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February 12, 2016

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AIR QUALITY DIVISION

District Supervisor
MDEQ – Air Quality Division
JACKSON DISTRICT OFFICE
301 E Louis B Glick Hwy
Jackson, MI 49201-1556

Subject: Emission Test Report for the Verification of Catalytic Oxidizer VOC Capture and Destruction Efficiency

Derenzo Environmental Services is submitting the enclosed test report on behalf of Pollard Banknote Ltd. for the verification of catalytic oxidizer volatile organic compound (VOC) capture and destruction efficiency at the printing facility in Ypsilanti, Michigan.

Testing was conducted in accordance with the Test Plan dated May 27, 2015 and MDEQ-AQD Test Plan Approval letter dated June 8, 2015.

Contact information is provided in the enclosed Emission Test Report documentation, should you have any questions or require additional information.

Sincerely,

DERENZO ENVIRONMENTAL SERVICES

N1622-TEST_20160120

Jason Logan
Environmental Consultant

Enclosure

CC: Karen Kajiya-Mills, MDEQ-AQD, Supervisor-TPU

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EMISSION TEST REPORT

Report Title EMISSION TEST REPORT FOR THE VERIFICATION OF CATALYTIC OXIDIZER VOC CAPTURE AND DESTRUCTION EFFICIENCY

Report Date February 10, 2016

Test Dates January 20, 2016

Facility Information	
Name	Pollard Banknote Limited
Street Address	775 James L Hart Parkway
City, County	Ypsilanti, Washtenaw
Phone	(734) 484-6937

Facility Permit Information	
State Registration No.: N1622	Permit to Install No.: 89-99D

Testing Contractor	
Company	Derenzo Environmental Services
Mailing Address	39395 Schoolcraft Road Livonia, Michigan 48150
Phone	(734) 464-3880
Project No.	1505011

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POLLARD BANKNOTE LIMITED
YPSILANTI, MICHIGAN

1.0 INTRODUCTION

Pollard Banknote Limited (Pollard) operates a printing facility located at 775 James L. Hart Parkway, Ypsilanti, Washtenaw County, Michigan (State Registration No. N1622). The facility prints instant game lottery tickets with water based, solvent based, and ultra-violet (UV) inks. Pollard has recently installed a flexographic printing line that is identified as emission unit EU-TRESU in Permit to Install (PTI) 98-99D.

Emissions from water based and UV inks contain little or no volatile organic compounds (VOC) and are released directly to atmosphere. The printing press is equipped with non-fugitive enclosures around each print station that uses solvent based inks. Captured VOC emissions are routed to a catalytic oxidizer and released through stack SV-CTO.

Conditions of PTI 89-99D specify that:

> Condition V.1: *"Within 180 days after commencement of trial operation, the permittee shall verify the destruction efficiency of the catalytic oxidizer"... "No less than 60 days prior to testing, the permittee shall submit a complete test plan to the AQD"*
>
> Condition VI.3: *"During the initial catalytic oxidizer destruction efficiency performance test, and semi-annually thereafter, the permittee shall verify the non-fugitive enclosure for EU-TRESU by verifying the direction of air flow at each natural draft opening (NDO) is into the non-fugitive enclosure, using a smoke-test"*

The VOC capture and destruction efficiency testing was performed by Derenzo Environmental Services representatives Jason Logan and Blake Beddow. The exhaust gas sampling and analysis was performed using procedures specified in the Test Plan dated May 27, 2015 that was submitted to the MDEQ-AQD for review and approval. The project was coordinated by Mr. Darrell Ward, Director of Quality, Safety, and Environment – Pollard Banknote Limited. Mr. Thomas Gasloli and Mr. Zachary Durham of the MDEQ-AQD were on-site to observe portions of the compliance testing.

Appendix 1 contains the test plan approval letter.

