Report of ...

CO Emission Testing

Performed for ...

Cleveland-Cliffs, Inc.
Tilden Mining Company, L.C.
Ishpeming, Michigan

On...

Boiler 4 (EU-BOILER4)

At the...

Tilden Mine
National Mine, Michigan

May 14, 2019

Project #: 053.41

Performed By:

Network Environmental, Inc.
Grand Rapids, MI

Performed for:

Cleveland-Cliffs, Inc.
Tilden Mining Company, L.C.
1 Tilden Mine Road
P.O. Box 2000
Ishpeming, MI 49849-0901
Contact: Tom O'Brien
Telephone: (906) 475-3306
e-mail: thomas.obrien@clevelandcliffs.com

Performed at the:

Tilden Mine
National Mine, MI

Performed by:

Network Environmental, Inc.
2629 Remico Street, Suite B
Grand Rapids, MI 49519
Contact: David D. Engelhardt
Telephone: (616) 530-6330
Fax: (616) 530-0001
e-mail: netenviro@aol.com

TABLE OF CONTENTS

Appendices

I. INTRODUCTION

Network Environmental, Inc. was retained by the Tilden Mining Company, L.C. of Ishpeming, Michigan to perform carbon monoxide (CO) emission testing at the Tilden Mine located in National Mine, Michigan.

The purpose of the testing was to conduct CO compliance emission testing on the new Gas Fired Boiler #4 (EU-BOILER4). The CO testing was performed in order to meet the requirements of Michigan Department of Environment, Great Lakes & Energy (EGLE), Air Quality Division ROP No. MI-ROP-B4885-2017a. EGLE - Air Quality Division ROP No. MI-ROP-B4885-2017a has established a CO emission limit of 0.0840 Lbs/MMBTU (pounds of CO per million BTU of heat input) for Boiler #4.

The CO emission testing was performed in conjunction with the RATA (relative accuracy test audit) on the new PEMS (predictive emission monitoring system). The CO testing was conducted during the 90% of capacity operating load.

The following reference test methods were used to conduct the sampling:

- Carbon Monoxide (CO) – U.S. EPA Method 10
- Oxygen (O_2) – U.S. EPA Method 3A

The sampling was performed on May 14, 2019 by Stephan K. Byrd and David D. Engelhardt of Network Environmental, Inc.. Assisting with the testing were Ms. Jennifer Fantich of Wunderlich-Malec Environmental Information Systems (EIS), Mr. Thomas O'Brien of the Tilden Mining Company, L.C. and the operating staff of the facility. Mr. Tom Gasloli of the Michigan Department of Environment, Greats Lakes & Energy (EGLE) – Air Quality Division was present to observe the sampling and source operation.

II. PRESENTATION OF RESULTS

II.1 TABLE 1
CARBON MONOXIDE (CO) EMISSION RESULTS
BOILER #4 (EU-BOILER4)
TILDEN MINING COMPANY, L.C.
NATIONAL MINE, MICHIGAN
MAY 14, 2019

Sample [1]	Time	CO PPM [2]	% O_2 [3]	CO Lbs/MMBTU [4]
1	07:22-09:01	4.1	3.2	0.0031
2	09:13-10:53	4.0	3.4	0.0030
3	11:04-14:06	3.8	3.3	0.0029
Average		**4.0**	**3.3**	**0.0030**

(1) Each sample consists of three (3) - 25 minute RATA sampling runs. CO Sample 1 = RATA Runs 1, 2 & 3. CO Sample 2 = RATA Runs 4, 5 & 6. CO Sample 3 = RATA Runs 7, 10 & 11. RATA Runs 8 & 9 were not used because the boiler dropped below 90% of capacity during these runs.
(2) PPM = Parts Per Million (v/v) On A Dry Basis
(3) % O_2 = Percent Oxygen On A Dry Basis
(4) Lbs/MMBTU = Pounds Of CO Per Million BTU Of Heat Input (Calculated Using Equation 2.1 From U. S. EPA Method 19 With An F-Factor of 8710 DSCF/MMBTU).
(5) EGLE - Air Quality Division ROP No. MI-ROP-B4885-2017a has established a CO emission limit of 0.0840 Lbs/MMBTU for Boiler 4.

III. DISCUSSION OF RESULTS

III.1 CO Emissions – The CO emissions are summarized in Table 1 (Section II.1) as follows:

- Sample
- Time
- CO Concentration (PPM) – Parts Per Million (v/v) On A Dry Basis
- O_2 Concentration (%) – Percent On A Dry Basis
- CO Emission Rate (Lbs/MMBTU) – Pounds of CO Per Million BTU of Heat Input (Calculated Using Equation 2.1 From U.S. EPA Method 19 With An F-Factor of 8710 DSCF/MMBTU)

The CO sampling was performed in conjunction with the RATA on the new PEMS. Each sample consisted of three (3) – twenty five (25) minute sampling runs. CO Sample 1 used RATA Runs 1, 2 and 3. CO Sample 2 used RATA Runs 4, 5 and 6. CO Sample 3 used RATA Runs 7, 10 and 11. RATA Runs 8 and 9 were not used because the boiler dropped below 90% of capacity during these runs.

III.2 Emission Limit – EGLE - Air Quality Division ROP No. MI-ROP-B4885-2017a has established a CO emission limit of 0.0840 Lbs/MMBTU (pounds of CO per million BTU of heat input) for Boiler #4.

