FINAL REPORT

DENSO MANUFACTURING MICHIGAN, INC.

BATTLE CREEK, MICHIGAN

SOURCE TESTING REPORT: H751 THERMAL OXIDIZER DESTRUCTION EFFICIENCY TESTING

RWDI #2407430

October 9, 2024

SUBMITTED TO

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EXECUTIVE SUMMARY

RWDI USA LLC (RWDI) was retained by DENSO Manufacturing Michigan, Inc. (DENSO) to complete an emission sampling program at their Battle Creek Facility located at 1 Denso Road, Battle Creek, Michigan. DENSO operates a manufacturing facility for automotive air conditioning and engine cooling components systems. DENSO operates under Renewable operating permit (ROP) MI-ROP-N1192-2023. This Source Report covers the required testing in the H751 Thermal Oxidizer (H751) under Emission Unit EU-HTR2.

Testing included measurements of Volatile Organic Compounds (VOC) by United States Environmental Protection Agency (U.S. EPA) Method 25A. The testing was completed to fulfill the requirements within the Michigan Department of Environment, Great Lakes, and Energy (EGLE)-issued ROP MI-ROP-N1192-2023. For VOCs, three (3) 60-minute tests were completed concurrently on the H751 Thermal Oxidizer inlet and outlet.

RWDI also completed flue gas velocity measurements and moisture content measurements at the inlet and outlet of the H751 Thermal Oxidizer using methods outlined by U.S. EPA Methods 1, 2, 3, and 4.

DENSO personnel recorded production rate of components processed and the Thermal Oxidizer combustion chamber temperature for each test.

Executive Table i: H751 Destruction Efficiency - Testing Summary

Parameter	Concentration & Emission Rate ($ppmv_w$, lb/hr & % Destruction)				
	Test 1	Test 2	Test 3	Average	ROP Limit
VOC Inlet (as propane)	680.5 $ppmv_w$ 1.97 lb/hr	432.0 $ppmv_w$ 1.26 lb/hr	784.2 $ppmv_w$ 2.30 lb/hr	632.3 $ppmv_w$ 1.84 lb/hr	-- --
VOC Outlet (as propane)	1.60 $ppmv_w$ 0.011 lb/hr	0.94 $ppmv_w$ 0.006 lb/hr	1.37 $ppmv_w$ 0.006 lb/hr	1.30 $ppmv_w$ 0.009 lb/hr	-- 0.29 lb/hr
Destruction Efficiency	99.5%	99.8%	99.7%	99.7%	95%
TO Temperature (°C)	780	782	780	781	--
Est. Production Cores Processed	952	941	939	944	--

Note: **VOC** – Volatile Organic Compound (Total Hydrocarbons (THC))
$ppmv_w$ – parts per million by volume (wet basis).
lb/hr – pounds per hour, wet basis

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1 INTRODUCTION

RWDI USA LLC (RWDI) was retained by DENSO Manufacturing Michigan, Inc. (Denso) to complete a VOC emission sampling program at their Battle Creek Facility located at 1 Denso Road, Battle Creek, Michigan. DENSO operates a manufacturing facility for automotive air conditioning and engine cooling components systems. DENSO operates under Renewable operating permit (ROP) MI-ROP-N1192-2023, this Source Report covers the required testing in the H751 Thermal Oxidizer (H751) under Emission Unit EU-HTR2.

1.1 Personnel Involved in Testing

Details with respect to the key individuals involved with the stack sampling survey are provided below:

Table 1.1.1: Testing Personnel

Jody Smith Environmental Supervisor Jody.Smith@na.denso.com	**DENSO Manufacturing Michigan, Inc.** 1 Denso Road Battle Creek, MI 49037	(269) 965-3322
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David Trahan Senior Field Technician Dave.Trahan@rwdi.com		(248) 841-8442
Shane Rabideau Field Technician Shane.Rabideau@rwdi.com		

2 SUMMARY OF RESULTS

The following tables summarize the testing results. Process data is provided in **Appendix A**. More detailed tables can be found in **Appendices B**. All field sheets are in **Appendix C.** Equipment calibration information is included in **Appendix D**.

Table 2.1: H751 Destruction Efficiency - Testing Summary

Parameter	Concentration & Emission Rate ($ppmv_w$, lb/hr & % Destruction)				
	Test 1	Test 2	Test 3	Average	ROP Limit
VOC Inlet (as propane)	680.5 $ppmv_w$ 1.97 lb/hr	432.0 $ppmv_w$ 1.26 lb/hr	784.2 $ppmv_w$ 2.30 lb/hr	632.3 $ppmv_w$ 1.84 lb/hr	-- --
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Note: **VOC** – Volatile Organic Compound (Total Hydrocarbons (THC))
$ppmv_w$ – parts per million by volume (wet basis).
lb/hr – pounds per hour, wet basis

2.1 Process and Control Equipment Data

Operating conditions during the sampling were monitored by DENSO personnel. All equipment was operated under normal maximum operating conditions.

Contact was maintained between the operator and the sampling team. A member of the RWDI sampling team contacted the operator before each test, to ensure that the process was at normal maximum operating conditions.

The following process and control equipment data was collected and is included in **Appendix C**.

- Estimated Core production rate for each test; and
- Thermal Oxidizer temperature for each test.

2.2 Description of Collected Samples

Details on sample collection are provided in **Section 4** of this report.

2.3 Process Upset Conditions During Testing

There were no process delays during the testing periods.

3 SOURCE DESCRIPTION

3.1 Plant and Source Overview

DENSO operates a manufacturing facility for automotive air conditioning and engine cooling components systems. Under Emission Unit: EU-HTR2, the H751 Thermal Oxidizer controls the emissions from a heater core manufacturing area consisting of metal stampings presses and tube mills. This includes metal forming of fins and mechanical assembly of cores with components for core oven degreasing (H751) and brazing.

3.2 Sampling Locations Overview

This following table summarizes the sampling locations.

Table 3.3.1: Summary of the Stack Characteristics– H751 TO

Source	Parameter	Diameter	Approximate Duct Diameters from Flow Disturbance	Number of Ports	Points per Traverse	Total Points per Test	Average Stack Temperature
TO Inlet	VOC	10"	8.0 downstream and 2.3 upstream	2	8 Flow	1 THC 16 Flow	345°F
TO Outlet	VOC	16.5"	8.5 downstream and 2.2 upstream	2	8 Flow	1 THC 16 Flow	1359°F

4 SAMPLING AND ANALYTICAL PROCEDURES

4.1 Description of Testing Methodologies

The following section provides brief descriptions of the sampling methods and discusses any modifications to the reference test methods that were completed with the testing.

4.1.1 Stack Velocity, Temperature, and Volumetric Flow Rate Determination

Flow rates, temperature, and moisture were collected from each source. The exhaust velocities and flow rates were determined following the US EPA Method 2, "Determination of Stack Gas Velocity and Flow Rate (Type S Pitot Tube)". Velocity measurements were taken with a pre-calibrated S-Type pitot tube and incline manometer. Volumetric flow rates were determined following the equal area method as outlined in US EPA Method 1. Temperature measurements were made simultaneously with the velocity measurements and were conducted using a chromel-alumel type "k" thermocouple in conjunction with a digital temperature indicator.

The dry molecular weight of the stack gas was determined following procedures outlined in US EPA Method 3, "Determination of Molecular Weight of Dry Stack Gas" by Fyrite. Stack moisture content was determined through direct condensation and according to US EPA Method 4, "Determination of Moisture Content of Stack Gas". Moistures were collected at a single point during each test.

4.1.2 VOC by U.S. EPA Method 25A

Regular performance checks on the CEMS were carried out by zero and span calibration checks using USEPA Protocol calibration gases. These checks verified the ongoing precision of the monitor over time by introducing pollutant-free (zero) air followed by known calibration gas (span) into the monitor. The response of the monitor to pollutant-free air and the corresponding sensitivity to the span gases are reviewed frequently as an ongoing indication of analyzer performance.

Prior to testing, a 4-point analyzer calibration error check was conducted using U.S. EPA protocol gases. The calibration error check was performed by introducing zero, low, mid, and high-level calibration gases directly into the analyzer. The calibration error check was performed to confirm that the analyzer response was within ±5% of the certified calibration gas introduced. At the conclusion of each test run a system-bias check was performed to evaluate the percent drift from pre- and post-test system bias checks. The system bias checks were used to confirm that the analyzer did not drift greater than ±3% throughout a test run.

Zero and upscale calibration checks were conducted both before and after each test run to quantify measurement system calibration drift and sampling system bias. During these checks, the calibration gases were introduced into the sampling system at the probe tip so that the calibration gases were analyzed in the same manner as the flue gas samples.

A gas sample was continuously extracted from the stack and delivered to the analyzer. The probe tip was equipped with a heated filter system for particulate removal. The end of the probe was connected to a heated Teflon sample line, which delivers the sample gas from the stack to the CEM system. The heated sample line is designed to maintain the gas temperature above 250°F to prevent condensation of stack gas moisture within the line.

4.1.3 Gas Dilution (Method 205)

Calibration gas was mixed using an Environics 4040 Gas Dilution System. The mass flow controllers are factory calibrated using a primary flow standard traceable to the United States National Institute of Standards and Technology (NIST). Each flow controller utilizes an 11-point calibration table with linear interpolation, to increase accuracy and reduce flow controller nonlinearity. The calibration is done yearly, and the records are included in **Appendix D** of this report**.** A multi-point EPA Method 205 check was executed in the field to ensure accurate gas mixtures. The gas dilution system consists of calibrated orifices or mass flow controllers and dilutes a high-level calibration gas to within ±2% of predicted values. The gas divider is capable of diluting gases at set increments and was evaluated for accuracy in the field in accordance with US EPA Method 205 "*Verification of Gas Dilution Systems for Field Instrument Calibrations*". Before testing, the gas divider dilutions were measured to evaluate that the responses are within ±2% of predicted values. In addition, a certified mid-level calibration gas within ±10% of one of the tested dilution gases was introduced into an analyzer to ensure the response of the gas calibration is within ±2% of gas divider dilution concentration.

5 CONCLUSIONS

Testing was successfully completed on September 4th, 2024. All parameters were tested in accordance with U.S. EPA referenced methodologies and the Test Plan submitted prior to testing.

TABLES

Table 1: Summary of Sampling Parameters and Methodology

Source Location	No. of Tests per Stack	Sampling Parameter	Sampling Method
H751 Thermal Oxidizer	3	Velocity, Temperature and Flow Rate	U.S. EPA [1] Methods 1-4
	3	Oxygen, Carbon Dioxide	U.S. EPA [1] Method 3
	3	THC	U.S. EPA [1] Method 25A

Notes:

[1] U.S. EPA - United States Environmental Protection Agency

Table 2: Sampling Summary and Sample Log

Source and Test #	Sampling Date	Start Time	End Time
H751 Thermal Oxidizer			
Test #1	4-Sep-24	7:52 AM	8:51 AM
Test #2	4-Sep-24	9:25 AM	10:24 AM
Test #3	4-Sep-24	12:03 PM	1:02 PM

Table 3: Sampling Summary - Flow Characteristics - H751

H751 Thermal Oxidizer Inlet		Test No. 1 Inlet	Test No. 2 Inlet	Test No. 3 Inlet	AVERAGE
Testing Date		4-Sep-24	4-Sep-24	4-Sep-24	-
Stack Temperature	°F	344	344	348	345
Moisture	%	5.0%	5.2%	4.3%	4.9%
Velocity	ft/min	1210.6	1214.6	1227.2	1217.5
Referenced Flow Rate (wet)	scfm	424	426	428	426
H751 Thermal Oxidizer Outlet		**Test No. 1 Outlet**	**Test No. 2 Outlet**	**Test No. 3 Outlet**	**AVERAGE**
Testing Date		4-Sep-24	4-Sep-24	4-Sep-24	-
Stack Temperature	°F	1367	1352	1358	1359
Moisture	%	7.8%	7.9%	7.3%	7.7%
Velocity	ft/min	2351.6	2332.1	2289.4	2324.4
Referenced Flow Rate (wet)	scfm	988	987	966	980

Notes:

[1] Referenced flow rate expressed as wet at 101.3 kPa, 68 °F, and Actual Oxygen

Table 4: THC EMISSIONS TABLE

Source: EUHTR2
RWDI Project 2407430

Parameter	Test 1	Test 2	Test 3	Average
Date	4-Sep-24	4-Sep-24	4-Sep-24	--
Start Time:	7:52	9:25	12:03	--
Stop Time:	8:51	10:24	13:02	--
Duration (mins):	60	60	60	--
Inlet VOC Concentration (as propane) $ppmv_{wet}$:	689.2	450.5	805.1	648.3
Inlet VOC Concentration (as propane) lb/hr_{wet}:	2.00	1.31	2.36	1.89
Inlet VOC Concentration (as propane) $ppmv_{wet}$ corrected per Method 7E:	680.5	432.0	784.2	632.3
Inlet VOC Concentration (as propane) lb/hr_{wet} corrected per Method 7E	1.97	1.26	2.30	1.84
Inlet Flowrate (scfm):	424	426	428	426
Outlet Flowrate (scfm):	988	987	966	980
Outlet VOC Concentration (as propane) $ppmv_{wet}$:	1.37	0.38	0.90	0.88
Outlet VOC Concentration (as propane) lb/hr_{wet}:	0.009	0.003	0.006	0.006
Outlet VOC Concentration (as propane) $ppmv_{wet}$ corrected per Method 7E:	1.60	0.94	1.37	1.30
Outlet VOC Concentration (as propane) lb/hr_{wet} corrected per Method 7E	0.011	0.006	0.009	0.009
Destruction Efficiency (VOC lb/hr) (%):	99.5%	99.8%	99.7%	99.7%
Destruction Efficiency (VOC ppm) (%)	99.8%	99.8%	99.8%	99.8%

Notes:

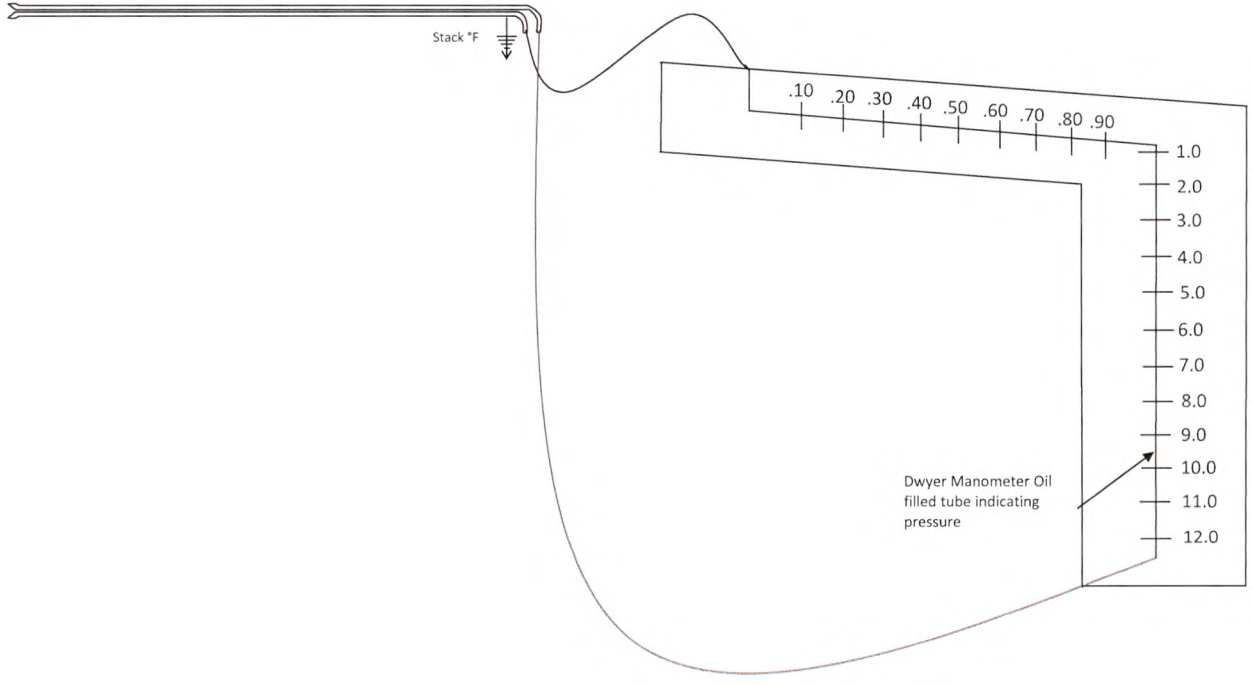
$ppmv_{wet}$ - concentration in parts per million by volume (wet basis)

lb/hr_{wet} - emission rate in pounds per hour VOCs (wet basis)

scfm - flow rate in standard cubic feet per minute (wet basis)

FIGURES

Figure 1: Schematic of USEPA Method 2



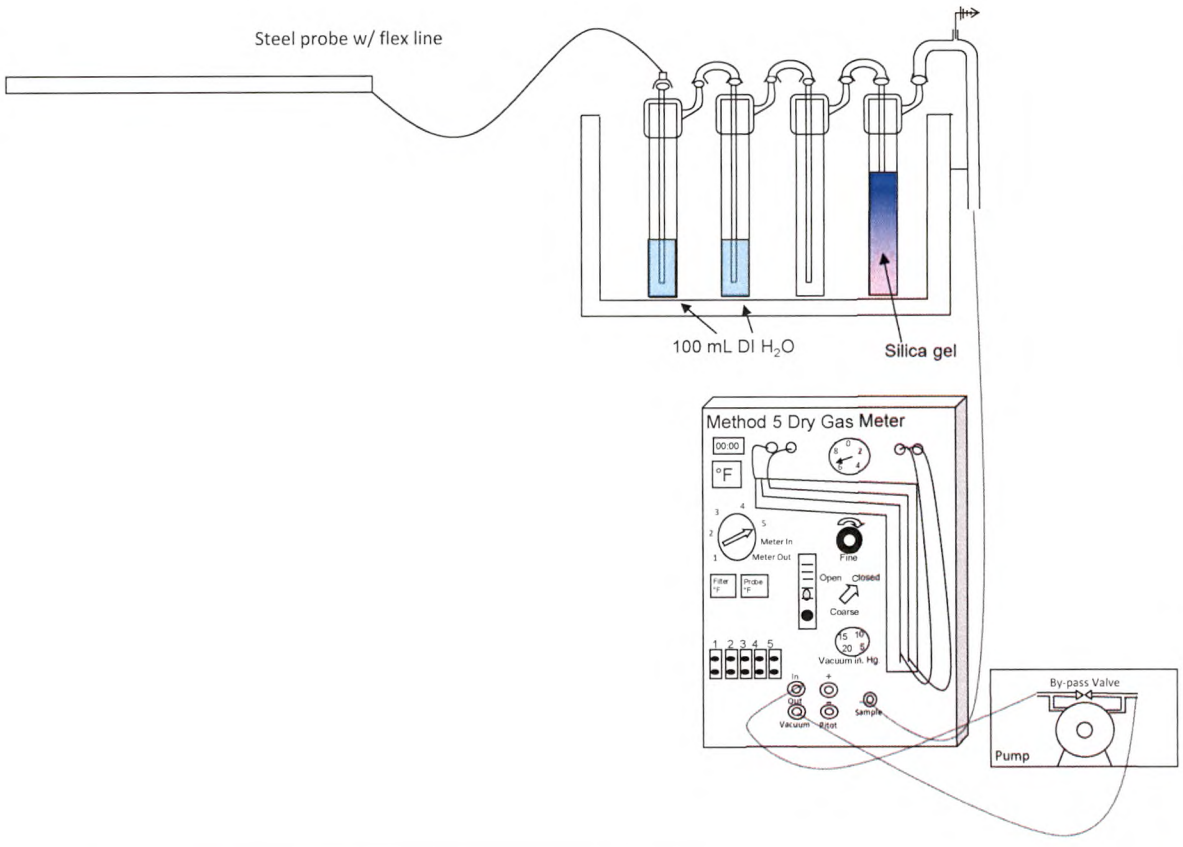
USEPA Method 2

H751 Thermal Oxidizer

Denso Manufacturing Michigan, Inc.

Battle Creek, MI

Figure 2: Schematic of USEPA Method 4



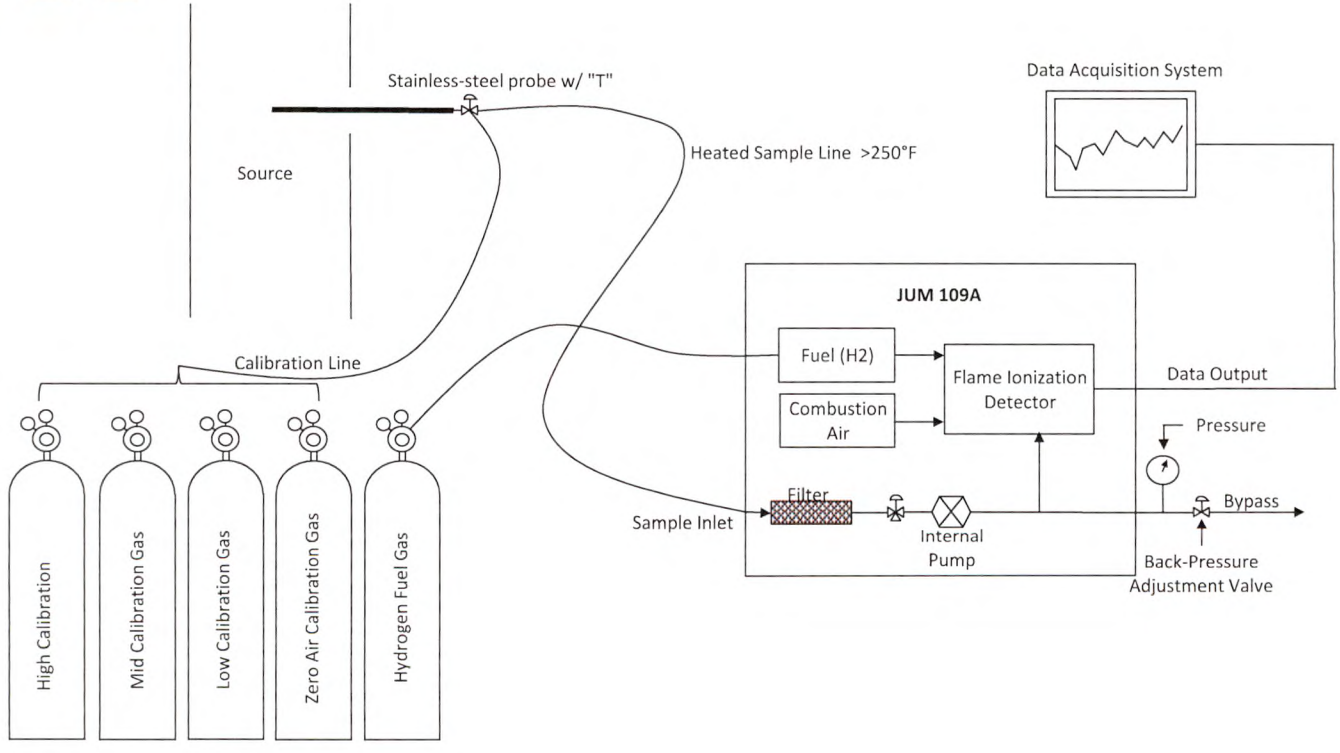
USEPA Method 4

H751 Thermal Oxidizer

Denso Manufacturing Michigan, Inc.

Battle Creek, MI

Figure 3: Schematic of USEPA Method 25A



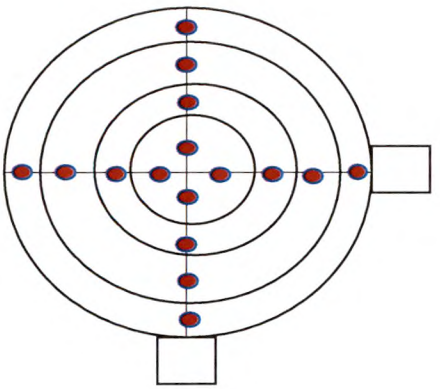
USEPA Method 25A

H751 Thermal Oxidizer

Denso Manufacturing Michigan, Inc.

