Alliance TECHNICAL GROUP

Source Test Report

Great Lakes Water Authority
9300 W. Jefferson Avenue
Detroit, Michigan 48209

Sources Tested:
Multiple hearth incinerators: units 7-10

Test Dates: November 29-30, 2022
Report Date: January 20, 2023

Project No. AST-2022-2554
Revision 0

Prepared By
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Regulatory Information

Permit No.	MI-ROP-B2103-2014d
Regulatory Citation	40 CFR Part 60, Subpart MMMM
Regulatory Agency	Michigan Department of Environment, Great Lakes & Energy Air Quality Division, Technical Programs Unit P.O. Box 30260, Lansing, MI 48909-7760
Regulatory Contact	Andrew Riley Environmental Quality Analyst Rileya8@michigan.gov (586) 565-7379

Source Information

Source Name	*Source ID*	*Target Parameter*
Incinerator 7	EUINC 7	NOx
Incinerator 8	EUINC 8	NOx
Incinerator 9	EUINC 9	NOx
Incinerator 10	EUINC 10	NOx

Test Summary

Test Dates	November 29-30, 2022
US EPA Test Methods Used	3A, 7E

Contact Information

Test Location
Great Lakes Water Authority
Water Resource Recovery Facility
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Detroit, MI 48209

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Alliance Technical Group, LLC (Alliance) has completed the source testing as described in this report. Results apply only to the source(s) tested and operating condition(s) for the specific test date(s) and time(s) identified within this report. All results are intended to be considered in their entirety, and Alliance is not responsible for use of less than the complete test report without written consent. This report shall not be reproduced in full or in part without written approval from the customer.

To the best of my knowledge and abilities, all information, facts, and test data are correct. Data presented in this report has been checked for completeness and is accurate, error-free, and legible. Onsite testing was conducted in accordance with approved internal Standard Operating Procedures. Any deviations or problems are detailed in the relevant sections in the test report.

This report is only considered valid once an authorized representative of Alliance has signed in the space provided below; any other version is considered draft. This document was prepared in portable document format (.pdf) and contains pages as identified in the bottom footer of this document.

01/20/23
Date

Michael Kelley
Project Manager
Alliance Technical Group, LLC

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Introduction

1.0 Introduction

Alliance Technical Group, LLC (Alliance) was retained by Great Lakes Water Authority (GLWA) to conduct compliance testing at the Water Resource Recovery Facility located in Detroit, MI. Portions of the facility are subject to 40 CFR 60 Subpart MMMM and the Renewable Operating Permit (ROP): MI-ROP-B2103-2014d. Testing will be conducted to determine the emission rates of NOx at the exhaust of the Multiple Hearth Incinerators (MHI) 7, 8, 9, 10.

1.1 Facility Description

GLWA operates an incineration complex. The incineration complex contains eight sewage sludge incinerators subject to the 40 CFR Part 60, Subpart MMMM emissions guidelines though Rule 972. Sludge is dewatered with belt filter presses and conveyed to the multiple hearth furnaces with belt conveyors. The sludge conveyors are equipped with weigh scales for continuous monitoring of the amount of sludge being incinerated. The dewatered sludge is introduced at the top hearth and rabbled down through successive hearths in a spiral path. The moisture in the sludge is evaporated in the upper hearths as hot combustion gases traveling concurrently from the middle hearths where combustion takes place. The maximum feed rate is 3.2 dry tons per hour at 25% solids and 75% volatiles condition. It is a continuous feed process. Under normal operating conditions each incinerator runs between 2.0 and 2.5 dry tons per hour with temperature of the solids between 50 and 80 °F. The furnace is equipped with auxiliary natural gas burners at hearths 2, 4, 6, 8, 10, and 12. The firing rate of the burners is modulated by a central control system to sustain the desired hearth temperatures.

1.2 Emission Unit and Control Unit Descriptions

Each air pollution control system is comprised of a Double Zero Hearth afterburner section of Hearths 1 and 2, a quench section, and EnviroCare® Venturi-Pak (venturi throat sections and mist eliminator) scrubber system. The total pressure-drop across the wet scrubber ranges between 25 and 40 inches of water column (in. wc). The total scrubber water flow should be greater than 1330 gallons per minute(gpm). Exhaust gases pass through this MHI via an induced draft (ID) fan and exit the scrubber at 100-150 °F

1.3 Source and Control System Descriptions

There have not been any adjustments or significant maintenance performed on the control equipment during the six-month period prior to testing. There have not been any equipment modifications, failures, or malfunctions since the last performance test. There have not been any emissions-related engineering evaluations conducted on the system since the last performance test.

