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Mod 7 Cooler and Kone Emissions Test Report

Prepared for:

Kellogg USA, Inc.

425 Porter Street
Battle Creek, Michigan 49014

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AIR QUALITY DIVISION

Project No. 049AS-435131
December 6, 2018

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Montrose Air Quality Services, LLC
4949 Fernlee Avenue
Royal Oak, Michigan 48071
(248) 548-8070

ACCREDITED
TO ASTM D7036 ONLY

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EXECUTIVE SUMMARY

Montrose Air Quality Services, LLC (MAQS) was retained by Kellogg USA Inc. (Kellogg) to evaluate Particulate Matter (PM_{10}) and ($PM_{2.5}$) from the Mod 7 Cooler (Mod7Cooler-800-26) and Kone packing lines (Kone-800-27) Rotoclones at the Kellogg facility located at 425 Porter Street in Battle Creek, Michigan. The purpose of the test program was to show compliance with Michigan Permit to Install 9-08L, which limits PM, PM_{10}, and $PM_{2.5}$ emissions from the Mod 7 Cooler and Kone Rotoclones.

Testing consisted of triplicate 240-minute test runs for the Mod 7 Cooler and two 240-minute tests on one 45-minute test on the Kone packing lines. Sampling and analysis for the emission test program was conducted on October 25-26, 2018 for the Mod 7 Cooler, and November 1-2, 2018 for the Kone packing lines. The results of this test program are summarized by the following table.

Table I
Test Program Summary

Source	Permit Limitation Emission Rate	Average PM Emission Rate
Mod7Cooler-800-24	0.13 lbs/hr	0.02 lbs/hr
	0.002 lbs/1,000 lbs dry exhaust gas	0.0003 lbs/1,000 lbs dry exhaust gas
Kone-800-27	0.28 lbs/hr	0.05 lbs/hr
	0.004 lbs/1,000 lbs dry exhaust gas	0.001 lbs/1,000 lbs dry exhaust gas

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1. Introduction

Montrose Air Quality Services, LLC (MAQS) was retained by Kellogg USA Inc. (Kellogg) to evaluate Particulate Matter (PM_{10}) and ($PM_{2.5}$) from the Mod 7 Cooler (Mod7Cooler-800-26) and Kone packing lines (Kone-800-27) Rotoclones at the Kellogg facility located at 425 Porter Street in Battle Creek, Michigan. The purpose of the test program was to show compliance with Michigan Permit to Install 9-08L, which limits PM PM_{10}, and $PM_{2.5}$ emissions from the Mod 7 Cooler and Kone Rotoclones. The test program was conducted on October 25-26, 2018 for the Mod 7 Cooler, and November 1-2, 2018 for the Kone packing lines. The purpose of this report is to document the results of the test program.

The Air Quality Division (AQD) of Michigan's Department of Environmental Quality has published a guidance document entitled "Format for Submittal of Source Emission Test Plans and Reports" (March 2018). The following is a summary of the emissions test program and results in the format suggested by the aforementioned document.

1.a Identification, Location, and Dates of Test

Sampling and analysis for the emission test program was conducted on October 25-26, 2018 for the Mod 7 Cooler, and November 1-2, 2018 for the Kone packing lines at the Kellogg facility in Battle Creek, Michigan. The test program included evaluation of PM emissions from both Rotoclone exhaust stacks.

1.b Purpose of Testing

The purpose of the testing is to show that both the Mod 7 Cooler exhaust and the Kone exhaust are in compliance with Michigan Permit to Install 9-08L. PM emission rate (in terms of pounds per hour) was verified with the Process at normal operating conditions.

1.c Source Description

The product temperature and moisture content is monitored at the output of Mod7Cooler-800-26, and process air flow is regulated using a variable frequency drive on the Rotoclone (fan) to control those parameters. During the operating scenario where the output of Mod7Cooler-800-26 is routed to Kone-800-27, product moisture content is also monitored at Kone-800-27, and if moisture levels are too high at this location, the airflow is regulated upwards at Mod7Cooler-800-26 to reduce product moisture content.