IV. SOURCE DESCRIPTION

Boiler 4 is a natural gas-fired boiler with a rated capacity of 300 MMBTU/Hr of heat input. The boiler is equipped with low NO_x burners. Boiler 4 is used to provide process steam to the facility. During the CO testing periods, the boiler was operated at 90% of capacity. Steam Load and Gas Flow data during the sampling can be found in Appendix B.

The boiler is exhausted to a stack through a four (4) foot by eight (8) foot breaching. A schematic diagram of the source and sampling location can be found in Appendix E.

V. SAMPLING AND ANALYTICAL PROTOCOL

The sampling methods used for the reference method determinations were as follows:

V.1 Carbon Monoxide – The CO sampling was conducted in accordance with U.S. EPA Reference Method 10. A Thermo Environmental Model 48C gas analyzer was used to monitor the boiler exhaust. A heated probe was used to extract the sample gases from the exhaust stack. A heated Teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the CO concentrations (PPM).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 89.7 PPM was used to establish the initial instrument calibration. A calibration gas of 49.5 PPM was used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 49.5 PPM gas to determine the system bias. After each sample, a system zero and system injection of 49.5 PPM were performed to establish system drift and system bias during the test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the boiler. A diagram of the CO sampling train is shown in Figure 1

V.2 Oxygen – The O_2 sampling was conducted in accordance with U.S. EPA Reference Method 3A. A Servomex Model 1400M portable stack gas analyzer was used to monitor the boiler exhaust. A heated probe was used to extract the sample gas from the stack. A heated Teflon sample line was used to transport the exhaust gases to a gas conditioner to remove moisture and reduce the temperature. From the gas conditioner stack gases were passed to the analyzer. The analyzer produces instantaneous readouts of the O_2 concentrations (%).

The analyzer was calibrated by direct injection prior to the testing. A span gas of 21.0% was used to establish the initial instrument calibration. Calibration gases of 12.1% and 5.96% were used to determine the calibration error of the analyzer. The sampling system (from the back of the stack probe to the analyzer) was injected using the 5.96% gas to determine the system bias. After each sample, a system zero and system injection of 5.96% were performed to establish system drift and system bias during the

test period. All calibration gases were EPA Protocol 1 Certified.

The analyzer was calibrated to the output of the data acquisition system (DAS) used to collect the data from the boiler. A diagram of the O_2 sampling train is shown in Figure 1.

V.3 Sampling Locations – Prior to the CO sampling, a twenty-four (24) point stratification test (as described in U.S. EPA Method 7E) was performed for the exhaust breaching. The breaching is 48 inches deep by 96 inches high with 4 sampling ports. The dimensions used for the stratification test were as follows:

Traverse Point	Dimension (Inches)
1	4.00
2	12.00
3	20.00
4	28.00
5	36.00
6	44.00

The stratification test showed no stratification (< 5%), so a single sampling point (Port 3 - Point 3) was used for the gas sampling. The results of the stratification test can be found in Appendix A.

This report was prepared by:

David D. Engelhardt
Vice President

This report was reviewed by:

Stephan K. Byrd
President

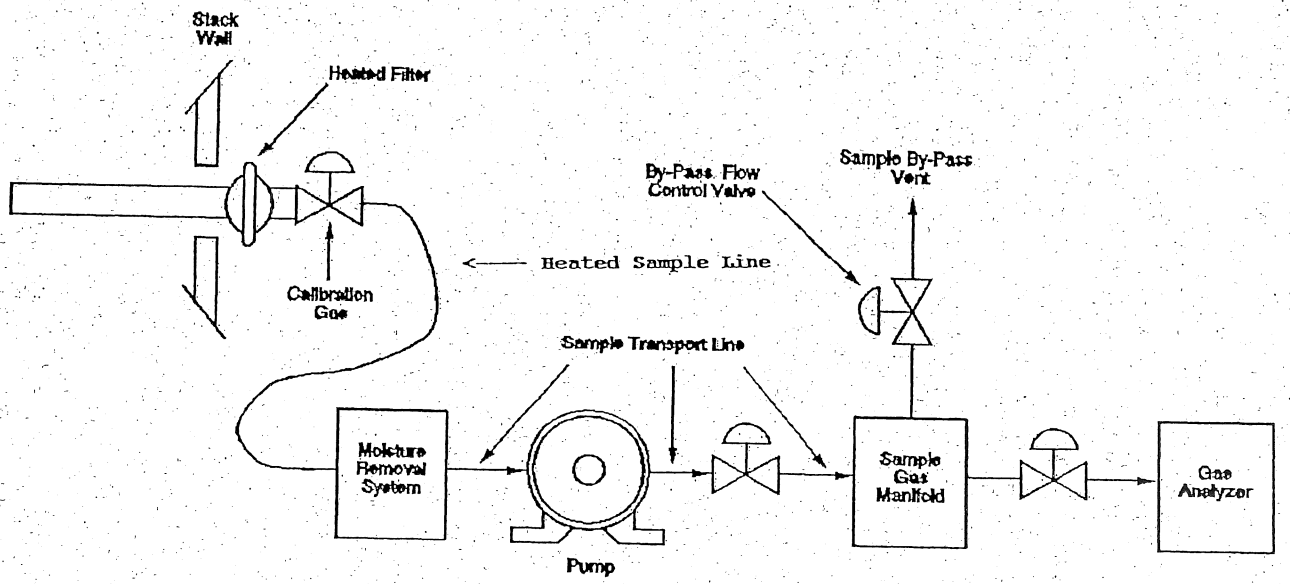

Figure 1

CO & O_2
Sampling Train