1.4 Process Monitoring

The process parameters that are monitored at the facility, at a minimum, consist of the following:

- Biosolids Feed Rate (wet tons/hr)
- Biosolid Cake Solids (%)
- Biosolids Feed Rate (dry tons/hr)
- Afterburner Exit Temp (°F)
- Total Scrubber Water Flow (gal/min)
- Total Scrubber Pressure Drop (in. wc)
- Scrubber Water Outlet pH

1.5 Project Team

Personnel involved in this project are identified in the following table.

Table 1-1: Project Team

Facility Personnel	Melvin Dacres Management Professional - Operations
Regulatory Agency	Michigan Department of Environment, Great Lakes & Energy Air Quality Division, Technical Programs Unit
Regulatory Personnel	Andrew Riley
Alliance Personnel	Michael Kelley, Project Manager Lucas Chisser

1.6 Test Protocol & Notification

Testing was conducted in accordance with the test protocol submitted to EGLE on October 18, 2022.

1.7 Test Program Notes

*No technical difficulties or protocol deviations were encountered during this test program.

Summary of Results

2.0 Summary of Results

Alliance conducted compliance testing at the GLWA facility in Detroit, MI on November 29-30, 2022. Testing consisted of determining the emission rates of NO_X, O_2, CO_2 at the exhaust of Incinerator Units 7, 8, 9, and 10.

Tables 2-1 to 2-4 provide a summary of the emission testing results with comparisons to the applicable state permit limits. Any difference between the summary results listed in the following tables and the detailed results contained in appendices is due to rounding for presentation.

Table 2-1: Summary of Results- Incinerator 7

Run Number	Run 1	Run 2	Run 3	Average	Permit Limit
Date	**11/29/22**	**11/29/22**	**11/29/22**		
Stack Data					
Oxygen Concentration, % dry	11.44	12.35	11.62	11.80	--
Carbon Dioxide Concentration, % dry	7.25	6.87	7.32	7.15	--
Nitrogen Oxide Data					
Concentration, ppmvd	100.33	100.69	116.82	105.94	--
Concentration, ppmvd @ 7 % (O_2)	147.43	163.69	174.94	**162.02**	**220**
Percent of Limit, %	--	--	--	74	--

Table 2-2: Summary of Results - Incinerator 8

Run Number	Run 1	Run 2	Run 3	Average	Permit Limit
Date	**11/29/22**	**11/29/22**	**11/29/22**		
Stack Data					
Oxygen Concentration, % dry	11.39	12.17	12.55	12.04	--
Carbon Dioxide Concentration, % dry	6.72	6.82	6.54	6.69	--
Nitrogen Oxide Data					
Concentration, ppmvd	138.23	117.97	119.40	125.20	--
Concentration, ppmvd @ 7 % (O_2)	202.14	187.82	198.72	196.23	**220**
Percent of Limit, %	--	--	--	89	--

Table 2-3: Summary of Results - Incinerator 9

Run Number	Run 1	Run 2	Run 3	Average	Permit Limit
Date	**11/29/22**	**11/29/22**	**11/29/22**		
Stack Data					
Oxygen Concentration, % dry	11.44	10.97	10.91	11.10	--
Carbon Dioxide Concentration, % dry	7.30	7.66	7.63	7.53	--
Nitrogen Oxide Data					
Concentration, ppmvd	128.98	133.85	135.76	132.87	--
Concentration, ppmvd @ 7 % (O_2)	189.43	187.42	188.82	188.56	**220**
Percent of Limit, %	--	--	--	86	--

Table 2-4: Summary of Results - Incinerator 10

Run Number	Run 1	Run 2	Run 3	Average	Permit Limit
Date	**11/29/22**	**11/29/22**	**11/29/22**		
Stack Data					
Oxygen Concentration, % dry	10.91	11.33	10.82	11.02	--
Carbon Dioxide Concentration, % dry	7.83	7.52	7.60	7.65	--
Nitrogen Oxide Data					
Concentration, ppmvd	121.15	125.54	134.44	127.05	--
Concentration, ppmvd @ 7 % (O_2)	168.57	182.38	185.48	178.81	**220**
Percent of Limit, %	--	--	--	81	--

Sampling Location

3.0 Reference Method Sampling Location

All MHI sampling locations are identical. Outlet flue gas sampling occurred at a location that is between the scrubber exhaust and induced draft fan. The inside diameter of the exhaust duct is 54 inches. Two test ports, spaced 90° apart, are located 120 inches (2.2 duct diameters) to the nearest upstream disturbance and 108 inches (2.0 duct diameters) to the nearest downstream disturbance. Prior to the start of the continuous emissions monitoring (CEM) a three-point stratification check was performed at the following traverse points (9", 27", and 45").