Collection points for both systems operate at near-ambient temperatures; the exhausts from both are controlled by American Air Filter Type W Rotoclones. Note that the Rotoclones serve not only as the control device but also as the fan that drives the process exhaust. If the Rotoclone is turned off, the process exhaust is halted.

1.d Test Program Contact

The contact for information regarding the test program as well as the test report is as follows:

Mr. Adam Childs, Jr.
EHS Specialist
Kellogg Company
425 Porter Street
Battle Creek, MI 49014
269-961-2396
adam.childs@kellogg.com

Mr. Matt Young
Client Project Manager
Montrose Air Quality Services, LLC
4949 Fernlee Avenue
Royal Oak, MI 48073
586-744-9133
myoung@montrose-env.com

1.e Testing Personnel

Names and affiliations for all personnel who were present during the testing program are summarized by Table 1.

Table 1
Testing Personnel

Name	Affiliation
Mason Sakshaug	MAQS
Mike Nummer	MAQS
Dave Trahan	MAQS
Ben Durham	MAQS
Adam Childs	Kellogg

2. Summary of Results

Sections 2.a through 2.d summarize the results of the emissions test program.

2.a Operating Data

Production rate will be continuously monitored automatically during the test using the facility's normal process instrumentation. Rotoclone water flow rate will be monitored once per hour during each test.

2.b Applicable Permit

Both the Mod 7 Cooler Rotoclone and Kone packing lines Rotoclone are included in Permit No. 9-08L.

2.c Results

Michigan Permit Number 9-08L limits PM from EU-101N process equipment to 0.13 lbs/hr for the Mod7Cooler-800-26, and limits PM from the Kone 800-27 process equipment to 0.28 lbs/hr. The average PM emission rate from the Mod7Cooler was 0.02 lbs/hr. The average PM emission rate from the Kone was 0.05 lb/hr. See Tables 2-3 for a detailed summary of PM emissions including all the runs.

2.d Emission Regulation Comparison

The results summarized by Tables 2-3 show that the PM emissions are below the limits summarized by section 1.b.

3. Source Description

Sections 3.a through 3.e provide a detailed description of the process.

3.a Process Description

The product temperature and moisture content is monitored at the output of Mod7Cooler-800-26, and process air flow is regulated using a variable frequency drive on the Rotoclone (fan) to control those parameters. During the operating scenario where the output of Mod7Cooler-800-26 is routed to Kone-800-27, product moisture content is also monitored at Kone-800-27, and if moisture levels are too high at this location, the airflow is regulated upwards at Mod7Cooler-800-26 to reduce product moisture content.

Collection points for both systems operate at near-ambient temperatures; the exhausts from both are controlled by American Air Filter Type W Rotoclones. Note that the Rotoclones serve not only as the control device but also as the fan that drives the process exhaust. If the Rotoclone is turned off, the process exhaust is halted.

3.b Process Flow Diagram

Due to the simplicity of the process, a process flow diagram is not necessary.

3.c Raw and Finished Materials

Raw Material used consists of rice.

3.d Process Capacity

The maximum and average production rate of the process varies depending on the specific product being produced, and both parameters are considered to be confidential business information. To avoid unnecessary communication of confidential business information, Kellogg's proposes to operate the process at no less than 90% of its design capacity during the test, based on the product being produced during the test, and to include in the test report the throughput rate in terms of percentage of design capacity rather than the actual mass throughput rate.

3.e Process Instrumentation

The only process operating parameters relevant to the emissions test program are the flowrate of water through the Rotoclones. The material throughput rating of the process equipment is confidential. Records of the material throughput rate are retained automatically by the plants control systems and will be made available to Michigan DEQ upon request.

4. Sampling and Analytical Procedures

Sections 4.a through 4.d provide a summary of the sampling and analytical procedures that were used to test for PM emissions.

4.a Sampling Train and Field Procedures

To evaluate PM mass emission rates, MAQS utilized the following reference test methods codified at Title 40, Part 60, Appendix A of the Code of Federal Regulations:

- Method 1 - *"Sample and Velocity Traverses for Stationary Sources"*
- Method 2 - *"Determination of Stack Gas Velocity and Volumetric Flowrate"*
- Method 3 - *"Gas Analysis for the Determination of Dry Molecular Weight" (Fyrite Analysis)*
- Method 4 - "*Determination of Moisture Content in Stack Gases*"
- Method 5 - *"Determination of Particulate Emissions from Stationary Sources"*
- Method 202 - "Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"

Stack gas velocity traverses were conducted in accordance with the procedures outlined in Methods 1 and 2. Figure 1 presents the test port and traverse/sampling point locations used. An S-type pitot tube and thermocouple assembly calibrated in accordance with Method 2, Section 4.1.1 was used to measure exhaust gas velocity pressures and temperatures during testing. Because the Pitot tube dimensions outlined in Sections 2-6 through 2-8 were within the specified limits, the baseline Pitot tube coefficient of 0.84 (dimensionless) was assigned for this testing.

Molecular weight determinations were conducted according to Method 3. The equipment used for this evaluation consisted of a one-way squeeze bulb with connecting tubing and a set of Fyrite® combustion gas analyzers. Moisture content was determined from the condensate collected in the Method 5 sampling train according to Method 4.

40 CFR 60, Appendix A, Method 5, *"Determination of Particulate Emissions from Stationary Sources"* and 40 CFR 60, Appendix A, Method 202, *"Dry Impinger Method for Determining Condensable Particulate Emissions from Stationary Sources"* were used to measure PM concentrations and calculate PM emission rates (see Figure 1 for a schematic of the sampling train). Triplicate 240-minute test runs were conducted on each Rotoclone exhaust stack.

BTEC's Nutech® Model 2010 modular isokinetic stack sampling system consists of (1) a Steel nozzle, (2) a glass probe, (3) a heated filter holder, (4) a vertical condenser, (5) an empty potbellied impinger, (6) an empty modified Greenburg-Smith (GS) impinger, (7) unheated filter holder with a Teflon filter, (8) a second modified GS impinger with 100 ml of deionized water, and a third modified GS impinger containing approximately 300 g of silica gel desiccant, (9) a length of sample line, and (10) a Nutech® control case equipped with a pump, dry gas meter, and calibrated orifice.

After completion of the final leak test for each test run, the filters were recovered, and the nozzle, probe, and the front half of the filter holder assemblies of the sampling train were brushed and triple rinsed with acetone and collected in a pre-cleaned sample container. The CPM filter was recovered and placed in a petri dish. The back half of the filter housing, the condenser, the potbellied impinger, the moisture drop out impinger, and the front half of the CPM filter housing and all connecting glassware were triple rinsed with deionized water and collected in a pre-cleaned sample container. The same glassware was then rinsed with acetone which was collected in a pre-cleaned sample container labeled as the organic fraction. The glassware was then double rinsed with hexane which was added to the same organic fraction sample bottle. MAQS labeled the containers with the test number, test location, and test date, and marked the level of liquid on the outside of each container. MAQS personnel transported all samples to MAQS's laboratory in Royal Oak, Michigan for analysis.

4.b Recovery and Analytical Procedures

Recovery and analytical procedures were described in Section 4.a.

4.c Sampling Ports

Sampling port and traverse point locations for the exhaust stacks are illustrated by Figures 1 and 2.

4.d Traverse Points

Sampling port and traverse point locations for the Mod 7 Cooler and Kone packing lines exhaust stacks are illustrated by Figures 1 and 2, respectively.

5. Test Results and Discussion

Sections 5.a through 5.k provide a summary of the test results.

5.a Results Tabulation

The results of the test program are summarized by Table 2-3.

5.b Discussion of Results

Michigan Permit Number 9-08L limits PM from EU-101N process equipment to 0.13 lbs/hr for the Mod7Cooler-800-26, and limits PM from the Kone 800-27 process equipment to 0.28 lbs/hr. The average PM emission rate from the Mod7Cooler was 0.02 lbs/hr. The average PM emission rate from the Kone was 0.05 lb/hr. See Tables 2-3 for a detailed summary of PM emissions including all the runs.