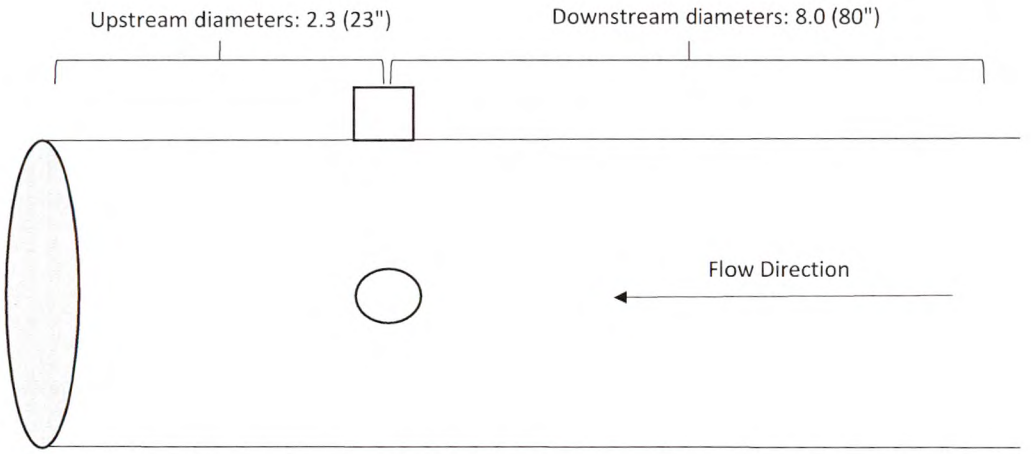
Battle Creek, MI

Figure 4: H751 TO Inlet Traverse Point Diagram



Diameter: 10

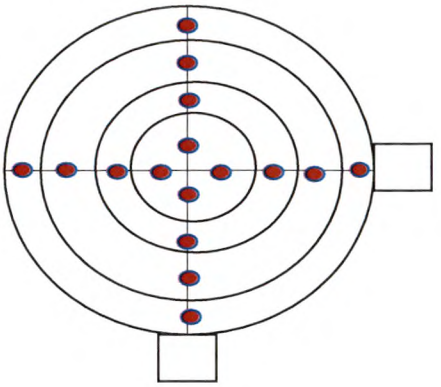
Sampling Points (in.)	
1	0.50
2	1.05
3	1.94
4	3.23
5	6.77
6	8.06
7	8.95
8	9.50

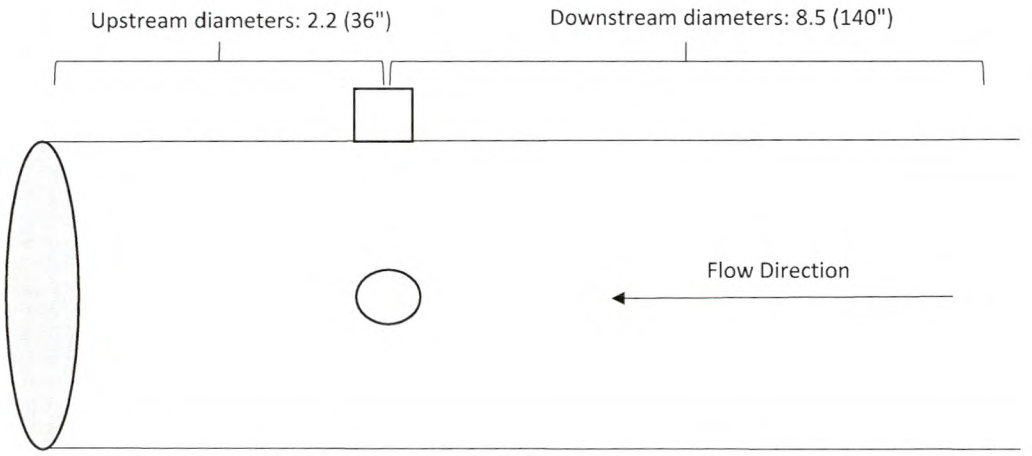


H751 Thermal Oxidizer Inlet
Denso Manufacturing Michigan, Inc.
Battle Creek, MI

RWDI USA LLC
24445 Forterra Dr.
Warren, MI 48089

Figure 5: H751 TO Outlet Traverse Point Diagram



Diameter: 16.5

Sampling Points (in.)	
1	0.50
2	1.73
3	3.20
4	5.33
5	11.17
6	13.30
7	14.77
8	16.00