TABLE OF CONTENTS

1.0 INTRODUCTION

TRC Environmental Corporation (TRC) performed an emissions compliance test program on EUTURBINE1, EUTURBINE2, EUDUCTBURNER1, and EUDUCTBURNER2 at the USG-Otsego Facility of USG-Otsego Paper, Inc. in Otsego, Michigan on June 4 through 6, 2019. The tests were authorized by and performed for USG-Otsego Paper, Inc.

The purpose of this test program was to determine emissions of nitrogen oxides (NOx), carbon monoxide (CO), oxygen (O_2) and volatile organic compounds (VOC). Complete test sets were performed at each turbine/duct burner group with duct burners off (CT emissions) and duct burners on (worst case duct burner emissions). Duct burners at the Otsego facility do not fire without the associated CT in operation. This test program was performed to demonstrate compliance with Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) No. MI-ROP-A0023-2013 and the CAIR Ozone Nitrogen Oxide Budget Permit No. MI-NOO-55799-2013 in Appendix 9 of the ROP. The test program was conducted according to the TRC Test Protocol 326438B dated March 18, 2019.

1.1 Project Contact Information

Participants		
Test Facility	USG-Otsego Paper, Inc. USG-Otsego Facility 320 N. Farmer Street Otsego, Michigan 49078	Franklin Knowles Environmental Compliance Supervisor 269-384-6351 (phone) fkonowles@usg.com
Air Emissions Testing Body (AETB)	TRC Environmental Corporation 7521 Brush Hill Road Burr Ridge, Illinois 60527	Gavin Lewis Project Manager 312-533-2025 (phone) glewis@trccompanies.com
State Representative	MDEQ – Air Quality Division 120 West Chapin Street Cadillac, Michigan 49601-2158	Jeremy Howe Environmental Quality Analyst Air Quality Division/Cadillac Distric Office 231-878-6687 (phone) howej1@michigan.gov

The tests were coordinated through Franklin Knowles, Environmental Compliance Supervisor, of Otsego Paper and conducted by Bill Harris, Rome Rothgeb and Chris Miller of TRC. Documentation of the on-site ASTM D7036-04 Qualified Individual(s) (QI) can be located in the appendix to this report.

1.2 Facility and Process Description

USG-Otsego Paper is a subsidiary of the United States Gypsum Company. The facility manufactures gypsum paper.

The USG-Otsego Paper facility produces electricity from two (2) Mars T-15000 gas turbines, designated as EUTURBINE1 and EUTURBINE2, with a maximum heat input rate of 141.5 million British thermal unit per hour (MMBtu/hr) at low temperature operating conditions as measured on a higher heating value (HHV) basis. Energy is generated at the combustion turbine by drawing in ambient air by means of burning fuel and expanding the hot combustion gases in the turbine. The hot exhaust gases of each turbine are directed to a multi-pressure ABCO heat recovery steam generator (HRSG). There are also natural gas-fired duct burners associated with each HRSG and coupled to a turbine, designated as EUDUCTBURNER1 and EUDUCTBURNER2, respectively.

2.0 SUMMARY OF RESULTS

The table below summarizes the test methods used, as well as the number and duration of each at each test location:

Unit ID	Parameter Measured	Test Method	No. of Runs/Unit	Run Duration (Min)
EUTURBINE1 EUDUCTBURNER1 EUTURBINE2 EUDUCTBURNER2	Volumetric Flow	USEPA 1, 2	4	~10
	Moisture	ALT-008	3	60
	O_2 and CO_2	USEPA 3A	3	60
	NOx	USEPA 7E	3	60
	CO	USEPA 10	3	60
	VOC	USEPA 25A	3	60
		USEPA Method 18*	3	60 (integrated)

* Only performed during duct burner on testing for methane and ethane determination

The results of this test program are summarized in the tables below. Detailed individual run results are presented in Section 6.0.

Unit ID	Test Results			Permitted Emission Limits
	Pollutant	Units	Measured Emissions	
EUDUCTBURNER1 (North)	NOx	lb/hr	9.86	115.1 ton/yr
		lb/MMBtu	0.069	0.20 lb/MMBtu
	CO	lb/hr	19.10	37.3 ton/yr
		lb/MMBtu	0.134	
	VOC as Propane (non-methane, non-ethane)	lb/hr	1.99	9.6 ton/yr
		lb/MMBtu	0.014	

Unit ID	Test Results			Permitted Emission Limits
	Pollutant	Units	Measured Emissions	
EUTURBINE1 (North)	NOx	lb/hr	8.94	87.7 ton/yr
		lb/MMBtu	0.072	
	CO	lb/hr	0.18	74.2 ton/yr
		lb/MMBtu	0.001	
	VOC as Propane (total hydrocarbons)	lb/hr	0.07	1.3 ton/yr
		lb/MMBtu	0.0006	

Note: VOC permit limit is based on non-methane hydrocarbons as propane.

