

**SOURCE TEST REPORT
FOR UNIVERSITY OF
MONTANA WESTERN
DILLON, MONTANA**

CHIP-TEC BOILER

Permit # 3829-00

Test Date: November 13, 2008

Prepared for:

University of Montana Western-Dillon
710 South Atlantic
Dillon, Montana 59725

Prepared by:

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Report Date:

December 18, 2008

EXECUTIVE SUMMARY

Bison Engineering, Inc. (Bison) was retained by the University of Montana Western (WMC) to perform emissions testing for particulate matter less than 10 microns (PM₁₀), nitrogen oxides (NO_x), carbon monoxide (CO) and visible emissions (VE) on the wood-fired Chip-Tec Boiler at the facility located in Dillon, Montana. The following table presents the results of the November 13, 2008, testing.

Table 1: Wood-Fired Chip-Tec Stack Compliance Determination

Wood-Fired Chip-Tec Boiler Stack Emissions, Nov 13, 2008		
Emissions		Limitations
MT-PM ₁₀	0.052	0.20 lbs/MMBtu
NO _x	0.09	0.22 lbs/MMBtu
CO	0.02	0.14 lbs/MMBtu
VE	0%	20%

CERTIFICATION OF REPORT INTEGRITY

Bison Engineering, Inc. (Bison) certifies that this report represents an accurate account of the air quality emissions testing performed at the University of Montana Western Steam Plant on November 13, 2008. Every effort was made to obtain reliable, repeatable, and representative data using source testing methods described in the pretest protocol and the Montana Source Testing Protocol and Procedures Manual.

Project Leader: Jim Wollenberg

Title: Environmental Technician

Signature: _____

Date: _____

Project Review: Calvin Loomis

Title: Project Engineer

Signature: _____

Date: _____

As required by the Montana Source Testing Protocol and Procedures Manual, Section 5, Table 5.1, Item 2.b, the University of Montana Western certifies that, to the best of our knowledge, this report represents the results of the emissions test of the wood-fired Chip-Tec Boiler on November 13, 2008.

Plant Official: Lee Richardson_____

Title:_____

Signature:_____

Date:_____

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1.0 INTRODUCTION

Bison Engineering, Inc. (Bison) was retained by The University of Montana Western - Dillon (WMC) to perform air quality emissions testing on the Wood-fired Chip-Tec Boiler at their facility located in Dillon, Montana. The testing was performed according to the details listed in this protocol and the Montana Source Testing Protocol and Procedures Manual. The test was performed on November 13, 2008.

This report summarizes the results from the testing project and the operating conditions of the process during the testing. The appendices of this report contain the pretest protocol, spreadsheets, testing field data, production data, nomenclature and formulae, equipment/analyzer calibrations and audits, and Protocol 1 gas certifications.

1.1 Program Organization

Bison is a full service air quality consulting company that provides ambient air and meteorological monitoring, air quality permitting, air quality modeling, regulatory negotiations, process-to-emissions optimization and source testing services. Bison's **Process and Emission Services** team is led by Calvin Loomis, P.E., Project Engineer and Team Leader. Additional team members are Mike Chovanak, E.I.T., Project Engineer; Bill Shaw, P.E., Project Engineer; Dave Blankenship, Senior Environmental Technician; Jim Wollenberg, Environmental Technician; and Devon McCarthy, Staff Engineer

Facility Info: University of Montana Western (WMC)
Address: 710 South Atlantic
Dillon, Montana 59725
Contact: Lee Richardson
Phone: 406/683-7037

MDEQ Operating Permit: #3829-00

Consultant: Bison Engineering, Inc.
Address: 1400 11th Avenue
Helena, MT 59601
Contacts: Cal Loomis, Project Engineer
Phone: (406) 442-5768 Fax: (406) 449-6653
Email: cwloomis@bison-eng.com

State Authority: Montana Department of Environmental Quality (MDEQ)
Address: Air Resources Management Bureau
PO Box 200901
Helena, MT 59620-0901
Contact: Bob Gallagher
Phone: (406) 444-4114

1.2 Project Personnel

The following personnel were on site during the emission test or were associated with the project.

1.2.1 Bison Engineering, Inc.

Jim Wollenberg, Environmental Technician, led the testing project. On-site testing was performed by Jim, Mike Chovanak, E.I.T., Project Engineer; and Bill Shaw, P.E., Project Engineer;.

1.2.2 University of Montana Western (WMC)

Lee Richardson was the primary contact for WMC. Jeff Nelson was the boiler operator during the emissions test.

1.2.3 Montana Department of Environmental Quality

Bob Gallagher was the MDEQ contact for the test project. Bob was onsite for part of the emission testing project.

2.0 EMISSION SOURCE INFORMATION

2.1 Facility Description

WMC is a university campus located in Dillon, Montana.

2.2 Emission Source Description

The tested source is located on the campus in Dillon. The source is a 19 MMBtu wood-fired Chip-Tec boiler (close coupled gasified boiler) with a steam production capacity of 11,000 pounds of steam per hour. The pollution controls for the boiler are multi-cyclones.

2.3 Emission Source Permit Limits

The boiler is limited by the specifications set forth in MDEQ Air Quality Permit #3829-00 which limits the plant boiler as follows:

- Opacity* shall not exceed 20% averaged over 6 consecutive minutes;
- Particulate shall not exceed 0.20 lbs/MMBtu;
- Oxides of nitrogen (NO_x) shall not exceed 0.22 lbs/MMBtu
- Carbon monoxide (CO) shall not exceed 0.14 lbs/MMBtu.

*Visible emissions observations were not listed as a required test in the MDEQ permit.

3.0 TEST RESULTS SUMMARY

3.1 Summary of Baghouse Compliance Determination

The following tables present the results from the November 13, 2008, emissions compliance test on the WMC wood-fired Chip-Tec boiler stack. The emission data is presented in pounds per million British thermal units (lbs/MMBtu). PM₁₀ is presented as MT-PM₁₀ because MDEQ includes condensible PM (CPM) which differs from the EPA's definition of PM₁₀.

Table 2: Wood-Fired Chip-Tec Test Results

Wood-Fired Chip-Tec Boiler PM₁₀, NO_x, CO and VE Emissions Test Results, Nov. 13, 2008					
	Run 1	Run 2	Run 3	Avg.	Limitations
Test start time	9:01	11:33	13:55	NA	---
Test duration, minutes	110	100	100	NA	≥ 60 min ¹
Test sample volume, dscf	36.50	34.45	34.41	NA	≥ 31.8 dscf ¹
Isokinetics, %I	92	96	98	NA	100% ±20%
D ₅₀ cut rate	10.19	9.77	9.87	NA	9 μm ≤ D ₅₀ ≤ 11 μm
MT-PM ₁₀ , lbs/MMBtu @9836Fd	0.079	0.048	0.030	0.052	0.20 lbs/MMBtu
VE, % opacity	0%	0%	0%	0%	20%
Combustion Gases Emission Factors					
NO _x , lbs/MMBtu @ 10399 Fd	0.106	0.107	0.064	0.09	0.22 lbs/MMBtu
CO, lbs/MMBtu @ 10399 Fd	0.010	0.011	0.031	0.02	0.14 lbs/MMBtu
Operating Conditions					
Heat input, MMBtu/hr	7.58	7.62	7.4	7.5	40% of 19 MMBtu/hr
Firing rate, %	41	41	41	41	NA
Steam pressure, lbs	13.6	14.3	14.1	14	NA

¹ MDEQ testing requirement.

3.2 Production Data

Boiler production data is presented in the above table.

3.3 Field Notes

There were no deviations from the methods listed in this report. Testing proceeded without interruption.

4.0 TESTING PROCEDURES

4.1 Sampling Site Locations

Sample site locations were determined by Method 1.

4.2 Test Methods and Procedures

Bison testing personnel performed the following EPA methods as described in Title 40, Code of Federal Regulations (CFR), Part 60, Appendix A:

EPA Reference Method 1, "Sample and Velocity Traverses for Stationary Sources." The objective of Method 1 is to determine a suitable location for testing and to determine the velocity measurement points for the source. The distance upstream to atmosphere from the sampling ports (Distance A) is measured and the distance downstream to the nearest disturbance from the sample points (Distance B) is measured. Distances A and B are applied to Method 1, Figure 1-2 for velocity measurement points. These figures give the minimum number of measurement points according to the dimensions of the source. The number of points and the stack diameter are then applied to Method 1, Table 1-2 to determine equal area measurement points within the source. The results of Method 1 location and velocity point measurement locations are included in the report appendices.

EPA Reference Method 2, "Determination of Stack Gas Velocity and Volumetric Flow Rate (Type-S Pitot Tube)." The objective of Method 2 is to measure stack gas velocity, collect temperature data, and calculate a volumetric flow. Method 2 velocity measurements are performed using a Type S pitot tube. Differential pressures are measured using an inclined manometer, and temperatures are measured using a k-type thermal indicator. Bison has incorporated 0.84 as the Type S pitot tube coefficient (C_p). The average velocity, temperature, static pressure, and source area are used to calculate volumetric flow within the source. This field data is recorded on field data sheets. Copies of the field data, results from the flow calculations, and calibration data can be found in the appendices to this report.

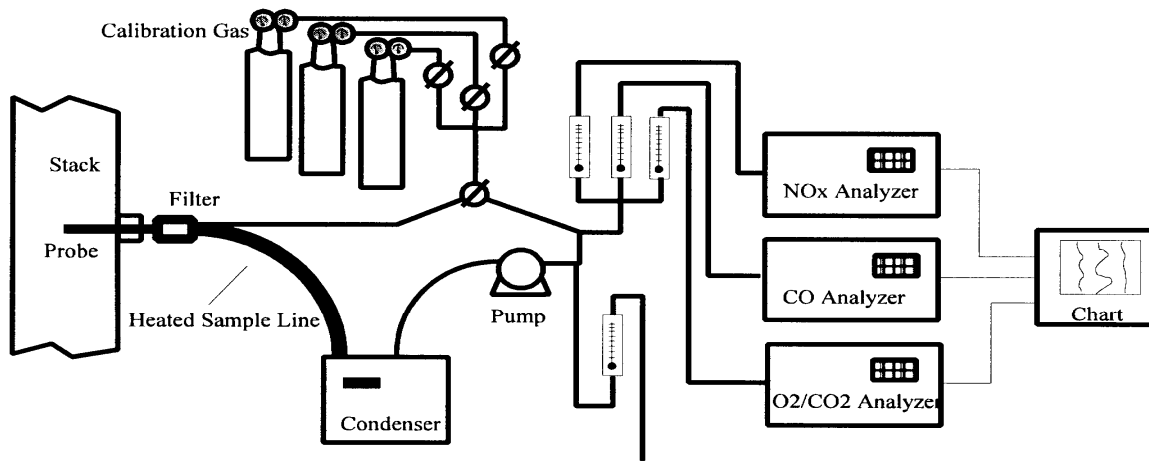
Method 3A, "Determination of Oxygen and Carbon Dioxide Concentrations in Emissions from Stationary Sources (Instrumental Analyzer Procedure)." The objective of Method 3A is to determine the molecular weight of the source stream by determining oxygen (O_2) and carbon dioxide (CO_2) concentrations in the stack gas stream. The principle is to extract a gas sample from a stationary source and route the sample through a conditioning system to a paramagnetic oxygen analyzer and an infrared carbon dioxide analyzer for the measurement of O_2 and CO_2 in percentages (%). The O_2 and CO_2 analyzers calibration adjustments are performed by sending EPA Protocol 1 gas directly to the analyzers. A system calibration is performed by sending calibration gas to the probe and through the system to the analyzers. Bison's CO_2/O_2 analyzer is a Servomex Series 1400 (Serial Numbers 01415/B198 and 014208/901,

respectively). The calibration error, system bias and system drift data, and measured concentrations were recorded on a stripchart or data acquisition system (DAS). A copy of this data is included in a report appendix.

Method 4, "Determination of Moisture Content in the Stack Gases." The objective of Method 4 is to determine the moisture content of a gas stream. The principle of the method is to extract a sample from the source at a constant rate and impinge it through chilled water and silica gel. The moisture is removed from the sample stream and the volume (or mass) of water extracted is determined. The sample volume and water volume (or mass) are used to calculate the moisture content of the stack gas. The results of pre- and post-test dry gas meter (DGM) calibrations can be found in the DGM calibrations table. The DGM calibration data can be found in an appendix of this report. The impinger waters are volumetrically measured on-site and the silica gels are transported to Bison's lab and weighed. The test data is hand-recorded on field data sheets and then entered into spreadsheets for moisture determination calculations. This data and the resulting moisture can be found in the appendices of this report.

EPA Reference Method 7E, "Determination of Nitrogen Oxides Emissions from Stationary Sources." The objective of Method 7E testing is to determine the NO_x concentration from the source. Method 7E entails extraction of a gas sample from a stationary source and routing the sample through a conditioning system to an analyzer for the measurement of NO_x (NO and NO₂) in ppmvd. The NO₂ analyzer calibration adjustment is performed by sending EPA Protocol 1 gas directly to the analyzer. A system bias check is performed by sending calibration gas to the probe and through the system to the analyzer. Bison uses a Thermo Environmental 42C (NO-NO₂-NO_x) analyzer, Serial Number 42CHL-56022-306. The calibration error, system bias and system drift data, and measured concentrations are recorded on a stripchart or DAS for permanent record.

Typical Layout of a Method 6C, 7E and 10 Sampling and RATA System



Method 9, "Visual Determination of the Opacity of Emissions from Stationary Sources." The objective of Method 9 is to quantify the visible opacity of a source plume. The principle of the method is for an observer to take quick observations of the plume at 15-second intervals, determine the reduction of light when looking through the plume and record a numerical value of the plume opacity. If the plume is white, the observer determines the reduction in background detail due to plume opacity. If the plume is black, the observer determines the reduction in light passing through the plume. Opacity observations are performed by a certified observer.

EPA Reference Method 10, "Determination of Carbon Monoxide Emissions from Stationary Sources (Instrumental Analyzer Procedure)." The objective of Method 10 is to determine the CO concentrations from the source. Method 10 entails extraction of a gas sample from a stationary source and routing the sample through a conditioning system to an analyzer for the measurement of CO in ppmvd. The CO analyzer calibration adjustment is performed by sending EPA Protocol 1 gas directly to the analyzer. A system bias check is performed by sending calibration gas to the probe and through the system to the analyzer. Bison uses a Thermo Environmental Instruments 48C CO Analyzer, Serial Number 48C-55909-305. The calibration error, system bias and system drift data, and measured concentrations are recorded on a stripchart for permanent record.

EPA Reference Method 19, "Determination of Sulfur Dioxide Removal Efficiency and Particulate Matter, Sulfur Dioxide, and Nitrogen Oxides Emissions Rates." Method 19 is employed for the determination of mass rate emissions. Results from Methods 3A, 7E and natural gas dry F factor (F_d) (from Table 19-1) are employed to calculate an NO_x emission rate (E) according to the following steps.

Step 1: Calculate NO_x in pounds per standard cubic feet (lbs/scf). Method 19, Table 19-1, provides factors to convert ppm NO_x to lb/scf.

$$C_d = NO_x \text{ ppm} \times 1.194 \times 10^{-7} \text{ lbs/scf/ppm} = NO_x \text{ lbs/scf}$$

Step 2: Calculate NO_x results in pounds per hour using Table 19-2 "Factors for Various Fuels," using the F_d factors and measured oxygen (O_2).

$$E = F_d^{dscf/MMBtu} C_d \frac{20.9}{(20.9 - \%O_2)} = NO_x \text{ lbs/MMBtu}$$

Where: E = pollutant emission rate (lbs/MMBtu)
 C_d = pollutant concentration dry basis (lbs/scf)

Step 3: Using the fuel usage measured during the test and the heating factor of 969.2 Btu/scf n.g., calculate the NO_x results in pounds per hour as follows.

$$E \text{ lbs/MMBtu} \times 9.692 \times 10^{-4} \text{ MMBtu/scf n.g.} \times \text{fuel} \text{ scf n.g./hr} = NO_x \text{ lbs/hr}$$

Method 201A, "Determination of PM₁₀ Emissions (Constant Sampling Rate Procedure)" (Methods 2 & 4 Inclusive). The objective of Method 201A is to determine the particulate matter (PM) emissions equal to or less than an aerodynamic diameter of 10 microns from stationary sources. Bison uses a Method 5 sampling train with a stainless steel probe, an in-stack cyclone and an in-stack filter to gather the PM₁₀ sample. Method 201A incorporates Method 2 "velocity measurements" and Method 4 "moisture measurements."

4.3 Analytical Methods

Chain of Custody: Bison staff maintained possession of the samples throughout sampling, transport and analysis.

Sample Description: Sample description was logged on the field data sheets.

Filter Analysis: Bison weighed filters in an environmentally controlled room. Before field use, the filters were desiccated for a minimum of 24 hours, then weighed and desiccated at 6-hour intervals until a constant pre-test tare was achieved. After the tests, the filters were desiccated for a minimum of 24 hours, then weighed and desiccated at 6-hour intervals until constant post-test weight was achieved. The difference between the average pre-test tare and average post-test weight was the filter mass capture. Sample descriptions are recorded on the field data forms.

Nozzle, Cyclone, Probe and Filter-bell Rinse Analysis: The nozzle, probe and filter-bell were rinsed with acetone. The rinsate was collected in a sample bottle, transferred to a pre-conditioned, tared aluminum sample boat and heated to evaporate the acetone. The boat was again conditioned and weighed to determine "front-half" rinse particulate matter. The rinse mass capture was added to the filter particulate capture to determine "front-half" filterable PM emissions.

Impinger Water: Post-test impinger water description of color and presence of film are recorded on field data sheets. The impinger waters are volumetrically measured after each test run. The water is then transferred to uniquely identified sample containers for transport to Bison's lab. At the lab, sample containers are checked for leakage then the waters are transferred to graduated cylinders where the volumes are checked for leakage. The samples are then poured into beakers and placed on a warming plate to evaporate. Once the water has evaporated to less than 50 mls, the water is transferred to a pre-conditioned, tared boat and placed on the warming plate until completely evaporated. After evaporation, the boats are then placed in a desiccator for a minimum of 6 hours after which they are weighed in 6-hour intervals until a constant weight is achieved.

Silica Gel: Bison transports pre-dried silica gel in airtight containers holding approximately 250 grams. Each container is weighed prior to use in a sampling train. After testing, the gel is placed back into the container and reweighed for moisture gain.

Pre- and post-test silica gel weights are recorded in the lab, entered into the spreadsheets and may be recorded on field data sheets.

Fuel samples were taken during the testing project and sent to the following lab for ultimate analysis and Btu determination. The lab results are presented in an appendix of this report.

Hazen Research Inc.
4601 Indiana Street
Golden, Colorado 80403
Tel. 303 279-4501
Fax 303 278-1528

Contact: Gerard H. