



ADVANCED INDUSTRIAL RESOURCES

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AIR QUALITY DIVISION

***COMPLIANCE TEST REPORT  
#10 RECOVERY FURNACE  
AT  
VERSO ESCANABA LLC  
ESCANABA, MICHIGAN  
PROJECT ID: KR-9989***

PREPARED FOR:



**VERSO ESCANABA LLC  
7100 COUNTY ROAD 426  
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PREPARED BY:

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Test Date:

**MAY 24, 2018**

## 1.0 INTRODUCTION

### 1.1 SUMMARY OF TEST PROGRAM

Verso Escanaba LLC (VE) operates a pulp and paper mill in Escanaba, Michigan. Mill operations include the #10 Recovery Furnace, which is subject to the requirements of the Michigan Department of Environmental Quality (MDEQ) Renewable Operating Permit (ROP) Number MI-ROP-A0884-2016.

Permit compliance testing was conducted on the Chemical Recovery Furnace (EURF15) which includes the #10 Recovery Furnace. Testing was conducted to determine mass flow rates and concentrations of particulate matter (total filterable), nitrogen oxides (NOx), and carbon monoxide (CO) on the #10 Recovery Furnace stack exhaust.

The field sampling portion of the test program was conducted on May 24, 2018, in accordance with the site-specific Test Plan submitted to the MDEQ and the associated approval letter received from MDEQ by the facility, dated April 26, 2018. All test methods and procedures were performed by Advanced Industrial Resources, Inc. (AIR) in accordance with approved USEPA Methods (i.e., 40 CFR 60 Appendix A Methods 1, 2, 3A, 4, 5, 7E, and 10) and 40 CFR 63, Subpart MM.

### 1.2 KEY PERSONNEL

The key personnel who coordinated the test program and their telephone numbers are:

Adam Becker, Verso Escanaba LLC	906-233-2929
Derek Stephens, <i>QSTI I-IV</i> , Advanced Industrial Resources	404-843-2100
Scott Wilson, Advanced Industrial Resources	800-224-5007

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## **2.0 PLANT AND SAMPLING LOCATION DESCRIPTIONS**

### **2.1 PROCESS & CONTROL EQUIPMENT DESCRIPTION**

The #10 Recovery Furnace is an integral part of the Chemical Recovery Furnace System and is used to regenerate chemicals used in the Kraft process. The #10 Recovery Furnace is rated for approximately 565,000 pounds of steam per hour (approximately 950 million BTU per hour heat input), burns black liquor, natural gas, #6 fuel oil, ultra-low sulfur diesel. Also, the #10 Recovery Furnace receives and incinerates HVLC noncondensable gases from the Digester System, Brownstock System, Evaporator System, and Chemical Recovery Furnace System. The secondary air forced-draft air handling fan on the Recovery Furnace has been modified. Emissions controls include an electrostatic precipitator.

### **2.2 SAMPLING LOCATION**

The #10 Recovery Furnace sampling point is located at least 2.0 stack diameters downstream and at least 0.5 stack diameters upstream from any flow disturbances. The stack has an internal diameter of 156.0 inches. The stack has four sampling ports oriented on a 90 degree horizontal plane perpendicular to the exhaust flow direction. A schematic diagram of the sampling location is presented in Appendix D. Twenty-four sampling points (six points per each of the four ports) were used for USEPA Methods 2, 3, 4, 5, 7E, and 10 sampling, in accordance with Method 1 requirements.

### 3.0 SUMMARY AND DISCUSSION OF TEST RESULTS

#### 3.1 OBJECTIVES

Permit compliance testing was conducted on the #10 Recovery Furnace. Testing was conducted to determine mass flow rates and concentrations of particulate matter (total filterable), nitrogen oxides (NO<sub>x</sub>), and carbon monoxide (CO) on the #10 Recovery Furnace stack exhaust.

#### 3.2 FIELD TEST CHANGES AND PROBLEMS

The testing was conducted in accordance with the Site-Specific Test Protocol submitted to the MDEQ. No significant problems were encountered during testing that required deviation from the planned test protocol.

#### 3.3 PRESENTATION OF TEST RESULTS

Emission rates and concentrations are summarized and compared to permit limits in Table 3-1. Emission concentrations and mass rates are presented in Appendix A. Reduced and tabulated data from the field-testing is included in Appendix B. The calculations and nomenclature used to reduce the data are presented in Appendix C. Actual raw field data sheets are presented in Appendix D. Laboratory reports and custody records are presented in Appendix E.

**TABLE 3-1: Measured and Allowable Emissions**

Source	Pollutant	Average Measured	Allowable	Units	% of Allowable
#10 Recovery Furnace	Particulate matter	0.0057	0.033	gr/dscf @ 8% O <sub>2</sub>	17%
		12.6	60.5	lb/hour	21%
	Nitrogen oxides	81.2	400	ppm	20%
		111	468	lb/hour	24%
	Carbon monoxide	196	2,000	ppm	10%
		162	1,424	lb/hour	11%

### 3.3.1 #10 RECOVERY FURNACE PARTICULATE MATTTTER TEST RESULTS

The MDEQ ROP Number MI-ROP-A0884-2016 establishes a concentration limit of 0.033 grains particulate matter (PM) per dry standard cubic foot corrected to 8% oxygen (gr/dscf@8% O<sub>2</sub>) on the #10 Recovery Furnace. The emission rate of PM was determined to be **0,0057 gr/dscf@8% O<sub>2</sub>, which is 17% of the allowable limit.** Thus, the #10 Recovery Furnace is operating within the PM emission rate limits established in Permit No. MI-ROP-A0884-2016.

The MDEQ ROP Number MI-ROP-A0884-2016 establishes an emission limit of 60.5 pounds of PM per hour (lb/hour) for the #10 Recovery Furnace. The emission rate of PM was determined to be **12.6 lb/hour, which is 21% of the allowable limit.** Thus, the #10 Recovery Furnace is operating within the PM emission rate limits established in Permit No. MI-ROP-A0884-2016.

### 3.3.2 #10 RECOVERY FURNACE NITROGEN OXIDE TEST RESULTS

The MDEQ ROP Number MI-ROP-A0884-2016 establishes a nitrogen oxide (NO<sub>x</sub>) concentration limit of 400 parts per million (ppm) for the #10 Recovery Furnace. The emission rate of NO<sub>x</sub> was determined to be **81.2 ppm, which is 20% of the allowable emission rate.** Thus, the #10 Recovery Furnace is operating within the NO<sub>x</sub> emission rate limits established in Permit No. MI-ROP-A0884-2016.

The MDEQ ROP Number MI-ROP-A0884-2016 establishes an emission limit of 468 pounds of NO<sub>x</sub> per hour (lb/hour) for the #10 Recovery Furnace. The emission rate of NO<sub>x</sub> was determined to be **111 lb/hour, which is 24% of the allowable emission rate.** Thus, the #10 Recovery Furnace is operating within the NO<sub>x</sub> emission rate limits established in Permit No. MI-ROP-A0884-2016.

### 3.3.3 #10 RECOVERY FURNACE CARBON MONOXIDE TEST RESULTS

The MDEQ ROP Number MI-ROP-A0884-2016 establishes an hourly average carbon monoxide (CO) concentration limit of 2,000 parts per million (ppm) for the #10 Recovery Furnace. The emission rate of CO was determined to be **196 ppm, which is 10% of the allowable emission rate.** Thus, the #10 Recovery Furnace is operating within the CO emission rate limits established in Permit No. MI-ROP-A0884-2016.

The MDEQ ROP Number MI-ROP-A0884-2016 establishes an hourly average emission limit of 1,424 pounds of CO per hour (lb/hour) for the #10 Recovery Furnace. The emission rate of CO was determined to be **162 lb/hour, which is 11% of the allowable emission rate**. Thus, the #10 Recovery Furnace is operating within the CO emission rate limits established in Permit No. MI-ROP-A0884-2016.

### 3.4 PROCESS MONITORING

All essential process monitoring equipment on the #10 Recovery Furnace exhaust points were operating properly and recording data throughout the test period and summarized below. Detailed process data is presented in Appendix G.

Run No.	Date & Time	BLS Production Rate MMlbs/day	Steam Flow KPPH	Opacity %	Secondary Fan Horsepower hp
1	Start 5/24/2018 8:45 Stop 5/24/2018 9:50	3.72	537	5.49	547
2	Start 5/24/2018 10:57 Stop 5/24/2018 12:01	3.78	543	5.77	547
3	Start 5/24/2018 13:15 Stop 5/24/2018 14:19	3.78	537	5.45	548

#### 4.0 SAMPLING AND ANALYTICAL PROCEDURES

Emission rate testing was performed on the #10 Recovery Furnace exhaust in accordance with 40 *CFR* 60 Appendix A. Specifically:

- EPA Method 1 was used for the qualification of the location of sampling ports and for the determination of the number and positions of stack traverse points, as applicable to sample traverses for Method 2.
- EPA Method 2 was employed for the determination of the stack gas velocity and volumetric flow rate during stack sampling using the Type "S" Pitot tube.
- EPA Method 3A was used for the calculation of the density and dry molecular weight of the effluent stack gas as well as to determine the oxygen and carbon dioxide concentrations using a calibrated instrumental analyzer.
- EPA Method 4 was used for the determination of moisture content.
- EPA Method 5 was used for determination of total particulate matter emissions. In accordance with the requirement of 40 *CFR* 63, Subpart MM, water was used as the rinse for Method 5 recovery instead of acetone.
- EPA Method 7E was used for the determination of nitrogen oxides concentrations.
- EPA Method 10 was used for the determination of carbon monoxide concentrations.

Method 5 was used for the determination of particulate matter emissions from stationary sources on No. 10 Recovery Furnace. Particulate matter is withdrawn isokinetically from the source and collected on a glass fiber filter maintained at a temperature of  $120 \pm 14^{\circ}\text{C}$  ( $248 \pm 25^{\circ}\text{F}$ ) or such other temperature as specified by an applicable subpart of the standards or approved by the Administrator for a particular application. The particulate matter mass, which includes any material that condenses at or above the filtration temperature, was determined gravimetrically after the removal of uncombined water.

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Prior to each test run for particulate matter emissions, the sampling line was cleaned with distilled water, and a labeled pre-tarred glass-fiber filter was placed in the filter holder. The first two impingers were loaded with 100 mL each of water; the last impinger was loaded with 200 g of indicating silica gel; and the train was reassembled. After each test run, the filter was recovered and stored in a labeled Petri dish, and the filter holder was rinsed with distilled water into a labeled sample bottle. The nozzle and probe liner were brushed and rinsed with distilled water, and the rinsing was added to the same sample bottle. Finally, the moisture collected in the impingers was measured, and the spent silica gel was stored in a labeled container. The final fluid level in the wash sample bottle was marked prior to shipment. All recovered filters and sample bottle were kept in a closed sample box until final laboratory analysis.



## **5.0 QUALITY ASSURANCE ACTIVITIES**

The quality assurance/quality control (QA/QC) measures associated with the sampling and analysis procedures given in the noted EPA reference methodologies, in Subparts A of 40 *CFR* 60 and 40 *CFR* 63, and in the *EPA QA/QC Handbook*, Volume III (EPA 600/R-94/038c) were employed, as applicable. Such measures included, but were not limited to, the procedures detailed below.

### **5.1 PARTICULATE MATTER FILTER PREPARATION**

Particulate matter filters employed for the determination of particulate matter emissions per USEPA Method 5 are high-purity glass-fiber filters, without organic binder. These filters exhibit at least 99.95% efficiency of removal of 0.3-micron dioctyl phthalate smoke particles and are manufactured by Scientific Glass & Instruments, Inc.

All filters are conditioned before field use according to procedures given in Section 4.1.1 of USEPA Method 5. The glass-fiber filters are oven dried at 220 °F for 2 to 3 hours. Filters are then quickly transferred to an ambient-pressure desiccator cabinet maintained at laboratory temperatures of  $68 \pm 10$  °F, where they are stored for not less than 24 hours, though only 2 hours is required. Filters are counted into groups of 15 and stored inside plastic Petri dishes, which are sealed with tape. After sample collection, each filter is collected individually, placed in a labeled Petri dish, and stored upright in the secure sample shipping box. After field sampling, one of the unused filters from this set of 15 is separated, placed individually in a labeled Petri dish, and stored upright with the other samples for use in the laboratory analysis blank.

### **5.2 PROBE NOZZLE DIAMETER CHECKS**

Probe nozzles were calibrated before field testing by measuring the internal diameter of the nozzle entrance orifice along three different diameters. Each diameter was measured to the nearest 0.001 inch, and all measurements were averaged. The diameters were within the limit of acceptable variation of 0.004”.

### **5.3 PITOT TUBE FACE PLANE ALIGNMENT CHECK**

Before field testing, each Type S Pitot tube was examined in order to verify that the face planes of the tube were properly aligned, per Method 2 of 40 *CFR* 60, Appendix A. The external tubing diameter and base-to-face plane distances were measured in order to verify the use of 0.84 as the baseline (isolated) Pitot coefficient. At that time the entire probe assembly (i.e., the sampling probe, nozzle, thermocouple, and Pitot tube) was inspected in order to verify that its components met the interference-free alignment specifications given in EPA Method 2. Because the specifications were met, then the baseline Pitot coefficient was used for the entire probe assembly.

After field testing, the face plane alignment of each Pitot tube was checked. No damage to the tube orifices was noted.

### **5.4 METERING SYSTEM CALIBRATION**

Every three months each dry gas meter (DGM) console is calibrated at five orifice settings according to Method 5 of 40 *CFR* 60, Appendix A. From the calibration data, calculations of the values of  $Y_m$  and  $\Delta H_{@}$  are made, and an average of each set of values is obtained. The limit of total variation of  $Y_m$  values is  $\pm 0.02$ , and the limit for  $\Delta H_{@}$  values is  $\pm 0.20$ .

After field testing, the calibration of the DGM console was checked by performing three calibration runs at a single intermediate orifice setting that is representative of the range used during field-testing. Each DGM was within the limit of acceptable relative variation from  $Y_m$  of 5.0%.

### **5.5 TEMPERATURE GAUGE CALIBRATION**

After field testing, the temperature measuring instruments on each sampling train was calibrated against standardized mercury-in-glass reference thermometers. Each indicated temperature was within the limit of acceptable variation between the absolute reference temperature and the absolute indicated temperature of 1.5%.

## **5.6 GAS ANALYZER CALIBRATION**

### **5.6.1 CALIBRATION GAS CONCENTRATION VERIFICATION**

AIR obtained a certificate from the gas manufacturer and confirmed that the documentation included all information required by the Environmental Protection Agency Traceability Protocol No. 1. AIR confirmed that the manufacturer certification was complete and current and that calibration gases certifications had not expired. This documentation was available on-site for inspection during testing and is presented in Appendix E.

### **5.6.2 MEASUREMENT SYSTEM PREPARATION**

AIR assembled, prepared, and preconditioned each measurement system by following the manufacturer's written instructions for preparing and preconditioning each gas analyzer and, as applicable, the other system components. AIR made all necessary adjustments to calibrate the analyzers and the data recorders and to achieve the correct sampling rate.

### **5.6.3 ANALYZER CALIBRATION ERROR**

After sampling system and analyzer assembly, preparation and calibration, AIR conducted a 3-point analyzer calibration error test before the first run. AIR introduced the low-, mid-, and high-level calibration gases sequentially in direct calibration mode. During the test, AIR made no adjustments to the system except to maintain the correct flow rate. AIR recorded the analyzer's response to each calibration gas and calculated the system calibration error. At each calibration gas level (low, mid, and high) the calibration error was within  $\pm 2.0$  percent or 0.5 ppm of the calibration span.

### **5.6.4 INITIAL SYSTEM BIAS AND CALIBRATION ERROR CHECKS**

Before sampling began, AIR determined that the high-level calibration gas best approximated the emissions and used it as the upscale gas. AIR introduced the upscale gas at the probe upstream of all sample conditioning components in system calibration mode. The time it took for the measured concentration to increase to a value that is within 95 percent of the certified gas concentration was recorded. AIR continued to observe the gas concentration reading until reached a final, stable value and recorded the value.

Next, AIR introduced the low-level gas in system calibration mode and recorded the time required for the concentration response to decrease to a value that was within 5.0 percent of the certified low-range gas concentration.

AIR continued to observe the low-level gas reading until it reached a final, stable value and recorded the result. AIR operated the measurement system at the normal sampling rate during all system bias checks and made only the adjustments necessary to achieve proper calibration gas flow rates at the analyzer. From this data, AIR determined the initial system bias was less than 5% of the calibration span for the low- and high- level gases.

#### 5.6.5 MEASUREMENT SYSTEM RESPONSE TIME

AIR calculated the measurement system response time from the data collected during the Initial System Bias Check.

### 5.7 INSTRUMENT INTERFERENCE RESPONSE

AIR obtained instrument vendor data that demonstrates the interference performance specification is not exceeded as defined in EPA Method 7E Section 13.4. Documentation is provided in Appendix D.

### 5.8 INSTRUMENT RESPONSE FACTOR

The instrument response factor documentation is presented in the "Relative Response Factor" document included in Appendix F, as applicable.

### 5.9 DATA REDUCTION CHECKS

AIR ran an independent check (using a validated computer program) of the calculations with predetermined data before the field test, and the AIR Team Leader conducted spot checks on-site to assure that data was being recorded accurately. After the test, AIR checked the data input to assure that the raw data had been transferred to the computer accurately.

## **5.10 EXTERNAL QUALITY ASSURANCE**

### **5.10.1 TEST PROTOCOL EVALUATION**

A Site-Specific Test Protocol (SSTP) was submitted to MDEQ in advance of testing, which provided regulatory personnel the opportunity to review and comment upon the test and quality assurance procedures used in conducting this testing.

### **5.10.2 ON-SITE TEST EVALUATION**

A test schedule was submitted with the Site-Specific Test Protocol and MDEQ personnel were notified of all changes in the schedule. No tests were performed earlier than stated in the original schedule. Therefore, regulatory personnel were afforded the opportunity for on-site evaluation of all test procedures.

## 6.0 DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) process is generally a seven-step iterative planning approach to ensure development of sampling designs for data collection activities that support decision making. The seven steps are as follows: (1) defining the problem; (2) stating decisions and alternative actions; (3) identifying inputs into the decision; (4) defining the study boundaries; (5) defining statistical parameters, specifying action levels, and developing action logic; (6) specifying acceptable error limits; and (7) selecting resource-effective sampling and analysis plan to meet the performance criteria. The first five steps are primarily focused on identifying qualitative criteria such as the type of data needed and defining how the data will be used. The sixth step defines quantitative criteria and the seventh step is used to develop a data collection design. In regards to emissions sampling, these steps have already been identified for typical monitoring parameters.

Monitoring methods presented in 40 *CFR* 60 Appendix A indicate the following regarding DQOs: Adherence to the requirements of this method will enhance the quality of the data obtained from air pollutant sampling methods. At a minimum, each method provides the following types of information: summary of method; equipment and supplies; reagents and standards; sample collection, preservation, storage, and transportation; quality control; calibration and standardization; analytical procedures, data analysis and calculations; and alternative procedures. These test methods have been designed and tested according to DQOs for emissions testing and analysis. These test methods have been specified and were followed in accordance with the Site-Specific Test Protocol submitted to the State of MDEQ to ensure that DQOs were met for this project.

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