No.: 2
Location: South unit inlet
Personnel: R Raymond

Stack Dimensions:
Barometric Pressure: 29.87 in. Hg
Static Pressure: in. H_2O

M2 Test Time : Start : Stop :

VELOCITY TRAVERSE

TRAVERSE POINT	VELOCITY PRESSURE (ΔP)	STACK TEMP.
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
Average		

IMPINGER WEIGHTS

Impinger	Initial Wt.	Final Wt.	Total
1	772.9	772.6	
2	742.4	742.2	
3	605.5	605.8	
4	874.4	880.1	
Total			

PITOT LEAK CHECK (> 3")

INITIAL	(+)	(-)
FINAL	(+)	(-)

TRAIN LEAK CHECK (ft^3 @ in, Hg.)

INITIAL	0.0	@ 15"
FINAL	0.0	@ 10"

MOISTURE TRAIN

SAMPLING TIME Clock	SAMPLING TIME Sample	DRY GAS METER	DGM TEMP.	LAST IMPINGER TEMP.	TRAIN VACUUM
1400	0	647.329	67	45	1.5
1410	10	653.04	69	45	1.5
1420	20	658.64	71	49	1.5
1430	30	664.24	73	53	1.5
1440	40	669.91	73	54	1.5
1450	50	675.52	74	55	1.5
1500	60	681.101			

M4 Sample Train I.D.: 2 O2%: 20.8 CO2%: .9
Control Console I.D.: 1 ΔH@: 1.6424 Y: 1.0278
Pitot Tube Type: S I.D. No.: ~~PT-02~~ Coefficient: .84
Manometer Type: Oil Incl. I.D. No.: 1
Thermometer Type: K I.D. No.: ~~PT-02~~

NOTES:

EPA M2/M4 DATA SHEET

Project Name: Denso Athens
Project No.: 184-556
Date: 10-30-2018

Test No.: 3
Location: South unit inlet
Personnel: R Raymond

Stack Dimensions: ________
Barometric Pressure: 29.87 in. Hg
Static Pressure: ________ in. H_2O

M2 Test Time : Start : ________ Stop : ________

VELOCITY TRAVERSE

TRAVERSE POINT	VELOCITY PRESSURE (ΔP)	STACK TEMP.
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
Average		

IMPINGER WEIGHTS

Impinger	Initial Wt.	Final Wt.	Total
1	772.6	771.7	
2	742.2	742.6	
3	605.8	606.7	
4	880.1	886.3	
Total			

PITOT LEAK CHECK (> 3")

INITIAL	(+)	(-)
FINAL	(+)	(-)

TRAIN LEAK CHECK (ft^3 @ in, Hg.)

INITIAL	0.0	@ 15"
FINAL	0.0	@ 8"

MOISTURE TRAIN

SAMPLING TIME Clock	Sample	DRY GAS METER	DGM TEMP.	LAST IMPINGER TEMP.	TRAIN VACUUM
1525	0	681.505	69	59	1.5
1535	10	687.11	72	47	1.5
1545	20	692.76	74	48	1.5
1555	30	698.49	75	50	1.5
1605	40	704.18	76	50	1.5
1615	50	709.92	76	49	1.5
1625	60	715.686			

M4 Sample Train I.D.: 3 O2%: 20.8 CO2%: 1.0
Control Console I.D.: 1 ΔH@: 1.6424 Y: 1.0278
Pitot Tube Type: S I.D. No.: ________ Coefficient: ________
Manometer Type: Oil Incl. I.D. No.: 1
Thermometer Type: K I.D. No.: ________

NOTES: ________

CEC

EPA M2/M4 DATA SHEET

South Unit

Project Name: Denso Athens
Project No.: 184-556
Date: 10-30-2018

Test No.: 1
Location: outlet
Personnel:

Stack Dimensions:
Barometric Pressure: 29.87 in. Hg
Static Pressure: +.11 in. H_2O

M2 Test Time : Start : 1040 Stop : 1046

VELOCITY TRAVERSE

TRAVERSE POINT	VELOCITY PRESSURE (ΔP)	STACK TEMP.
1	.28	68
2	.29	92
3	.28	138
4	.24	154
5	.28	87
6	.29	74
7	.29	69
8	.29	68
9	.26	77
10	.28	91
11	.28	119
12	.25	137
13	.24	115
14	.26	88
15	.26	77
16	.26	73
17		
18		
19		
20		
21		
22		
23		
24		
Average		

IMPINGER WEIGHTS

Impinger	Initial Wt.	Final Wt.	Total
1	777.1	779.3	
2	709.9	710.8	
3	600.6	601.0	
4	868.9	876.6	
Total			

PITOT LEAK CHECK (> 3")

	(+)	(-)
INITIAL	✓ >3"	
FINAL	✓ >3"	

TRAIN LEAK CHECK (ft^3 @ In, Hg.)

INITIAL	0.0	@ 15"
FINAL	0.0	@ 6"

MOISTURE TRAIN

SAMPLING TIME Clock	SAMPLING TIME Sample	DRY GAS METER	DGM TEMP.	LAST IMPINGER TEMP.	TRAIN VACUUM
1027	0	499.389	50	40	1.5
1037	10	508.15	54	39	1.5
1047	20	514.98	58	43	1.5
1057	30	522.20	60	45	1.5
1107	40	529.31	62	47	1.5
1117	50	536.47	64	48	1.5
1127	60	543.549			

M4 Sample Train I.D.: 1
Control Console I.D.: 2
Pitot Tube Type: S
Manometer Type: Oil Incl.
Thermometer Type: K

O2%: 19.8% CO2%: 1.5%
ΔH@: 1.7556 Y: 1.0067
I.D. No.: PT4-01 Coefficient: .84
I.D. No.: /
I.D. No.: PT4-01

NOTES:

EPA M2/M4 DATA SHEET

Project Name: Denso Athens
Project No.: 184-556
Date: 10-30-2018
M2 Test Time :

Test No.: 2
Location: South unit outlet
Personnel: R Raymond, T Currier
Start : 1359 Stop : 1404

Stack Dimensions:
Barometric Pressure: 29.87 in. Hg
Static Pressure: +.11 in. H_2O

VELOCITY TRAVERSE		
TRAVERSE POINT	VELOCITY PRESSURE (ΔP)	STACK TEMP.
1	.19	95
2	.20	97
3	.19	125
4	.16	155
5	.15	134
6	.17	98
7	.16	90
8	.16	85
9	.16	85
10	.19	107
11	.17	121
12	.15	135
13	.17	102
14	.19	92
15	.20	88
16	.21	85
17		
18		
19		
20		
21		
22		
23		
24		
Average		

IMPINGER WEIGHTS			
Impinger	Initial Wt.	Final Wt.	Total
1	779.3	783.1	
2	710.9	711.7	
3	601.0	601.2	
4	876.6	881.8	
Total			

PITOT LEAK CHECK (> 3")		
INITIAL	(+)	(-)
FINAL	(+)	(-)

TRAIN LEAK CHECK (ft³ @ in, Hg.)			
INITIAL	0.0	@	15"
FINAL	0.0	@	7"

MOISTURE TRAIN					
SAMPLING TIME Clock	Sample	DRY GAS METER	DGM TEMP.	LAST IMPINGER TEMP.	TRAIN VACUUM
1400	0	543.825	71	50	1.5
1410	10	549.74	72	46	1.5
1420	20	555.47	74	50	1.5
1430	30	581.23	76	52	1.5
1440	40	586.98	78	53	1.5
1450	50	572.74	79	54	1.5
1500	60	578.539			

M4 Sample Train I.D. : 2 O2%: 19.7% CO2%: 1.7%
Control Console I.D.: 2 ΔH@: 1.7556 Y: 1.0067
Pitot Tube Type: S I.D. No.: PT4-01 Coefficient: .84
Manometer Type: Oil Incl. I.D. No.: PT4-01
Thermometer Type: K I.D. No.: 1

NOTES:

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EPA M2/M4 DATA SHEET

Project Name: Denso Athens
Project No.: 184-556
Date: 10-30-2018

Test No.: 3
Location: South unit outlet
Personnel: R Raymond, T Currier

Stack Dimensions:
Barometric Pressure: 29.87 in. Hg
Static Pressure: -.05 in. H_2O

M2 Test Time : Start : 1526 Stop : 1532

VELOCITY TRAVERSE		
TRAVERSE POINT	VELOCITY PRESSURE (ΔP)	STACK TEMP.
1	.21	88
2	.24	104
3	.27	133
4	.25	150
5	.24	127
6	.27	102
7	.29	97
8	.30	92
9	.19	99
10	.23	107
11	.26	141
12	.24	160
13	.24	133
14	.27	114
15	.26	101
16	.26	98
17		
18		
19		
20		
21		
22		
23		
24		
Average		

IMPINGER WEIGHTS			
Impinger	Initial Wt.	Final Wt.	Total
1	783.1	785.2	
2	711.7	712.8	
3	601.2	602.4	
4	881.8	888.3	
Total			

PITOT LEAK CHECK (> 3")		
INITIAL	(+)	(-)
FINAL	(+)	(-)
TRAIN LEAK CHECK (ft³ @ in, Hg.)		
INITIAL	0.0	@ 15"
FINAL	0.0	@ 8"

MOISTURE TRAIN					
SAMPLING TIME Clock	Sample	DRY GAS METER	DGM TEMP.	LAST IMPINGER TEMP.	TRAIN VACUUM
1525	0	578.824	75	56	1.5
1535	10	584.81	77	48	1.5
1545	20	590.62	77	49	1.5
1555	30	596.38	78	51	1.5
1605	40	602.08	78	52	1.5
1615	50	607.83	78	53	1.5
1625	60	613.552			

M4 Sample Train I.D.: 3
O2%: 20.3%
CO2%: 1.3%
Control Console I.D.: 2
ΔH@: 1.7556
Y: 1.0067
Pitot Tube Type: S
I.D. No.: PT-4-01
Coefficient: .84
Manometer Type: Oil Incl.
I.D. No.: 2
Thermometer Type: K
I.D. No.: PT-4-01

NOTES:

CEC

VELOCITY TRAVERSE DATA SHEET

Project Name: Denso Athens

Project No.: 184-556

Date: 10-30-2018

Test No.: Flow #4

Location: South unit outlet

Personnel: R Raymond, T Currier

M2 Test Time : Start : 1621 Stop : 1626

VELOCITY TRAVERSE			
TRAVERSE POINT	VELOCITY PRESSURE (ΔP)	STACK TEMPERATURE	CYCLONIC FLOW CHECK
1	.27	94	
2	.32	102	
3	.31	114	
4	.27	136	
1	.27	140	
2	.29	117	
3	.32	101	
4	.33	94	
1	.23	103	
2	.27	102	
3	.29	112	
4	.28	131	
1	.27	140	
2	.28	124	
3	.28	109	
4	.28	101	
Average			

Stack Dimensions: ____

Barometric Pressure: 29.87 in. Hg

Static Pressure: - .05 in. H_2O

O2%: ____

CO2%: ____

PITOT LEAK CHECK (> 3")		
INITIAL	(+)	(-)
FINAL	(+)	(-)

Pitot I.D. No.: PT4-01

T/C I.D. No.: PT4-01

T/C Readout I.D. No.: ____

NOTES:

Response Time

RESPONSE TIME TEST

Date of Test:	**October 30, 2018**
Facility / Location	**Denso Athens**
Analyzer Type:	**THC Outlet**
Span Gas Concentration:	**233.7**
Analyzer Span Setting:	**1000**

UPSCALE RESPONSE			
	Start	**95% Response**	**Time (sec)**
1	0.0	222.0	36.5
2	0.0	222.0	36.0
3	0.0	222.0	36.3
Average Upscale Response			**36.3**

DOWNSCALE RESPONSE			
	Start	**95% Response**	**Time (sec)**
1	222.0	11.7	35.2
2	222.0	11.7	35.3
3	222.0	11.7	35.5
Average Downscale Response			**35.3**

UPSCALE RESPONSE = Time required to reach 95% of stable reading shifting from stable zero to stack gas.

DOWNSCALE RESPONSE = Time required to reach 95% of stable reading shifting from stable high-level cal to stack gas.

RESPONSE TIME = The longer of the two mean times.

RESPONSE TIME TEST

Date of Test:	**October 30, 2018**
Facility / Location	**Denso Athens**
Analyzer Type:	**THC Inlet**
Span Gas Concentration:	**500.7**
Analyzer Span Setting:	**1000**

UPSCALE RESPONSE			
	Start	95% Response	Time (sec)
1	0.0	475.7	32.4
2	0.0	475.7	32.6
3	0.0	475.7	32.1
Average Upscale Response			**32.4**

DOWNSCALE RESPONSE			
	Start	95% Response	Time (sec)
1	475.7	25.0	32.9
2	475.7	25.0	32.6
3	475.7	25.0	32.7
Average Downscale Response			**32.7**

UPSCALE RESPONSE = Time required to reach 95% of stable reading shifting from stable zero to stack gas.

DOWNSCALE RESPONSE = Time required to reach 95% of stable reading shifting from stable high-level cal to stack gas.

RESPONSE TIME = The longer of the two mean times.

Project Field Notes

Project Field Notes

CEC
Civil & Environmental Consultants, Inc.

Prepared By T. Greggs Date 10 / 30 / 18 Checked By ______ Date / /

Project Denso Athens Project Number ______

Subject THC Calibrations Sheet 1 of 2 Sheets

~~outlet~~

	Time	THC out	THC in
Zero	735	0.03	
High	738	50.15	
mid	741	25.13	
low	744	9.98	
zero	747		-0.03
High	753		973.31
mid	756		494.52
low	802		227.15

EB0065494 - 233.7
CC89356 - 500.7
EB0065408 - 975.0
XC032387 - 10.02
XC021249 - 25.10
CC400426 - 50.09

System Bias

	Time	THC out	THC in
Zero	846		1.24
mid	850		~~486.66~~ 489.43
Zero	857	0.38	
mid	900	25.20	

R1 @ 1020 start 1130 end
~~to~~ unit fan shut down for just a short period 1020 - 1021

~~Sy~~ Bias

	Time	THC out	THC in
Zero	1135	0.81	
mid	1139	25.18	
Zero	1150		2.73
mid	1155		494.31

outlet
linerozation check
1143 / 227.3

Recalibrate outlet to 0-500

	Time	THC out
zero	1311	0.47
High	1314	500.27
mid	1317	233.33
Low	1320	49.19

Project Field Notes

Civil & Environmental Consultants, Inc.

Prepared By T. Gregg Date 10/30/18 Checked By Date / /

Project Denso Athens Project Number

Subject THC Calibrations Sheet 2 of 2 Sheets

R2 @ 1400-1459

	Time	THC out	THC in
Zero	1502	-0.20	
THC	1505	48.95	
THC	1509	24.96	
THC	1514		2.61
THC	1519		223.53

R3 @ 1525-1624

	Time	THC out	THC in
Zero	1630		2.06
THC	1633		219.61
THC	1637	-1.03	
THC	1641	47.68	
THC	1644	24.59	

APPENDIX B

Equipment Calibrations

THERMOCOUPLE READOUT CALIBRATION DATA FORM
(FOR K-TYPE THERMOCOUPLES)

Control Box / Thermocouple Readout Number: Box 2 Calibrated By: R.Raymond

Ambient Temperature: 72 °F Date: 9/17/2018

Omega Engineering Calibrator Model No. 3307T-K Serial #'s 9508079

Primary Standards Directly Traceable to the National Institute of Standards and Technology (NIST).

Reference[a] Source Temperature, (°F)	Test Thermometer Temperature, (°F)	Temperature Difference, %
0	1	0.22
200	201	0.15
400	398	0.23
600	600	0.00
1000	1000	0.00
1200	1198	0.12

Are all the Thermocouple Readout calibration points within calibration standard of <= to 1.5 %? Yes

$$\frac{\text{(Ref. Temp., oF + 460) - (Test Therm. Temp., oF + 460)}}{\text{Ref. Temp., oF + 460}} * 100 <= 1.5\ \%$$

Calibrator Signature: [signature] Date: 9-17-2018

Approval Signature: [signature] Date: 9-17-2018

CEC

DRY GAS METER CALIBRATION SPREADSHEET

CONTROL BOX ID:		Box 2		CALIBRATED BY:		R. Raymond
CALIBRATION STANDARD:		Standard		AMBIENT TEMPERATURE (F):		72
CALIBRATION STANDARD ID:		543569		AMBIENT PRESSURE (In Hg):		28.84
DATE CALIBRATED:		9/17/2018		Wet Test Meter		1.00
			GAS VOLUME			
Setting Control Console (delta H)	Gas Volume Metered (liters) Standard Starting Reading	Gas Volume Metered (liters) Standard Ending Reading	Gas Volume Corrected (ft3) Vw	Gas Volume DGM (ft3) Control Console Starting Reading	Gas Volume DGM (ft3) Control Console Ending Reading	Gas Volume DGM (ft3) Control Console Vd
0.5	120000	120150	5.297	467.076	472.35	5.274
1.0	120150	120300	5.297	472.35	477.635	5.285
2.0	120300	120600	10.594	477.635	488.272	10.637
3.0	120600	120900	10.594	488.272	498.932	10.660
			TEMPERATURE			
Calibrator Starting Temperature (C)	Calibrator Ending Temperature (C)	Calibrator Average Temperature Tw (F)	DGM Starting Temperature (F)	DGM Ending Temperature (F)	DGM Average Temperature Td (F)	
24.0	24.2	77.8	80	82	81.0	
24.2	24.3	78.1	82	84	83.0	
24.3	24.4	78.3	84	87	85.5	
24.4	24.5	78.5	87	90	88.5	

Time (min)	Gamma (Y)	Delta H@
13.16	1.0091	1.8133
9.14	1.0089	1.7448
13.05	1.0043	1.7716
10.44	1.0047	1.6926
	Avg Y	**Avg Delta H@**
	1.0067	**1.7556**
Tolerances	0.9867 1.0267	1.5556 1.9556

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values +/- 0.02 from average.

Delta H @ = Orfice pressure differential that equates to 0.75 cfm of air @ 68 degrees F and 29.92 inches of mercury, in.H2O: tolerance for individual values +/- 0.20 from average.

Is Unit Within Calibration Tolerances? **YES**

Calibrator: [signature] Date: 9-17-2018

Approved by: [signature] Date: 9-17-2018

CEC

DRY GAS METER CALIBRATION SPREADSHEET

CONTROL BOX ID:	Box 2	CALIBRATED BY:	R. Raymond
CALIBRATION STANDARD:	Standard	AMBIENT TEMPERATURE (F):	70
CALIBRATION STANDARD ID:	543569	AMBIENT PRESSURE (In Hg):	28.69
DATE CALIBRATED:	11/1/2018	Wet Test Meter	1.00

GAS VOLUME

Setting Control Console (delta H)	Gas Volume Metered (liters) Standard Starting Reading	Gas Volume Metered (liters) Standard Ending Reading	Gas Volume Corrected (ft3) Vw	Gas Volume DGM (ft3) Control Console Starting Reading	Gas Volume DGM (ft3) Control Console Ending Reading	Gas Volume DGM (ft3) Control Console Vd
0.5	124600	124750	5.297	624.542	629.836	5.294
1.0	124750	124900	5.297	629.836	635.137	5.301
2.0	124900	125200	10.594	635.137	645.788	10.651
3.0	125200	125500	10.594	645.788	656 472	10.684

TEMPERATURE

Calibrator Starting Temperature (C)	Calibrator Ending Temperature (C)	Calibrator Average Temperature Tw (F)	DGM Starting Temperature (F)	DGM Ending Temperature (F)	DGM Average Temperature Td (F)
22.8	22.9	75.4	74	75	74.5
22.9	22 9	75.5	75	77	76.0
22.9	22.8	75.4	77	81	79.0
22.8	22.8	75.3	81	82	81.5

Time (min)	Gamma (Y)	Delta H@
13.22	0.9976	1.8454
9.19	0.9976	1.7793
12.53	0.9962	1.6440
10.39	0.9954	1.6872
	Avg Y	**Avg Delta H@**
	0.9967	**1.7390**
Tolerances	0.9767 1.0167	1.5390 1.9390

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values +/- 0.02 from average.

Delta H @ = Orifice pressure differential that equates to 0.75 cfm of air @ 68 degrees F and 29.92 inches of mercury, in.H2O: tolerance for individual values +/- 0.20 from average.

Is Unit Within Calibration Tolerances? **YES**

Calibrator: [signature] Date: 11-1-2018

Approved by: Todd Gregg Date: 11/1/2018

THERMOCOUPLE READOUT CALIBRATION DATA FORM
(FOR K-TYPE THERMOCOUPLES)

Control Box / Thermocouple Readout Number: Box 1

Calibrated By: R.Raymond

Ambient Temperature: 70 °F

Date: 11/1/2018

Omega Engineering Calibrator Model No. 3307T-K

Serial #'s 9508079

Primary Standards Directly Traceable to the National Institute of Standards and Technology (NIST).

Reference[a] Source Temperature, (°F)	Test Thermometer Temperature, (°F)	Temperature Difference, %
0	-2	0.43
200	198	0.30
400	394	0.70
600	597	0.28
1000	999	0.07
1200	1197	0.18

Are all the Thermocouple Readout calibration points within calibration standard of <= to 1.5 %? Yes

$$\frac{(\text{Ref. Temp., oF} + 460) - (\text{Test Therm. Temp., oF} + 460)}{\text{Ref. Temp., oF} + 460} * 100 <= 1.5\ \%$$

Calibrator Signature: [signature] Date: 11/1/2018

Approval Signature: [signature] Date: 11/1/18

CEC

DRY GAS METER CALIBRATION SPREADSHEET

CONTROL BOX ID:		Box 1		CALIBRATED BY:		R Raymond
CALIBRATION STANDARD:		Standard		AMBIENT TEMPERATURE (F):		70
CALIBRATION STANDARD ID:		543569		AMBIENT PRESSURE (In Hg):		28.72
DATE CALIBRATED:		11/1/2018		Wet Test Meter		1.00
GAS VOLUME						
Setting Control Console (delta H)	Gas Volume Metered (liters) Standard Starting Reading	Gas Volume Metered (liters) Standard Ending Reading	Gas Volume Corrected (ft3) Vw	Gas Volume DGM (ft3) Control Console Starting Reading	Gas Volume DGM (ft3) Control Console Ending Reading	Gas Volume DGM (ft3) Control Console Vd
0.5	123700	123850	5.297	735.332	740.621	5.289
1.0	123850	124000	5.297	740.621	745.914	5.293
2.0	124000	124300	10.594	745.914	756.552	10.638
3.0	124300	124600	10.594	756.552	767.239	10.687
TEMPERATURE						
Calibrator Starting Temperature (C)	Calibrator Ending Temperature (C)	Calibrator Average Temperature Tw (F)	DGM Starting Temperature (F)	DGM Ending Temperature (F)	DGM Average Temperature Td (F)	
21.9	22	71.5	71	72	71.5	
22.0	22.1	71.7	72	74	73.0	
22.1	22.2	71.9	74	77	75.5	
22.2	22.2	72.0	77	80	78.5	
CALCULATIONS						
Time (min)	Gamma (Y)		Delta H@			
13.17	1.0003		1.8132			
9.20	1.0007		1.7658			
13.07	0.9976		1.7748			
10.37	0.9959		1.6671			
	Avg Y		Avg Delta H@			
	0.9986		**1.7552**			
Tolerances	0.9786 1.0186		1.5552 1.9552			

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values +/- 0.02 from average.

Delta H @ = Orifice pressure differential that equates to 0.75 cfm of air @ 68 degrees F and 29.92 inches of mercury, in.H2O; tolerance for individual values +/- 0.20 from average.

Is Unit Within Calibration Tolerances? **YES**

Calibrator: [signature] Date: 11/1/2018

Approved by: [signature] Date: 11/1/18

THERMOCOUPLE READOUT CALIBRATION DATA FORM
(FOR K-TYPE THERMOCOUPLES)

Control Box / Thermocouple Readout Number: 1 | Calibrated By: TC

Ambient Temperature: 71 °F | Date: 7/10/2018

Omega Engineering Calibrator Model No. 22 | Serial #'s 9508079

Primary Standards Directly Traceable t National Institute of Standards and Technology (NIST)

Reference[a] Source Temperature, (°F)	**Test Thermometer Temperature, (°F)**	**Temperature Difference, %**
0	0	0.00
200	200	0.00
400	396	0.47
600	599	0.09
1000	1000	0.00
1200	1198	0.12

Are all the Thermocouple Readout calibration points within calibration standard of <= to 1.5 %? **Yes**

$$\frac{(\text{Ref. Temp., oF} + 460) - (\text{Test Therm. Temp., oF} + 460)}{\text{Ref. Temp., oF} + 460} * 100 <= 1.5\ \%$$

Calibrator Signature: [signature] Date: 7/10/2018

Approval Signature: [signature] Date: 7/10/18

CEC

DRY GAS METER CALIBRATION SPREADSHEET

CONTROL BOX ID:	1	CALIBRATED BY:	TC
CALIBRATION STANDARD:	Standard	AMBIENT TEMPERATURE (F):	71
CALIBRATION STANDARD ID:	543569	AMBIENT PRESSURE (In Hg):	30.14
DATE CALIBRATED:	7/10/2018	Wet Test Meter	1.00

GAS VOLUME

Setting Control Console (delta H)	Gas Volume Metered (liters) Standard Starting Reading	Gas Volume Metered (liters) Standard Ending Reading	Gas Volume Corrected (ft3) Vw	Gas Volume DGM (ft3) Control Console Starting Reading	Gas Volume DGM (ft3) Control Console Ending Reading	Gas Volume DGM (ft3) Control Console Vd
0.5	116610	116760	5.297	329.178	334.329	5.151
1.0	115850	116005	5.474	302.945	308.24	5.295
2.0	116005	116305	10.594	308.24	318.575	10.335
3.0	116305	116610	10.771	318.575	329.178	10.603

TEMPERATURE

Calibrator Starting Temperature (C)	Calibrator Ending Temperature (C)	Calibrator Average Temperature Tw (F)	DGM Starting Temperature (F)	DGM Ending Temperature (F)	DGM Average Temperature Td (F)
22.8	22.9	73.1	77	76	76.5
22.8	22.8	73.0	70	73	71.5
22.8	22.8	73.0	73	79	76.0
22.8	22.7	73.0	79	83	81.0

Time (min)	Gamma (Y)	Delta H@
13.20	1.0336	1.7300
9.22	1.0283	1.5952
13.07	1.0258	1.6971
10.41	1.0237	1.5474
	Avg Y	**Avg Delta H@**
	1.0278	**1.6424**
Tolerances	1.0078 1.0478	1.4424 1.8424

Y = Ratio of reading of wet test meter to dry test meter; tolerance for individual values +/- 0.02 from average.

Delta H @ = Orifice pressure differential that equates to 0.75 cfm of air @ 68 degrees F and 29.92 inches of mercury, in.H2O; tolerance for individual values +/- 0.20 from average.

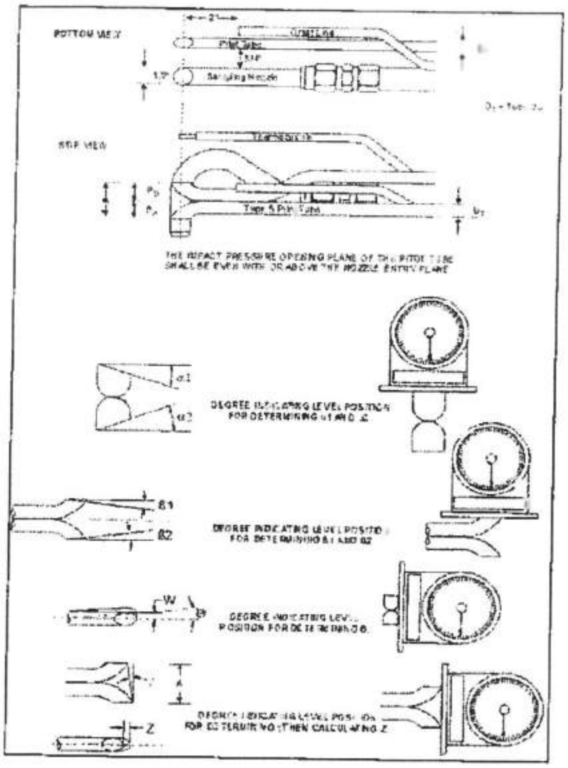
Is Unit Within Calibration Tolerances? **YES**

Calibrator: [signature] Date: 7/10/2018

Approved by: [signature] Date: 7/10/18

APEX SOURCE TESTING EQUIPMENT INSTRUMENTS

Type S Pitot Tube Inspection Form



PITOT TUBE/PROBE # 8350 PT 4-01

Parameter	Value	Allowable Range	Check
Assembly Level?	yes	Yes	OK
Ports Damaged?	no	No	OK
$\alpha 1$	0	$-10° < \alpha 1 < +10°$	OK
$\alpha 2$	0	$-10° < \alpha 2 < +10°$	OK
1	0	$-5° < b1 < +5°$	OK
1	1	$-5° < \beta 2 < +5°$	OK
γ	1		
0	0		
$Z = A \tan \gamma$	0.000	$Z \leq .125"$	OK
$W = A \tan \theta$	0.000	$W \leq .031"$	OK
Dt	0.375	.188" to .375"	OK
A/2Dt	1.210667	$1.05 \leq P_A/D_t \leq 1.5$	OK
A	0.908	$2.1D_t \leq A \leq 3D_t$	OK

Certification

I certify that pitot tube/probe number 8350 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube certification factor of 0.84. See 40 CFR Pt. 60, App. A, EPA Method 2.

Certified by: [signature] 9-5-18
Personnel (Signature/Date)

Calibration Gas Certificates

Airgas

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Airgas Specialty Gases
12722 South Wentworth Avenue
Chicago, IL 60628
(773) 785-3000 Fax: (773) 785-1928
Airgas.com

Part Number:	E02AI99E15A1224	Reference Number:	54-124483488-1
Cylinder Number:	EB0065494	Cylinder Volume:	146.2 CF
Laboratory:	ASG - Chicago - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12015	Valve Outlet:	590
Gas Code:	PPN,BALA	Certification Date:	Apr 06, 2015

Expiration Date: Apr 06, 2023

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
PROPANE	225.0 PPM	233.7 PPM	G1	+/- 0.7% NIST Traceable	04/06/2015
AIR	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	08061116	CC262367	249.1 PPM PROPANE/AIR	+/- 0.6%	Jun 22, 2018

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801332	FTIR	Mar 08, 2015

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E02AI99E15A0332	Reference Number:	54-124625632-1
Cylinder Number:	CC89356	Cylinder Volume:	146.3 CF
Laboratory:	124 - Chicago - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12017	Valve Outlet:	590
Gas Code:	PPN,BALA	Certification Date:	Jun 23, 2017

Expiration Date: Jun 23, 2025

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
PROPANE	500.0 PPM	500.7 PPM	G1	+/- 0.7% NIST Traceable	06/23/2017
AIR	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	10060532	CC281503	495.3 PPM PROPANE/AIR	+/- 0.5%	Jan 06, 2022

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801332	FTIR	Jun 21, 2017

Triad Data Available Upon Request

Approved for Release

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E02AI99E15A1484	Reference Number:	54-124483485-1
Cylinder Number:	EB0065408	Cylinder Volume:	146.3 CF
Laboratory:	ASG - Chicago - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12015	Valve Outlet:	590
Gas Code:	PPN,BALA	Certification Date:	Apr 06, 2015

Expiration Date: Apr 06, 2023

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
PROPANE	950.0 PPM	975.0 PPM	G1	+/- 0.8% NIST Traceable	04/06/2015
AIR	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	11060908	CC343401	1000.3 PPM PROPANE/NITROGEN	+/- 0.7%	Mar 04, 2017

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801332	FTIR	Mar 08, 2015

Triad Data Available Upon Request

Signature on file

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E02AI99E15A1734	Reference Number:	54-124614982-2
Cylinder Number:	XC032387B	Cylinder Volume:	146.2 CF
Laboratory:	124 - Chicago - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12017	Valve Outlet:	590
Gas Code:	PPN,BALA	Certification Date:	May 05, 2017

Expiration Date: May 05, 2025

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
PROPANE	10.00 PPM	10.02 PPM	G1	+/- 0.7% NIST Traceable	05/05/2017
AIR	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	10061440	CC316745	9.93 PPM PROPANE/AIR	+/- 0.6%	Jun 29, 2022

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801332	FTIR	Apr 21, 2017

Triad Data Available Upon Request

Approved for Release

Airgas
an Air Liquide company

Airgas Specialty Gases
Airgas USA, LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS
Grade of Product: EPA Protocol

Part Number:	E02AI99E15A0557	Reference Number:	54-124626508-1
Cylinder Number:	XC021249B	Cylinder Volume:	146.2 CF
Laboratory:	124 - Chicago - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12017	Valve Outlet:	590
Gas Code:	PPN,BALA	Certification Date:	Jul 05, 2017

Expiration Date: Jul 05, 2025

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
PROPANE	25.00 PPM	25.10 PPM	G1	+/- 0.8% NIST Traceable	07/05/2017
AIR	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	16061113	EB0081680	50.06 PPM PROPANE/AIR	+/- 0.4%	Jul 26, 2022

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801332	FTIR	Jun 21, 2017

Triad Data Available Upon Request

Approved for Release

Airgas.
an Air Liquide company

Airgas USA, LLC
12722 S. Wentworth Ave.
Chicago, IL 60628
Airgas.com

CERTIFICATE OF ANALYSIS

Grade of Product: EPA Protocol

Part Number:	E02AI99E15A0456	Reference Number:	54-124626503-1
Cylinder Number:	CC400426	Cylinder Volume:	146.2 CF
Laboratory:	124 - Chicago - IL	Cylinder Pressure:	2015 PSIG
PGVP Number:	B12017	Valve Outlet:	590
Gas Code:	PPN,BALA	Certification Date:	Jun 30, 2017

Expiration Date: Jun 30, 2025

Certification performed in accordance with "EPA Traceability Protocol for Assay and Certification of Gaseous Calibration Standards (May 2012)" document EPA 600/R-12/531, using the assay procedures listed. Analytical Methodology does not require correction for analytical interference. This cylinder has a total analytical uncertainty as stated below with a confidence level of 95%. There are no significant impurities which affect the use of this calibration mixture. All concentrations are on a volume/volume basis unless otherwise noted.

Do Not Use This Cylinder below 100 psig, i.e. 0.7 megapascals.

ANALYTICAL RESULTS

Component	Requested Concentration	Actual Concentration	Protocol Method	Total Relative Uncertainty	Assay Dates
PROPANE	50.00 PPM	50.09 PPM	G1	+/- 0.8% NIST Traceable	06/30/2017
AIR	Balance				

CALIBRATION STANDARDS

Type	Lot ID	Cylinder No	Concentration	Uncertainty	Expiration Date
NTRM	16061113	EB0081680	50.06 PPM PROPANE/AIR	+/- 0.4%	Jul 26, 2022

ANALYTICAL EQUIPMENT

Instrument/Make/Model	Analytical Principle	Last Multipoint Calibration
Nicolet 6700 AHR0801332	FTIR	Jun 21, 2017

Triad Data Available Upon Request

Approved for Release

STACK TESTING ACCREDITATION COUNCIL

American Association for Laboratory Accreditation

Accredited Air Emission Testing Body

A2LA has accredited

CIVIL AND ENVIRONMENTAL CONSULTANTS, INC. (CEC)

In recognition of the successful completion of the joint A2LA and Stack Testing Accreditation Council (STAC) evaluation process, this laboratory is accredited to perform testing activities in compliance with ASTM D7036:2004 - Standard Practice for Competence of Air Emission Testing Bodies.

Presented this 20th day of December 2017.

President and CEO
For the Accreditation Council
Certificate Number 3913.01
Valid to November 30, 2019

This accreditation program is not included under the A2LA ILAC Mutual Recognition Arrangement.