Questions regarding this emission test report should be directed to:

Jason Logan
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39395 Schoolcraft Road
Livonia, MI 48150
(734) 464-3880
jlogan@derenzo.com

Mr. Darrell Ward
Director of Quality, Safety, and Environment
Pollard Banknote Limited
775 James L Hart Parkway
Ypsilanti, MI 48197
(734) 484-6937
dward@pbl.ca

This test report was prepared by Derenzo Environmental Services based on field sampling data collected by Derenzo Environmental Services personnel. Facility process data were collected and provided by Pollard Banknote Limited employees or representatives.

I certify that the testing was conducted in accordance with approved methods and procedures unless otherwise specified in this report. I believe the information provided in this report and its attachments are true, accurate, and complete.

Report Prepared By:

Jason Logan
Environmental Consultant
Derenzo Environmental Services

Report Reviewed By:

Andy Rusnak, QSTI
Technical Manager
Derenzo Environmental Services

This test report has been reviewed by Pollard Banknote Limited representatives and approved for submittal to the MDEQ-Air Quality Division. I certify that the process equipment and associated emission control device were operated at maximum routine conditions during the test periods. Based on information and belief formed after reasonable inquiry, the statements and information in this report are true, accurate and complete.

Darrell Ward
Director of Quality, Safety, and Environment
Pollard Banknote Limited

2.0 SUMMARY OF RESULTS

The MEGTEC Magnum™ catalytic oxidizer inlet and exhaust gas streams were monitored simultaneously during three (3) one-hour test periods to determine the VOC mass flowrate entering and exiting the oxidizer for VOC destruction efficiency (DE) determination. The calculated VOC DE for the oxidizer averaged 99.0% by weight. During the test periods, the catalytic oxidizer cell operated at a minimum inlet temperature of 606°F and a minimum outlet temperature of 624°F.

The VOC destruction efficiency test results (three-test average) are summarized in Table 2.1. Results for each one hour test period are presented in Section 6 of this report.

VOC capture efficiency for each active print station connected to the emission control system was evaluated using the smoke tube test method; observation of the airflow direction of visual smoke at enclosure openings. Eight total print stations are enclosed, and only four of the eight stations run solvent-based scratch off material at any given time. All active enclosures connected to the VOC collection system exhibited inward flow as indicated by the observation of air current smoke.

The VOC collection system operated at an average:

- Fan speed of 74% (as displayed on the oxidizer control panel)
- Inlet vacuum of -3.0 inches of water column (as displayed on the oxidizer control panel)
- Capture gas flowrate of 23,238 scfm (as measured using USEPA Method 2)

Table 2.1 Summary of VOC destruction efficiency test results

Tested Parameter	Avg. Catalyst Cell Inlet Temp (°F)	Avg. Catalyst Cell Outlet Temp (°F)	Avg. Destruction Efficiency (%wt)
Measurement Results	611	650	99.0%
Permit Limit			**>95.0%**

3.0 SOURCE DESCRIPTION

3.1 Process Description

Pollard Banknote has installed a new printing line that will produce scratch-off lottery tickets. The new line, which was manufactured by the Tresu Group, incorporates previously separate operations of offset printing, Ink-Jet imaging and flexographic printing. The process consists of one continuous line that prints tickets with game data, water-based inks, solvent-based inks, scratch-off coatings, and varnish.

Applied inks are cured using UV energy or dried using natural gas fired heaters between print stations.

3.2 Type of Raw Materials Used

The raw stock for scratch-off lottery tickets are mill rolls of paperboard that are loaded into the press unwind station. In general, water based inks are used to print the game graphic designs. Then lottery ticket game data are printed using an imager, next the ticket surface is covered with a varnish and finally solvent-based scratch-off coatings are applied. The primary raw materials used in formulating the scratch-off coatings are petroleum naphtha solvent, pigment, and aluminum oxide.

3.3 Emission Control System Description

Solvent laden process air is collected in non-fugitive enclosures surrounding each print station. Each enclosure operates at a pressure lower than all adjacent areas so that air flows into the enclosure through all natural draft openings (NDO). The collected air is combined and exhausted to a MEGTEC Magnum™ catalytic oxidizer.

The MEGTEC Magnum™ catalytic oxidizer consists of a main system fan, a stainless steel plate-type heat exchanger, a high-efficiency natural-gas fired burner, and a catalyst bed. Thermal energy is recovered as the exhaust gas leaves the catalyst bed to pre-heat the incoming process air. The unit has a design capacity of 30,000 standard cubic feet per minute (scfm) and is designed to maintain a VOC destruction efficiency of greater than 95%.

3.4 Process Operating Conditions During the Compliance Testing

All print stations were operated normally during the oxidizer test periods and applied solvent-based coating at typical application rates.

Appendix 2 provides a copy of the Pollard Banknote process data sheets during the oxidizer performance testing.

Destruction efficiency for the oxidizer emission control system was tested while the oxidizer catalyst cell inlet temperature ranged between 606°F and 614°F and the outlet temperature ranged between 624°F and 660°F. The oxidizer system fan operated as designed during all test periods and ranged between 73 and 75% of maximum fan speed as indicated by the oxidizer output display. The averaged measured pressure drop in the enclosures was 3.0 inches of water.

4.0 SAMPLING AND ANALYTICAL PROCEDURES

A description of the sampling and analytical procedures is provided in the Test Plan dated May 27, 2015, which was approved by the MDEQ-AQD Technical Programs Unit. This section provides a summary of those procedures.

4.1 Summary of VOC Destruction Efficiency Test Procedures

Derenzo Environmental Services performed the specified pollutant measurements in accordance with the following USEPA reference test methods:

Method 1	Velocity and sampling locations based on physical measurements in accordance with USEPA Method 1.
Method 2	Gas flowrate determined using a type S Pitot tube in accordance with USEPA Method 2.
Method 3	Oxidizer inlet gas O_2 and CO_2 content determined by Fyrite® combustion gas analyzers.
Method 3A	Oxidizer outlet gas O_2 and CO_2 content was determined using zirconia ion/paramagnetic and infrared instrumental analyzers, respectively.
Method 4	Oxidizer exhaust gas moisture determined based on the water weight gain in chilled impingers. Oxidizer inlet gas moisture determined by wet bulb/dry bulb temperature measurements.
Methods 25A/18	Oxidizer inlet gas total hydrocarbon concentration using a flame ionization analyzer (FIA) compared to a propane standard. Oxidizer outlet gas non-methane hydrocarbon concentration (NMHC) using a flame ionization analyzer equipped with an internal methane separation (gas chromatograph) column. Reported as non-methane hydrocarbons relative to a propane standard.

4.2 Sampling Locations

The sampling location for the combined print station exhaust (oxidizer inlet) is in the 44.75-inch diameter duct on the roof of the Pollard Banknote facility. The sampling location is approximately 16.6 feet downstream of the nearest flow disturbance and 9 feet upstream from the nearest flow disturbance.

The sampling location for the oxidizer exhaust is in the cylindrical 47.25-inch vertical exhaust stack. The sampling location is approximately 24.8 feet downstream of the nearest flow disturbance (elbow at the stack base) and 54 inches upstream from the stack atmospheric discharge.

Appendix 3 provides diagrams of the performance test sampling locations.

4.3 Process Air Flowrate Measurements

Velocity traverse locations for the sampling points were determined in accordance with USEPA Method 1 based on the stack diameter and measured distance to upstream and downstream flow disturbances.

Exhaust gas velocity pressure and temperature were measured at each sampling location in accordance with USEPA Method 2. An S-type Pitot tube connected to a red-oil manometer was used to determine velocity pressure and a K-type thermocouple mounted to the Pitot tube was used for temperature measurements. The Pitot tube and connective tubing were periodically leak-checked to verify the integrity of the measurement system.