5.c Sampling Procedure Variations

No sampling procedure variations were used during testing.

5.d Process or Control Device Upsets

Run 3 of the Kone packing line was ended after 45 minutes rather than 240 minutes because the process ran out of product. Run 3 pounds per hour equated to 0.11 while the average of Run 1 and Run 2 was 0.024 pounds per hour. The shorter run time of Run 3 may be skewing the average of the data high, but Run 3 and the average of all 3 runs are still within the limits of the permit.

5.e Control Device Maintenance

No maintenance was performed during the test program.

5.f Re-Test Changes

The test program performed was not previously performed.

5.g Audit Sample Analyses

Audit samples were not applicable to this test program.

5.h Calibration Sheets

Relevant equipment calibration documents are provided as Appendix B.

5.i Sample Calculations

Sample calculations are provided as Appendix C.

5.j Field Data Sheets

Copies of field data sheets and relevant field notes are provided in Appendix A.

5.k Laboratory Data

Laboratory Data is provided in Appendix D

Tables

Table 2
Particulate Matter Emission Rates

Company	**Kellog**			
Source Designation	**Mod 7**			
Test Date	**10/25/2018**	**10/25/2018**	**10/26/2018**	
Meter/Nozzle Information	Run 1	Run 2	Run 3	Average
Meter Temperature Tm (F)	83.4	87.8	85.8	85.7
Meter Pressure - Pm (in. Hg)	29.5	29.5	30.1	29.7
Measured Sample Volume (Vm)	202.3	204.0	200.2	202.2
Sample Volume (Vm-Std ft3)	198.4	198.5	199.4	198.8
Sample Volume (Vm-Std m3)	5.62	5.62	5.65	5.63
Condensate Volume (Vw-std)	6.403	6.714	5.955	6.357
Gas Density (Ps(std) lbs/ft3) (wet)	0.0737	0.0736	0.0737	0.0737
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	15.08	15.10	15.14	15.11
Total weight of sampled gas (m g lbs) (dry)	14.79	14.79	14.86	14.81
Nozzle Size - An (sq. ft.)	0.000501	0.000501	0.000501	0.000501
Isokinetic Variation - I	101.3	100.4	100.3	100.7
Stack Data				
Average Stack Temperature - Ts (F)	82.8	83.8	84.2	83.6
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.5	28.5	28.5	28.5
Stack Gas Specific Gravity (Gs)	0.984	0.983	0.985	0.984
Percent Moisture (Bws)	3.13	3.27	2.90	3.10
Water Vapor Volume (fraction)	0.0313	0.0327	0.0290	0.0310
Pressure - Ps ("Hg)	29.3	29.3	29.9	29.5
Average Stack Velocity -Vs (ft/sec)	29.4	29.8	29.3	29.5
Area of Stack (ft2)	4.8	4.8	4.8	4.8
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	8,507	8,616	8,469	8,530
Flowrate ft^3 (Standard Wet)	8,116	8,204	8,220	8,180
Flowrate ft^3 (Standard Dry)	7,862	7,935	7,981	7,926
Flowrate m^3 (standard dry)	223	225	226	224
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	4.7	1.4	1.4	2.5
Organic Condensible Particulate	0.8	1.0	1.2	1.0
Inorganic Condensible Particulate	2.2	2.3	2.7	2.4
Condensible Blank Correction	1.3	1.3	1.3	1.3
Total Condensible Particulate	1.7	2.0	2.6	2.1
Total Filterable and Condensible Particulate	6.4	3.4	4.0	4.6
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.001	0.000	0.000	0.000
lb/1000 lb (dry)	0.001	0.000	0.000	0.000
mg/dscm (dry)	0.8	0.2	0.2	0.4
gr/dscf	0.0004	0.0001	0.0001	0.0002
Filterable Particulate Emission Rate				
lb/ hr	0.02	0.01	0.01	0.01
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.000	0.000	0.000	0.000
lb/1000 lb (dry)	0.000	0.000	0.000	0.0003
mg/dscm (dry)	0.3	0.4	0.5	0.4
gr/dscf	0.0001	0.0002	0.0002	0.0002
Condensible Particulate Emission Rate				
lb/ hr	0.01	0.01	0.01	0.01
Total Particulate Concentration				
lb/1000 lb (wet)	0.001	0.000	0.001	0.001
lb/1000 lb (dry)	0.001	0.001	0.001	0.001
mg/dscm (dry)	1.1	0.6	0.7	0.8
gr/dscf	0.0005	0.0003	0.0003	0.0004
Total Particulate Emission Rate				
lb/ hr	0.03	0.02	0.02	0.02

Table 3
Particulate Matter Emission Rates

Company	**Kellogg**			
Source Designation	**Kone**			
Test Date	**11/1/2018**	**11/1/2018**	**11/2/2018**	
Meter/Nozzle Information	Run 1	Run 2	Run 3	Average
Meter Temperature Tm (F)	77.9	71.2	70.2	73.1
Meter Pressure - Pm (in. Hg)	29.1	29.1	29.1	29.1
Measured Sample Volume (Vm)	189.6	183.6	33.4	135.5
Sample Volume (Vm-Std ft3)	178.8	175.2	32.0	128.6
Sample Volume (Vm-Std m3)	5.06	4.96	0.90	3.64
Condensate Volume (Vw-std)	2.551	2.607	0.646	1.935
Gas Density (Ps(std) lbs/ft3) (wet)	0.0741	0.0741	0.0740	0.0741
Gas Density (Ps(std) lbs/ft3) (dry)	0.0745	0.0745	0.0745	0.0745
Total weight of sampled gas (m g lbs) (wet)	13.44	13.18	2.41	9.68
Total weight of sampled gas (m g lbs) (dry)	13.32	13.06	2.38	9.59
Nozzle Size - An (sq. ft.)	0.000189	0.000189	0.000189	0.000189
Isokinetic Variation - I	99.8	99.9	100.4	100.0
Stack Data				
Average Stack Temperature - Ts (F)	66.2	67.4	68.7	67.4
Molecular Weight Stack Gas- dry (Md)	28.8	28.8	28.8	28.8
Molecular Weight Stack Gas-wet (Ms)	28.7	28.7	28.6	28.7
Stack Gas Specific Gravity (Gs)	0.990	0.990	0.988	0.990
Percent Moisture (Bws)	1.41	1.47	1.98	1.62
Water Vapor Volume (fraction)	0.0141	0.0147	0.0198	0.0162
Pressure - Ps ("Hg)	28.9	28.9	28.9	28.9
Average Stack Velocity -Vs (ft/sec)	68.9	67.7	66.0	67.5
Area of Stack (ft2)	2.6	2.6	2.6	2.6
Exhaust Gas Flowrate				
Flowrate ft^3(Actual)	10,907	10,712	10,442	10,687
Flowrate ft^3 (Standard Wet)	10,587	10,373	10,088	10,349
Flowrate ft^3 (Standard Dry)	10,438	10,221	9,888	10,182
Flowrate m^3 (standard dry)	296	289	280	288
Total Particulate Weights (mg)				
Total Nozzle/Probe/Filter	1.4	2.2	1.4	1.7
Organic Condensible Particulate	1.1	0.7	0.7	0.8
Inorganic Condensible Particulate	1.9	2.0	2.3	2.1
Condensible Blank Correction	1.6	1.6	1.6	1.6
Total Condensible Particulate	1.4	1.1	1.4	1.3
Total Filterable and Condensible Particulate	2.8	3.3	2.8	3.0
Filterable Particulate Concentration				
lb/1000 lb (wet)	0.000	0.000	0.001	0.001
lb/1000 lb (dry)	0.000	0.000	0.001	0.001
mg/dscm (dry)	0.3	0.4	1.5	0.8
gr/dscf	0.0001	0.0002	0.0007	0.0003
Filterable Particulate Emission Rate				
lb/ hr	0.01	0.02	0.06	0.03
Condensible Particulate Concentration				
lb/1000 lb (wet)	0.000	0.000	0.001	0.001
lb/1000 lb (dry)	0.000	0.000	0.001	0.001
mg/dscm (dry)	0.3	0.2	1.5	0.7
gr/dscf	0.0001	0.0001	0.0007	0.0003
Condensible Particulate Emission Rate				
lb/ hr	0.01	0.01	0.06	0.03
Total Particulate Concentration				
lb/1000 lb (wet)	0.000	0.001	0.003	0.001
lb/1000 lb (dry)	0.000	0.001	0.003	0.001
mg/dscm (dry)	0.5	0.7	3.1	1.4
gr/dscf	0.0002	0.0003	0.0013	0.0006
Total Particulate Emission Rate				
lb/ hr	0.02	0.03	0.11	0.05

Figures

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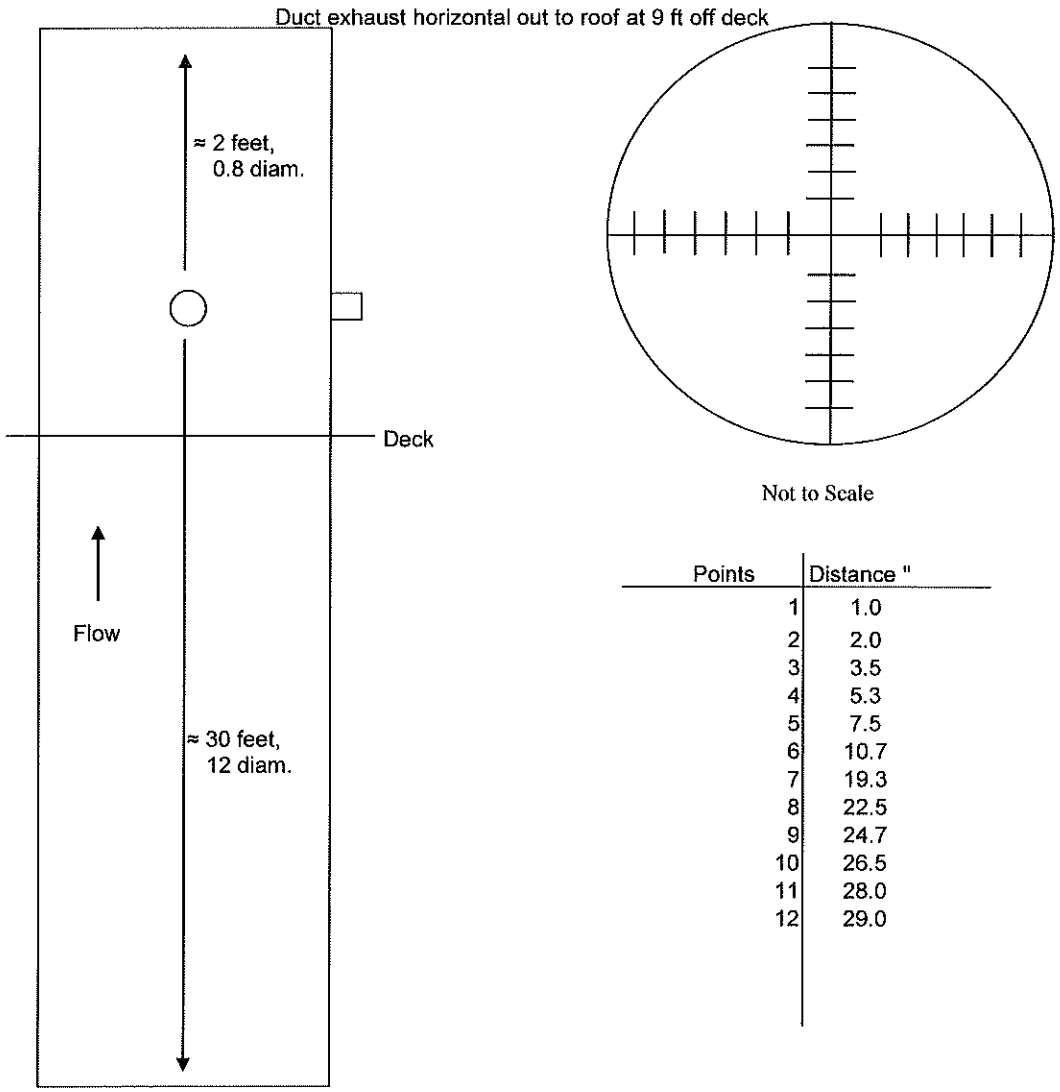
diameter = 30 inches