Testing Methodology

4.0 Testing Methodology

The emission testing program was conducted in accordance with the test methods listed in Table 3-1. Method descriptions are provided below while quality assurance/quality control data is provided in Appendix D.

Table 4-1: Source Testing Methodology

Parameter	U.S. EPA Reference Test Methods	Notes/Remarks
Oxygen/Carbon Dioxide	3A	Instrumental Analysis
Nitrogen Oxides	7E	Instrumental Analysis

4.1 U.S. EPA Reference Test Method 3A – Oxygen/Carbon Dioxide

The oxygen (O_2) and carbon dioxide (CO_2) testing were conducted in accordance with U.S. EPA Reference Test Method 3A. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, heated Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. The quality control measures are described in Section 4.4.

4.2 U.S. EPA Reference Test Method 7E – Nitrogen Oxides

The nitrogen oxides (NOx) testing was conducted in accordance with U.S. EPA Reference Test Method 7E. Data was collected online and reported in one-minute averages. The sampling system consisted of a stainless-steel probe, heated Teflon sample line(s), gas conditioning system and the identified gas analyzer. The gas conditioning system was a non-contact condenser used to remove moisture from the stack gas. The quality control measures are described in Section 4.4.

4.3 CEMS Sampling System and Procedures

What follows is a description of the transportable continuous emissions monitor system used to quantify oxygen, and oxides of nitrogen. The system meets all the specifications of Reference Methods 3A and 7E and conforms to the requirements of The Measurement System Performance Tests as specified in 40 Code of Federal Regulations (CFR), Part 60, Appendix A.

Sample Probe - A heated stainless-steel probe of sufficient length to sample the location specified in Section 1.1.

Sample Line - Approximately 200' of heated 3/8" Teflon tubing (1/16" wall) was used to transport the sample gas from the probe to the emission monitoring analyzers. The sample line is heated to 248°F, ± 25°. Prior to entering the sample gas conditioning system, the gas stream is split. One portion of the sample stream is passed through the sample conditioning system before being delivered to the O2 and NOx analyzers.

Sample Conditioning System

In-Stack Filter - A spun glass fiber filter was located at the probe tip to remove particulate from the gas stream.

Condenser - a Universal Analyzer Sample Cooler or ice cooled condenser was located after the heated sample line for bulk moisture removal and a thermo-electric condenser system is located downstream from the pump to remove any remaining moisture from the gas stream.

Sample Pump - A diaphragm type vacuum pump was used to draw gas from the probe through the conditioning system and to the analyzers. The pump head is stainless steel, the valve disks are Viton, and the diaphragm is Teflon coated.

Calibration Valve - A t-valve, located at the base of the probe allowed the operator to select either the sample stream or introduce calibration gas to the system.

Sample Distribution System - A series of flow meters, valves and backpressure regulators allowed the operator to maintain constant flow and pressure conditions during sampling and calibration.

Gas Analyzers - capable of the continuous determination of O_2 and NOx concentrations in a sample gas stream. They each meet or exceed the following specifications:

Calibration Error	- Less than +2% of span for the zero, mid-and hi-range calibration gases
System Bias	- Less than +5% of span for the zero, mid- or hi-range calibration gases.
Zero Drift	- Less than +3% of span over the period of each test run.
Calibration Drift	- Less than +3% of span over the period of each test run.

Data Acquisition System - A Monarch Model 4600, or equivalent, data logger system was used to record analyzer response to the sample and calibration gas streams. The data logger records at 60-second intervals and the data used to report test interval averages. The Monarch saves data to a compact flash drive that is downloaded to a computer. Separate files for each test run and associated calibrations are generated and saved. Data was loaded into a Microsoft Excel® spreadsheet for calculation of test interval average concentrations and emission rates.