Unit ID	Test Results			Permitted Emission Limits
	Pollutant	Units	Measured Emissions	
EUDUCTBURNER2 (South)	NOx	lb/hr	5.65	115.1 ton/yr
		lb/MMBtu	0.042	0.20 lb/MMBtu
	CO	lb/hr	8.36	37.3 ton/yr
		lb/MMBtu	0.062	
	VOC as Propane (non-methane, non-ethane)	lb/hr	0.39	9.6 ton/yr
		lb/MMBtu	0.003	

Unit ID	Test Results			Permitted Emission Limits
	Pollutant	Units	Measured Emissions	
EUTURBINE2 (South)	NOx	lb/hr	4.47	87.7 ton/yr
		lb/MMBtu	0.039	
	CO	lb/hr	0.16	74.2 ton/yr
		lb/MMBtu	0.001	
	VOC as Propane (total hydrocarbons)	lb/hr	0.08	1.3 ton/yr
		lb/MMBtu	0.0007	

Note: VOC permit limit is based on non-methane hydrocarbons as propane.

3.0 DISCUSSION OF RESULTS

No problems were encountered with the testing equipment during the test program. Source operation appeared normal during the entire test program. No changes or problems were encountered that required modification of any procedures presented in the test plan. No adverse test or environmental conditions were encountered during the conduct of this test program.

MDEQ requested that TRC perform one additional 20-min. test run on June 6th following EUDUCTBURNER2 testing. Raw data from the additional run is appended. Note: this data is not included in the emissions test results (report sections 2.0 and 6.0).

4.0 SAMPLING AND ANALYSIS PROCEDURES

All testing, sampling, analytical, and calibration procedures used for this test program were performed in accordance with the methods presented in the following sections. Where applicable, the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume III, Stationary Source Specific Methods, USEPA 600/R-94/038c, September 1994 was used to supplement procedures.

4.1 Determination of Sample Point Locations by USEPA Method 1

This method is applicable to gas streams flowing in ducts, stacks, and flues and is designed to provide guidance for the selection of sampling ports and traverse points at which sampling for air pollutants will be performed. Sample ports must be located at least two duct diameters downstream and a half a duct diameter upstream from any flow disturbance.

The cross-section of the measurement site was divided into a number of equal areas, and the traverse points were located in the center of each area. The minimum number of points were determined from Figure 1-2 (non-particulate) of the Method.

4.2 Volumetric Flow Rate Determination by USEPA Method 2

This method is applicable for the determination of the average velocity and the volumetric flow rate of a gas stream.

The gas velocity head (ΔP) and temperature were measured at traverse points defined by USEPA Method 1. The velocity head was measured with a Type S (Stausscheibe or reverse type) pitot tube and oil-filled manometer; and the gas temperature was measured with a Type K thermocouple. The average gas velocity in the flue was calculated based on: the gas density (as determined by USEPA Methods 3A and ALT-008); the flue gas pressure; the average of the square roots of the velocity heads at each traverse point, and the average flue gas temperature.

4.3 Determination of the Concentration of Gaseous Pollutants Using a Multi-Pollutant Sampling System

Concentrations of the pollutants in the following sub-sections were determined using one sampling system. The number of points at which sample was collected was determined in accordance with Method 7E specifications.

A straight-extractive sampling system was used. A data logger continuously recorded pollutant concentrations and generated one-minute averages of those concentrations. All calibrations and system checks were conducted using USEPA Protocol gases. Three-point linearity checks were performed prior to sampling, and in the event of a failing system bias or drift test (and subsequent corrective action). System bias and drift checks were performed using the low-level gas and either the high- or mid-level gas (as specified in the appendices) prior to and following each test run.

The Low Concentration Analyzers (those that routinely operate with a calibration span of less than 20 ppm) used by TRC are ambient-level analyzers. Per Section 3.12 of Method 7E, a Manufacturer's Stability Test is not required for ambient-level analyzers. Analyzer interference tests were conducted in accordance with the regulations in effect at the time that TRC placed an analyzer model in service.

4.3.1 CO_2 Determination by USEPA Method 3A

This method is applicable for the determination of CO_2 concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The CO_2 analyzer was equipped with a non-dispersive infrared (IR) detector.

4.3.2 O_2 Determination by USEPA Method 3A

This method is applicable for the determination of O_2 concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The O_2 analyzer was equipped with a paramagnetic-based detector.

4.3.3 NO_x Determination by USEPA Method 7E

This method is applicable for the determination of NO_x concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The NO_x analyzer utilized a photomultiplier tube to measure the linear and proportional luminescence caused by the reaction of nitric oxide and ozone.

4.3.4 CO Determination by USEPA Method 10

This method is applicable for the determination of CO concentrations in controlled and uncontrolled emissions from stationary sources only when specified within the regulations. The non-dispersive infrared analyzer (NDIR) CO analyzer was equipped with an internal gas correlation filter wheel, which eliminates potential detector interference. As such, use of an interference removal trap was not required.

4.4 Moisture Determination by USEPA Method ALT-008

This method is an approved alternative to USEPA Method 4 for the determination of stack gas moisture content using midget impingers. A gas sample was extracted at a constant rate from the source. Moisture was removed from the sample stream by a series of pre-weighed impingers immersed in an ice bath.

4.5 Gaseous Organic Compound Determination by USEPA Method 18

This method is designed to measure gaseous organics emitted from an industrial source. This method will not determine compounds that (1) are polymeric (high molecular weight), (2) can polymerize before analysis, or (3) have very low vapor pressures at stack or instrument conditions.

An integrated sample of flue gas was collected in Tedlar® bags. The major organic components of the sample were separated by gas chromatography (GC) and individually quantified by flame ionization.

4.6 Total Organic Concentration Determination by USEPA Method 25A

This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The concentration is expressed in terms of propane (or other appropriate organic calibration gas) or in terms of carbon.

A gas sample was extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). If necessary, a source-specific response factor was developed for the FIA.

4.7 Determination of F-Factors by USEPA Method 19

This method is applicable for the determination of the pollutant emission rate using oxygen (O_2) or carbon dioxide (CO_2) concentrations and the appropriate F factor (the ratio of combustion gas volumes to heat inputs) and the pollutant concentration. The appropriate F-Factor was selected from Table 19-2 of Method 19.

5.0 QUALITY ASSURANCE PROCEDURES

TRC integrates our Quality Management System (QMS) into every aspect of our testing service. We follow the procedures specified in current published versions of the test Method(s) referenced in this report. Any modifications or deviations are specifically identified in the body of the report. We routinely participate in independent, third party audits of our activities, and maintain:

- Accreditation from the Louisiana Environmental Laboratory Accreditation Program (LELAP);
- Accreditation from the Stack Testing Accreditation Council (STAC) and the American Association for Laboratory Accreditation (A2LA) that our operations conform with the requirements of ASTM D 7036 as an Air Emission Testing Body (AETB).

These accreditations demonstrate that our systems for training, equipment maintenance and calibration, document control and project management will fully ensure that project objectives are achieved in a timely and efficient manner with a strict commitment to quality.

All calibrations are performed in accordance with the test Method(s) identified in this report. If a Method allows for more than one calibration approach, or if approved alternatives are available, the calibration documentation in the appendices specifies which approach was used. All measurement devices are calibrated or verified at set intervals against standards traceable to the National Institute of Standards and Technology (NIST). NIST traceability information is available upon request.

ASTM D7036-04 specifies that: *"AETBs shall have and shall apply procedures for estimating the uncertainty of measurement. Conformance with this section may be demonstrated by the use of approved test protocols for all tests. When such protocols are used, reference shall be made to published literature, when available, where estimates of*

uncertainty for test methods may be found." TRC conforms with this section by using approved test protocols for all tests.

6.0 TEST RESULTS SUMMARIES

GASEOUS TEST RESULTS SUMMARY

Project Number:	326438	Start Date:	6/4/19
Customer:	USG-Otsego Paper	End Date:	6/4/19
Unit Identification:	EUDUCTBURNER 1 (North)	Facility:	Otsego, MI
Sample Location:	Stack	Recorded by:	C. Miller
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	100% - DB On	Fd Factor:	8710

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOx ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	6/4/19	9:22	10:21	18.9	61.0	3.4	14.9
2	6/4/19	11:07	12:06	19.1	60.6	3.5	14.9
3	6/4/19	12:50	13:49	19.2	60.6	3.5	14.9
Average				19.1	60.7	3.5	14.9

Emission Rate Calculation Summary

Run #	NOx lb/MMBtu	CO lb/MMBtu	NOx lb/hr	CO lb/hr	Flow DSCFM
1	0.069	0.135	9.82	19.25	72,372
2	0.070	0.134	9.89	19.10	72,295
3	0.070	0.134	9.85	18.95	71,672
Average	0.069	0.134	9.86	19.10	72,113

Method 25A Test Results Summary

Project Number:	326438	Test Date(s):	06/04/19
Customer:	USG-Otsego Paper	Facility:	Otsego, MI
Unit Identification:	EUDUCTBURNER 1	Recorded by:	C. Miller
Load Level/Condition:	DB On		

Location	North turbine			
Test Run No.	1	2	3	Average
Test Date	6/4/2019	6/4/2019	6/4/2019	
Test Time - Start	9:22	11:07	12:50	
Test Time - End	10:21	12:06	13:49	
THC (ppmvw as Propane)	43.37	42.00	41.29	42.22
Fractional Gas Moisture Content (B_{ws})	0.061	0.071	0.069	0.067
THC (ppmvd as Propane)	46.19	45.21	44.35	45.25
Methane/Ethane (ppmvd as Methane)	105.94	106.60	101.76	104.77
Response Factor (RF)	1.18	1.18	1.18	1.18
Methane/Ethane (ppmvw as Propane)	39.15	38.98	37.29	38.47
NMHC (ppmvw as Propane)	4.22	3.02	4.00	3.75
NMHC (ppmvd as Propane)	4.49	3.25	4.30	4.02
Volumetric Flow Rate (scfm)	77,046	77,404	77,084	77,178
NMHC (lb/hr as Propane)	2.23	1.61	2.12	1.99
O_2 (% dry)	14.90	14.90	14.90	14.90
F_d	8710	8710	8710	8710
NMHC - Fd Basis (lb/MMBtu)	0.016	0.011	0.015	0.014

GASEOUS TEST RESULTS SUMMARY

Project Number:	326438	Start Date:	6/5/19
Customer:	USG-Otsego Paper	End Date:	6/5/19
Unit Identification:	EUTURBINE1 (North)	Facility:	Otsego, MI
Sample Location:	Stack	Recorded by:	C. Miller
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	100% - DB Off	Fd Factor:	8710

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOx ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	6/5/19	7:58	8:57	17.9	0.6	3.1	15.5
2	6/5/19	9:30	10:29	17.6	0.6	3.1	15.5
3	6/5/19	11:02	12:01	17.7	0.6	3.1	15.6
Average				17.7	0.6	3.1	15.5

Emission Rate Calculation Summary

Run #	NOx lb/MMBtu	CO lb/MMBtu	NOx lb/hr	CO lb/hr	Flow DSCFM
1	0.072	0.001	9.09	0.19	70,710
2	0.071	0.002	8.91	0.19	70,778
3	0.072	0.001	8.83	0.17	69,659
Average	0.072	0.001	8.94	0.18	70,382

Method 25A Test Results Summary

Project Number:	326438	Test Date(s):	06/05/19
Customer:	USG-Otsego Paper	Facility:	Otsego, MI
Unit Identification:	EUTURBINE1	Recorded by:	C. Miller
Load Level/Condition:	DB off		

Location	North turbine			
Test Run No.	1	2	3	Average
Test Date	6/5/2019	6/5/2019	6/5/2019	
Test Time - Start	7:58	9:30	11:02	
Test Time - End	8:57	10:29	12:01	
THC (ppmvw as Propane)	0.16	0.12	0.15	0.14
Volumetric Flow Rate (scfm)	75496	75784	74897	75392
THC (lb/hr as Propane)	0.08	0.06	0.08	0.07
Fractional Gas Moisture Content (B_{ws})	0.06	0.07	0.07	0.07
THC (ppmvd as Propane)	0.17	0.13	0.16	0.15
O_2 (% dry)	15.50	15.50	15.60	15.53
F_d	8710	8710	8710	8710
THC - F_d Basis (lb/MMBTU)	0.0007	0.0005	0.0006	0.0006

GASEOUS TEST RESULTS SUMMARY

Project Number:	326438	Start Date:	6/6/19
Customer:	USG-Otsego Paper	End Date:	6/6/19
Unit Identification:	EUDUCTBURNER 2 (South)	Facility:	Otsego, MI
Sample Location:	Stack	Recorded by:	C. Miller
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	100% - DB On	Fd Factor:	8710