Points	Distance "
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2	2.0
3	3.5
4	5.3
5	7.5
6	10.7
7	19.3
8	22.5
9	24.7
10	26.5
11	28.0
12	29.0

Figure No. 1

Site: **Mod 7 Cooling Exhaust** **Kellog USA, Inc.** **Battle Creek, Michigan**	**Sampling Date:** **October 25-26, 2018**	**Montrose Air Quality Services, LLC** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**

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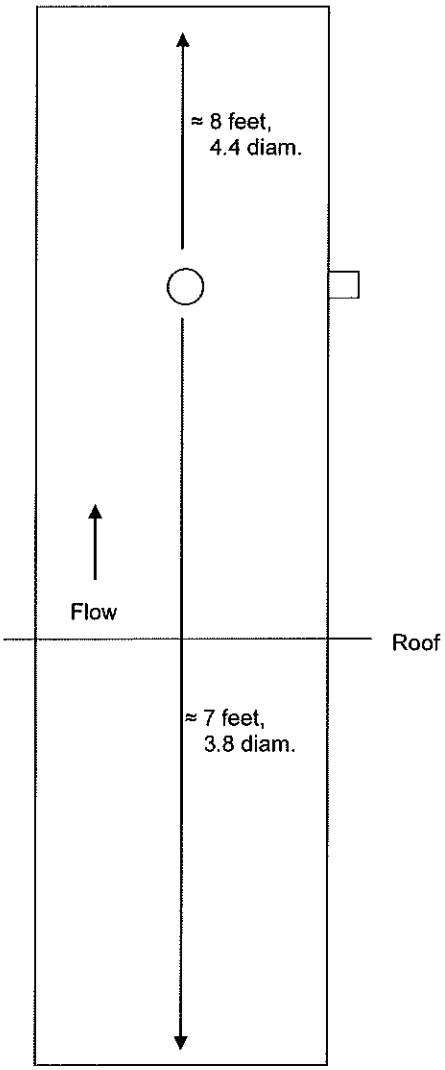
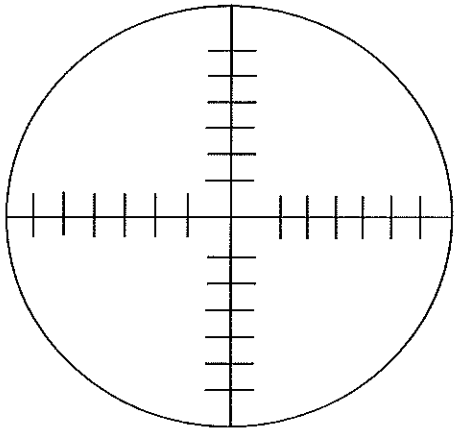
diameter = 22 inches





Not to Scale

Points	Distance "
1	0.5
2	1.5
3	2.6
4	3.9
5	5.5
6	7.8
7	14.2
8	16.5
9	18.1
10	19.4
11	20.5
12	21.5

Figure No. 2

Site: **Kone Exhaust** **Kellog USA, Inc.** **Battle Creek, Michigan**	**Sampling Date:** **November 1-2, 2018**