4.4 Quality Assurance/Quality Control – U.S. EPA Reference Test Methods 3A and 7E

EPA Protocol 1 Calibration Gases

Cylinder calibration gases will meet EPA Protocol 1 (+/- 2%) standards. Copies of all calibration gas certificates are included in the Quality Assurance/Quality Control Appendix of the report.

Direct Calibration & Calibration Error Test

Low Level gas was introduced directly to the analyzer. After adjusting the analyzer to the Low Level gas concentration and once the analyzer reading is stable, the analyzer value will be recorded. This process was repeated for the High Level gas. For the Calibration Error Test, Low, Mid, and High Level calibration gases was sequentially introduced directly to the analyzer. The Calibration Error for each gas was within 2.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference.

System Bias and Response Time

High or Mid Level gas (whichever is closer to the stack gas concentration) was introduced at the probe and the time required for the analyzer reading to reach 95 percent or 0.5 ppm/% (whichever was less restrictive) of the gas concentration will be recorded. The analyzer reading was observed until it reaches a stable value, and this value was recorded. Next, Low Level gas was introduced at the probe and the time required for the analyzer reading to decrease to a value within 5.0 percent or 0.5 ppm/% (whichever was less restrictive) was recorded. If the Low Level gas is zero gas, the acceptable response must be 5.0 percent of the upscale gas concentration or 0.5 ppm/% (whichever was less restrictive). The analyzer reading was observed until it reaches a stable value, and this value

was recorded. The measurement system response time and initial system bias was determined from these data. The System Bias for each gas must be within 5.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference.

Post Test System Bias Checks

High or Mid Level gas (whichever is closer to the stack gas concentration) was introduced at the probe. After the analyzer response is stable, the value was recorded. Next, Low Level gas was introduced at the probe, and the analyzer value was recorded once it reaches a stable response. The System Bias for each gas was within 5.0 percent of the Calibration Span or 0.5 ppmv/% absolute difference or the data is invalidated and the Calibration Error Test and System Bias must be repeated.

Post Test Drift Checks

The Drift between pre- and post-run System Bias was within 3 percent of the Calibration Span or 0.5 ppmv/% absolute difference or the Calibration Error Test and System Bias was repeated.

Stratification Check

To determine the number of sampling points, a gas stratification check was conducted prior to initiating testing. The pollutant concentrations were measured at three points (16.7, 50.0 and 83.3 percent of the measurement line). Each traverse point was sampled for a minimum of twice the system response time.

NO_x Converter Check

An NO_2 – NO converter check was performed on the analyzer prior to initiating testing or at the completion of testing. An approximately 50 ppm nitrogen dioxide cylinder gas was introduced directly to the NOx analyzer and the instrument response was recorded in an electronic data sheet. The instrument response was within +/- 10 percent of the cylinder concentration.

Data Collection

A Data Acquisition System with battery backup was used to record the instrument response in one (1) minute averages. The data was continuously stored as a *.CSV file in Excel format on the hard drive of a computer. At the completion of testing, the data was also saved to the Alliance server. All data was reviewed by the Field Team Leader before leaving the facility. Once arriving at Alliance's office, all written and electronic data was relinquished to the report coordinator and then a final review will be performed by the Project Manager.

Appendix A

Location: Great Lakes Water Authority - Detroit, MI
Source: Incinerator 7
Project No.: 2022-2554
Run No. /Method Run 1 / Method 7E

NOx - Outlet Concentration (C_{NOx}), ppmvd

$$C_{NOx} = (C_{obs} - C_0) \times \left(\frac{C_{MA}}{(C_M - C_0)}\right)$$

where,

C_{obs}	103.5	= average analyzer value during test, ppmvd
C_o	5.0	= average of pretest & posttest zero responses, ppmvd
C_{MA}	109.6	= actual concentration of calibration gas, ppmvd
C_M	112.6	= average of pretest & posttest calibration responses, ppmvd
C_{NOx}	100.3	= NOx Concentration, ppmvd

NOx - Outlet Concentration (C_{NOxc7}), ppmvd @ 7% O_2

$$C_{NOxc7} = C_{NOx} \times \left(\frac{20.9 - 7}{20.9 - O_2}\right)$$

where,

C_{NOx}	100.3	= NOx - Outlet Concentration, ppmvd
C_{O_2}	11.4	= oxygen concentration, %
C_{NOxc7}	147.4	= ppmvd @7% O_2

Appendix B

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Location Great Lakes Water Authority - Detroit, MI
Source Incinerator 7
Project No. 2022-2554