The absence of cyclonic flow for each sampling location was verified using the gas velocity measurement train (S-type Pitot tube connected to an oil manometer). The Pitot tube was positioned at each velocity traverse point with the planes of the face openings of the Pitot tube perpendicular to the stack cross-sectional plane. The Pitot tube was then rotated to determine the null angle (rotational angle as measured from the perpendicular, or reference, position at which the differential pressure is equal to zero). The measured null angle for each traverse location was recorded on a data sheet. Cyclonic flow at each sampling location is minimal.

4.4 Gas Molecular Weight Determinations

Carbon dioxide (CO_2) and oxygen (O_2) content for the oxidizer inlet gas stream was measured using Fyrite® gas analyzers containing scrubbing solutions to selectively remove CO_2 and O_2 from the gas sample. Samples were withdrawn from the air stream near the beginning of each test period using a sample probe and hand-held aspirator and introduced to the Fyrite® solutions through the scrubbing tube inlet valve. The sampled gas was passed through the appropriate scrubbing solution several times and the gas concentration (CO_2 or O_2) was determined by the solution volume change as indicated by the calibrated scale on the Fyrite® scrubber chamber.

Carbon dioxide (CO_2) and oxygen (O_2) content for the oxidizer exhaust gas stream was measured using a Servomex 4900 instrumental analyzer which utilizes single beam single wavelength (SBSW) technology for CO_2 and a paramagnetic sensor for O_2.

4.5 Gas Stream Moisture Determinations

Moisture content for the oxidizer exhaust gas was determined using the USEPA Method 4 chilled impinger method. Moisture content for oxidizer inlet gas stream was determined based on wet bulb-dry bulb temperature measurements using a type-K thermocouple and calibrated digital pyrometer (USEPA Method 4 approximation technique using a psychometric chart).

4.6 Hydrocarbon Concentration Measurements

Total hydrocarbon (THC) concentration in the oxidizer inlet gas stream was determined using a Thermo Environmental Instruments, Inc. (TEI) Model 51 flame ionization analyzer (FIA) in accordance with USEPA Method 25A, *Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer.*

Due to the potential for minor quantities of methane in the catalytic oxidizer exhaust, the exhaust gas non-methane hydrocarbon (NMHC) concentration was measured using a TEI Model 55i Methane-NMHC analyzer. The TEI 55i is an automated batch analyzer that repeatedly collects and analyzes samples of the exhaust gas stream that are drawn into the instrument by the internal sampling pump. The sampled gas is separated by an internal gas chromatography (GC) column into methane and non-methane fractions and each fraction is analyzed separately using a flame ionization detector (FID), in accordance with USEPA Method 25A.

Throughout each test period, a sample of the gas from each measurement location was delivered to each analyzer, independently, using an extractive gas sampling system and heated Teflon® sample line equipped with a heating element and temperature controller to maintain the temperature of the sample line at approximately 250°F. The sampled gas streams were not dried prior to being introduced to the FIA instruments; therefore, THC concentration measurements correspond to standard conditions with no moisture correction. Instrument response for each analyzer was recorded on an ESC Model 8816 data logging system that monitors the analog output of the instrumental analyzers continuously and logs data as one-minute averages.

Prior to the first test period, appropriate high-range, mid-range and low-range span gases (USEPA protocol 1 certified calibration gases of propane in air) followed by a zero gas (hydrocarbon free air) were introduced into each sampling system to verify instrument response and sampling system integrity. The calibration gas was delivered to the sampling system through a spring-loaded check valve and a stainless steel "Tee" installed at the base of the sample probe. At the conclusion of each test period, instrument calibration was verified against mid-range and low-range calibration gases and zero gas. A STEC Model SGD-710C 10-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

The scale for the FIA instrument used for the oxidizer exhaust gas was set to 100 ppm. The calibration error test was performed based on a 0-100 ppmv span. The scale for the FIA instrument used for the oxidizer inlet gas was set to 1000 ppm. The calibration error test was performed based on a 0-1000 ppmv span.

Appendix 3 provides diagrams and a description of the USEPA Method 25A sample trains.

4.7 VOC Capture Efficiency Determination

Ventilation or air current smoke tubes were used to observe the direction of air flow for the air collection systems associated with the printing booths on EU-TRESU.

The smoke tube was placed in front of each natural draft opening, an adequate amount of smoke was generated manually using the squeeze bulb, and the direction of air flow was noted (into or out of the natural draft opening). All active natural draft openings for each print station were tested and recorded on a data sheet.

Appendix 4 provides print station enclosure drawings and field data sheets that were used to identify natural draft openings and record the direction of airflow.

5.0 QA/QC ACTIVITIES

5.1 Gas Divider Certification (USEPA Method 205)

A STEC Model SGD-710C 10-step gas divider was used to obtain appropriate calibration span gases. The ten-step STEC gas divider was NIST certified (within the last 12 months) with a primary flow standard in accordance with Method 205. When cut with an appropriate zero gas, the ten-step STEC gas divider delivered calibration gas values ranging from 0% to 100% (in 10% step increments) of the USEPA Protocol 1 calibration gas that was introduced into the system. The field evaluation procedures presented in Section 3.2 of Method 205 were followed prior to use of gas divider. The field evaluation yielded no errors greater than 2% of the triplicate measured average and no errors greater than 2% from the expected values.

5.2 Instrumental Analyzer Interference Check

The instrumental analyzer used to measure O_2 and CO_2 have had an interference response test preformed prior to their use in the field, pursuant to the interference response test procedures specified in USEPA Method 7E. The appropriate interference test gases (i.e., gases that would be encountered in the exhaust gas stream) were introduced into each analyzer, separately and as a mixture with the analyte that each analyzer is designed to measure. All of analyzers exhibited a composite deviation of less than 3.0% of the span for all measured interferent gases. No major analytical components of the analyzers have been replaced since performing the original interference tests.

5.3 Instrument Calibration and System Bias Checks

At the beginning of each day of the testing program, initial three-point instrument calibrations were performed for the CO_2 and O_2 analyzer by injecting calibration gas directly into the inlet sample port for each instrument. System bias checks were performed prior to and at the conclusion of each sampling period by introducing the upscale calibration gas and zero gas into the sampling system (at the base of the stainless steel sampling probe prior to the particulate filter and Teflon® heated sample line) and determining the instrument response against the initial instrument calibration readings.

At the beginning of each test day, appropriate high-range, mid-range, and low-range span gases followed by a zero gas were introduced to the THC and NMHC analyzers, in series at a tee connection, which is installed between the sample probe and the particulate filter, through a poppet check valve. After each one hour test period, mid-range and zero gases were re-introduced in series at the tee connection in the sampling system to check against the method's performance specifications for calibration drift and zero drift error.

The instruments were calibrated with USEPA Protocol 1 certified concentrations of CO_2 and O_2 in nitrogen and zeroed using hydrocarbon free nitrogen. The THC and NMHC instruments were calibrated with USEPA Protocol 1 certified concentrations of propane in air and zeroed using hydrocarbon-free air. A STEC Model SGD-710C ten-step gas divider was used to obtain intermediate calibration gas concentrations as needed.

5.4 Meter Box Calibrations

The metering console, which was used for exhaust gas moisture content sampling, was calibrated prior to and after the testing program. This calibration uses the critical orifice calibration technique presented in USEPA Method 5. The metering console calibration exhibited no data outside the acceptable ranges presented in USEPA Method 5.

The digital pyrometer in the metering console was calibrated using a NIST traceable Omega® Model CL 23A temperature calibrator.

Appendix 5 presents test equipment quality assurance data (instrument calibration and system bias check records, calibration gas and gas divider certifications, interference test results, meter box calibration records, Pitot tube calibration records).