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOx ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	6/6/19	11:46	12:45	12.5	29.7	3.7	14.5
2	6/6/19	13:15	14:14	12.3	30.9	3.7	14.5
3	6/6/19	14:51	15:50	12.5	30.1	3.7	14.5
Average				12.4	30.2	3.7	14.5

Emission Rate Calculation Summary

Run #	NOx lb/MMBtu	CO lb/MMBtu	NOx lb/hr	CO lb/hr	Flow DSCFM
1	0.043	0.061	5.70	8.24	63,574
2	0.042	0.064	5.60	8.59	63,658
3	0.042	0.062	5.64	8.25	62,931
Average	0.042	0.062	5.65	8.36	63,388

Method 25A Test Results Summary

Project Number:	326438	Test Date(s):	06/06/19
Customer:	USG-Otsego Paper	Facility:	Otsego, MI
Unit Identification:	EUDUCTBURNER 2	Recorded by:	C. Miller
Load Level/Condition:	DB On		

Location	South turbine			
Test Run No.	1	2	3	Average
Test Date	6/6/2019	6/6/2019	6/6/2019	
Test Time - Start	11:46	13:15	14:51	
Test Time - End	12:45	14:14	15:50	
THC (ppmvw as Propane)	4.58	4.98	4.77	4.78
Fractional Gas Moisture Content (B_{ws})	0.071	0.076	0.074	0.074
THC (ppmvd as Propane)	4.93	5.39	5.15	5.16
Methane/Ethane (ppmvd as Methane)	8.95	11.70	11.92	10.86
Response Factor (RF)	1.18	1.18	1.18	1.18
Methane/Ethane (ppmvw as Propane)	3.27	4.25	4.34	3.96
NMHC (ppmvw as Propane)	1.31	0.73	0.43	0.82
NMHC (ppmvd as Propane)	1.41	0.78	0.46	0.88
Volumetric Flow Rate (scfm)	68,456	68,704	68,034	68,398
NMHC (lb/hr as Propane)	0.61	0.34	0.20	0.39
O_2 (% dry)	14.50	14.50	14.50	14.50
F_d	8710	8710	8710	8710
NMHC - Fd Basis (lb/MMBtu)	0.005	0.003	0.001	0.003

GASEOUS TEST RESULTS SUMMARY

Project Number:	326438	Start Date:	6/5/19
Customer:	USG-Otsego Paper	End Date:	6/5/19
Unit Identification:	EUTURBINE2 (South)	Facility:	Otsego, MI
Sample Location:	Stack	Recorded by:	C. Miller
RM Probe Type:	Extractive (Dry)	Fc Factor:	-
Load Level/Condition:	100% - DB Off	Fd Factor:	8710

Reference Method Results, As Measured Moisture Basis

Run #	Date	Start Time	End Time	NOx ppmvd	CO ppmvd	CO2 % v/v dry	O2 % v/v dry
1	6/5/19	13:02	14:01	9.0	0.5	3.0	15.7
2	6/5/19	14:35	15:34	9.2	0.5	3.0	15.7
3	6/5/19	16:07	17:06	9.4	0.7	3.0	15.7
Average				9.2	0.5	3.0	15.7

Emission Rate Calculation Summary

Run #	NOx lb/MMBtu	CO lb/MMBtu	NOx lb/hr	CO lb/hr	Flow DSCFM
1	0.038	0.001	4.41	0.15	68,129
2	0.038	0.001	4.46	0.14	67,663
3	0.039	0.002	4.53	0.19	67,041
Average	0.039	0.001	4.47	0.16	67,611

Method 25A Test Results Summary

Project Number:	326438	Test Date(s):	06/05/19
Customer:	USG-Otsego Paper	Facility:	Otsego, MI
Unit Identification:	EUTURBINE2	Recorded by:	C. Miller
Load Level/Condition:	DB Off		

Location	South Turbine			
Test Run No.	1	2	3	Average
Test Date	6/5/2019	6/5/2019	6/5/2019	
Test Time - Start	13:02	14:35	16:07	
Test Time - End	14:01	15:34	17:06	
THC (ppmvw as Propane)	0.20	0.15	0.12	0.16
Volumetric Flow Rate (scfm)	73244	72582	71768	72531
THC (lb/hr as Propane)	0.10	0.07	0.06	0.08
Fractional Gas Moisture Content (B_{ws})	0.070	0.056	0.066	0.064
THC (ppmvd as Propane)	0.22	0.16	0.13	0.17
O_2 (% dry)	15.70	15.70	15.70	15.70
F_d	8710	8710	8710	8710
THC - F_d Basis (lb/MMBTU)	0.0009	0.0006	0.0005	0.0007