Montrose Air Quality Services, LLC
4949 Fernlee Avenue
Royal Oak, Michigan 48073

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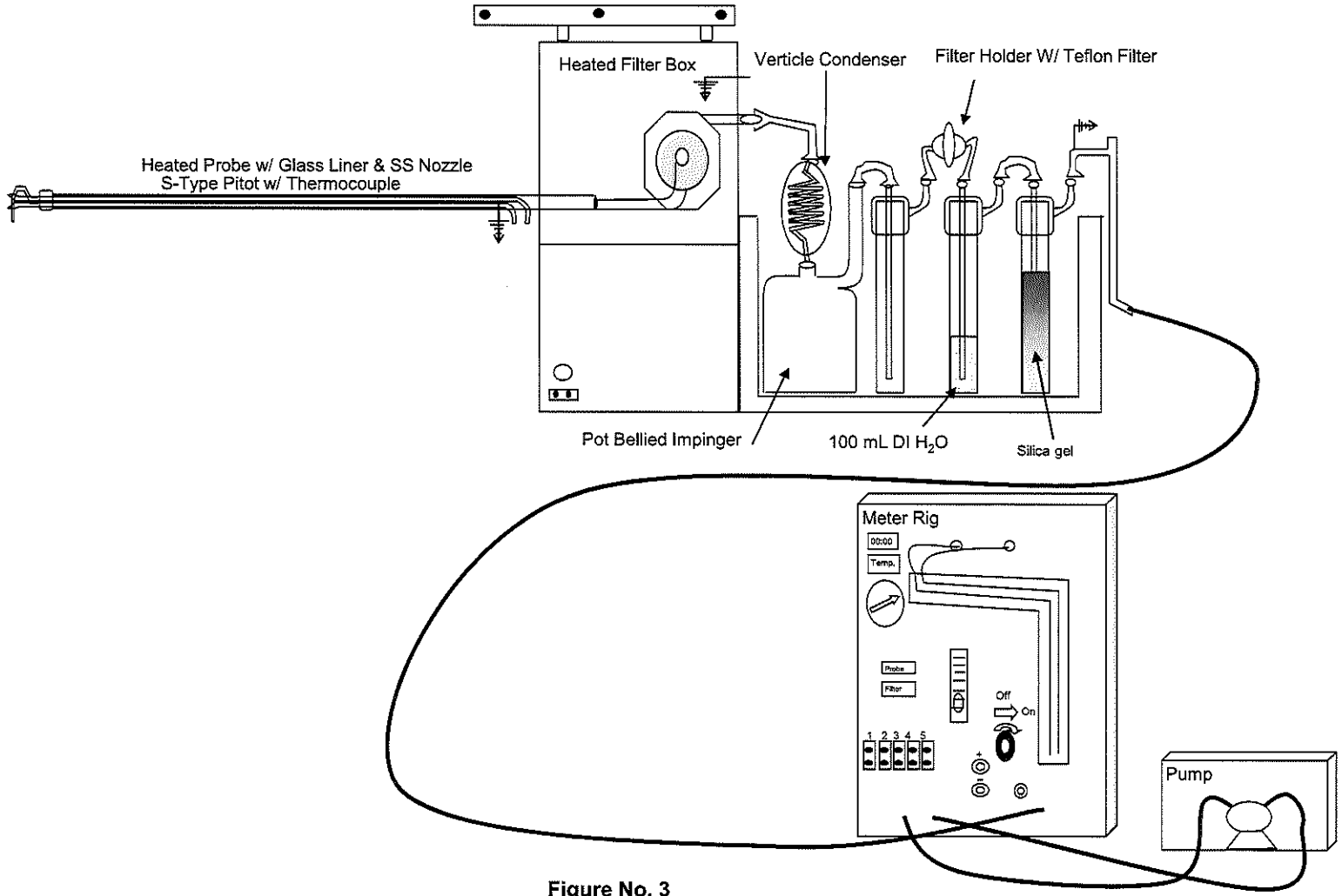

Figure No. 3

Site: **USEPA Method 5/202** **Kellogg** **Battle Creek, Michigan**	**Sampling Date:** **October 25-26, 2018, November 1-2, 2018**	**Montrose Air Quality Services, LLC** **4949 Fernlee Avenue** **Royal Oak, Michigan 48073**