6.0 TEST RESULTS AND DISCUSSION

6.1 Oxidizer VOC Destruction Efficiency

The THC concentration in the oxidizer inlet and NMHC concentration in the oxidizer exhaust gas streams were monitored simultaneously to determine the mass flowrate entering and exiting the emission control system. Three (3) one-hour sampling periods were performed.

Air flowrate measurements were performed near the beginning and end of each one-hour test period. Gas molecular weight measurements (fixed gases and moisture determinations) were performed for each one-hour test period.

The VOC mass flowrate into and out of the oxidizer emission control system was calculated using the following equation:

$$M_{VOC} = Q\,[C_{VOC}]\,(MW_{C3})\,(60\text{ min/hr}) / V_M / 1E{+}06$$

Where: M_{VOC} = Mass flowrate VOC (lb/hr)
Q = Volumetric flowrate (scfm)
C_{VOC} = THC concentration (ppmv C_3)
MW_{C3} = Molecular weight of propane (44.1 lb/lb-mol)
V_M = Molar volume of ideal gas at standard condition (385 scf/lb-mol)

The THC destruction efficiency of the oxidizer emission control system was determined for each test period using the following equation:

$$DE = [1 - (M_{VOC\ in} / M_{VOC\ out})] * 100\%$$

Where: DE = VOC destruction efficiency (%wt)
$M_{VOC\ in}$ = VOC mass flowrate into the oxidizer (lb/hr)
$M_{VOC\ out}$ = VOC mass flowrate exhausted from the oxidizer (lb/hr)

The calculated VOC destruction efficiency for three tests averaged 99.0%.

Calculations for each test period are presented in Appendix 6. Raw instrument response data is presented in Appendix 7.

For printing operations controlled by an add-on emission control device, the conditions of PTI No. 89-99D require an overall minimum VOC reduction of 95% by weight. The results of the January 20, 2016 test event demonstrate compliance with the permit requirements.

Table 5.1 presents measured gas conditions and VOC destruction efficiency results for each oxidizer test periods.

6.2 VOC Capture Efficiency

The results of the capture efficiency evaluation are presented in Appendix 4. All active enclosures that are connected to the VOC collection system exhibited inward flow as indicated by the observation of air current smoke. Eight enclosures are used, and only four run solvent based scratch-off material at any given time.

6.3 Variations from Normal Sampling Procedures or Operating Conditions

The testing was performed in accordance with the Test Plan dated May 27, 2015 and the MDEQ-AQD test plan approval letter. During the testing program the printing stations were operated at normal operating conditions.

Table 5.1 Measured gas conditions and VOC destruction efficiency test results for the oxidizer emission control system

Test No.	Test 1	Test 2	Test 3	Avg
Date	1/20/16	1/20/16	1/20/16	
Test Times	13:10-14:10	15:00-16:20*	17:25-18:25	
Collection System Parameters				
Line Speed (fpm)	460	475	550	495
Fan Speed (%)	74	74	74	74
Inlet Duct Vacuum (in. wc)	-3.0	-3.0	-3.0	-3.0
Catalyst Cell Inlet Temp (°F)	611	611	611	611
Catalyst Cell Outlet Temp (°F)	647	646	656	650
Oxidizer Inlet Gas Stream				
Temperature (°F)	80	82	84	82
Flowrate (scfm)	23,370	23,228	23,106	23,235
Average THC Conc. (ppmv C_3)	362	463	306	377
Calculated VOC Mass Flow (lb/hr)	58.2	73.8	48.6	60.2
Oxidizer Exhaust Gas Stream				
Temperature (°F)	289	290	289	289
Flowrate (scfm)	21,663	21,821	21,886	21,790
Average THC Conc. (ppmv C_3)	3.39	3.85	4.41	3.88
Calculated VOC Mass Flow (lb/hr)	0.50	0.58	0.66	0.58
Calculated Destruction Efficiency				
1 - [VOC_{out} / VOC_{in}] x 100%	99.1%	99.2%	98.6%	99.0%

*Test paused at 15:08, resumed at 15:38