Run Number		Run 1	Run 2	Run 3	Average
Date		11/29/22	11/29/22	11/29/22	--
Start Time		9:30	10:48	12:14	--
Stop Time		10:30	11:48	13:14	--
Calculated Data - Outlet					
O_2 Concentration, % dry	C_{O_2}	11.44	12.35	11.62	11.80
CO_2 Concentration, % dry	C_{CO_2}	7.25	6.87	7.32	7.15
NOx Concentration, ppmvd	C_{NOx}	100.33	100.69	116.82	105.94
NOx Concentration, ppmvd @ 7 % O_2	C_{NOxc7}	147.43	163.69	174.94	162.02

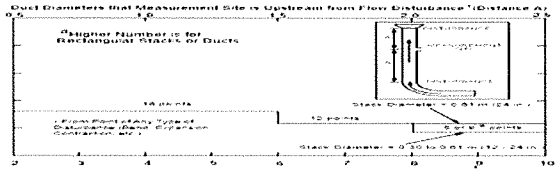
input Nox reading

Method 1 Data

Location: Great Lakes Water Authority - Detroit, MI
Source: Incinerator 7
Project No.: 2022-2554
Date: 11/29/22

Stack Parameters

Duct Orientation:	Horizontal	
Duct Design:	Circular	
Distance from Far Wall to Outside of Port:	57.00	in
Nipple Length:	3.00	in
Depth of Duct:	54.00	in
Cross Sectional Area of Duct:	15.90	ft^2
No. of Test Ports:	1	
Actual Number of Traverse Points:	3	



CIRCULAR DUCT

LOCATION OF TRAVERSE POINTS

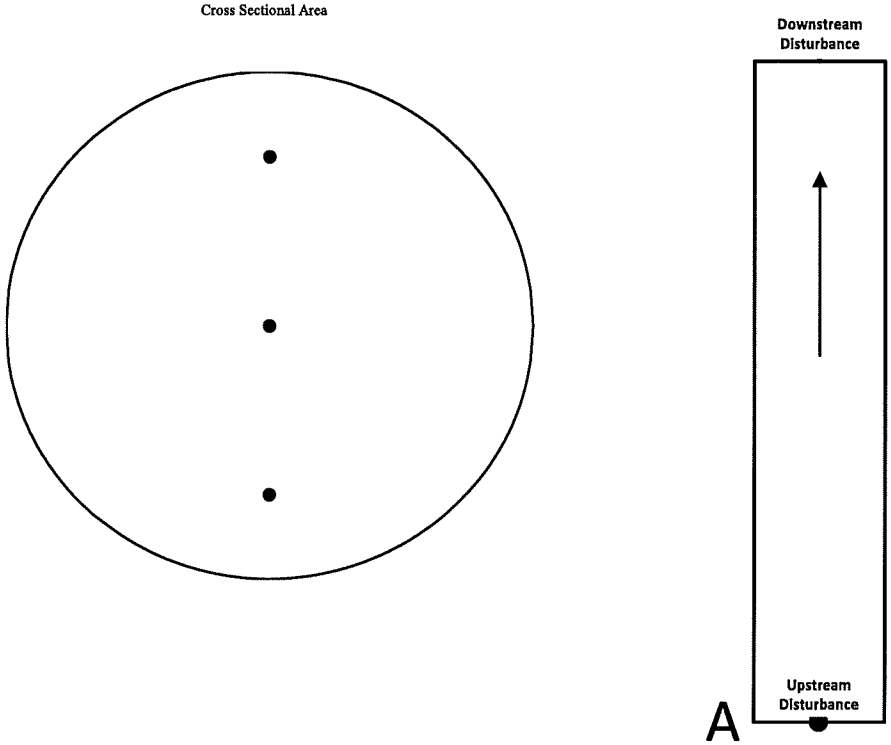
Number of traverse points on a diameter

	2	3	4	5	6	7	8	9	10	11	12
1	14.6	16.7	6.7	--	4.4	--	3.2	--	2.6	--	2.1
2	85.4	50.0	25.0	--	14.6	--	10.5	--	8.2	--	6.7
3	--	83.3	75.0	--	29.6	--	19.4	--	14.6	--	11.8
4	--	--	93.3	--	70.4	--	32.3	--	22.6	--	17.7
5	--	--	--	--	85.4	--	67.7	--	34.2	--	25.0
6	--	--	--	--	95.6	--	80.6	--	65.8	--	35.6
7	--	--	--	--	--	--	89.5	--	77.4	--	64.4
8	--	--	--	--	--	--	96.8	--	85.4	--	75.0
9	--	--	--	--	--	--	--	--	91.8	--	82.3
10	--	--	--	--	--	--	--	--	97.4	--	88.2
11	--	--	--	--	--	--	--	--	--	--	93.3
12	--	--	--	--	--	--	--	--	--	--	97.9

**Percent of stack diameter from inside wall to traverse point.*

Traverse Point	% of Diameter	Distance from inside wall	Distance from outside of port
1	16.7	9.02	12.02
2	50.0	27.00	30.00
3	83.3	44.98	47.98
4	--	--	--
5	--	--	--
6	--	--	--
7	--	--	--
8	--	--	--
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--

Stack Diagram
A = -- ft.
B = -- ft.
Depth of Duct = 54 in.



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Location: Great Lakes Water Authority - Detroit, MI
Source: Incinerator 7
Project No.: 2022-2554
Date: 11/29/22

Time	O_2 - Outlet	CO_2 - Outlet	NOx - Outlet
Unit	% dry	% dry	ppmvd
Status	Valid	Valid	Valid
9:30:06	10.91	7.69	82.37
9:30:36	10.81	7.72	78.73
9:31:06	10.73	7.73	78.71
9:31:36	10.51	7.89	74.70
9:32:06	10.60	7.89	78.71
9:32:36	10.51	7.92	78.18
9:33:06	10.43	7.99	83.62
9:33:36	10.38	8.04	81.81
9:34:06	10.53	7.95	86.51
9:34:36	10.53	7.95	84.83
9:35:06	10.51	7.95	86.01
9:35:36	10.40	8.01	81.82
9:36:06	10.40	8.00	81.69
9:36:36	10.68	7.83	80.52
9:37:06	10.73	7.76	83.62
9:37:36	10.76	7.73	81.56
9:38:06	10.76	7.72	82.34
9:38:36	10.58	7.88	81.30
9:39:06	10.63	7.83	81.81
9:39:36	10.60	7.84	80.67
9:40:06	10.51	7.85	83.24
9:40:36	10.51	7.87	83.25
9:41:06	10.45	7.95	81.56
9:41:36	10.53	7.88	80.89
9:42:06	10.71	7.75	80.53
9:42:36	10.73	7.70	80.77
9:43:06	10.78	7.71	80.17
9:43:36	10.76	7.68	79.21
9:44:06	10.76	7.72	79.93
9:44:36	10.66	7.78	78.72
9:45:06	10.66	7.77	79.51
9:45:36	10.66	7.76	79.64
9:46:06	10.71	7.75	79.24
9:46:36	10.58	7.80	80.31
9:47:06	10.73	7.75	78.71
9:47:36	10.78	7.68	79.91
9:48:06	10.80	7.68	79.64
9:48:36	10.88	7.60	82.47
9:49:06	10.76	7.73	82.34
9:49:36	10.68	7.75	82.96
9:50:06	10.83	7.69	82.36
9:50:36	10.78	7.72	83.26
9:51:06	10.96	7.66	83.89
9:51:36	11.84	6.86	88.25
9:52:06	11.00	7.57	83.64
9:52:36	11.08	7.52	88.86
9:53:06	11.03	7.55	90.08
9:53:36	10.88	7.67	93.25
9:54:06	10.94	7.66	91.97
9:54:36	10.98	7.63	96.27
9:55:06	10.96	7.66	95.07
9:55:36	11.03	7.59	98.85
9:56:06	11.17	7.54	98.43
9:56:36	11.32	7.41	102.61
9:57:06	11.27	7.40	102.45
9:57:36	11.37	7.41	106.96
9:58:06	11.41	7.35	107.34
9:58:36	11.52	7.23	109.89
9:59:06	11.49	7.28	112.34
9:59:36	11.61	7.20	112.49
10:00:06	11.57	7.21	112.37
10:00:36	11.64	7.17	115.59
10:01:06	11.57	7.19	116.67
10:01:36	11.67	7.15	117.18
10:02:06	11.64	7.17	119.75
10:02:36	11.64	7.16	121.84
10:03:06	11.72	7.06	126.45
10:03:36	11.72	7.06	124.64
10:04:06	11.77	7.05	129.18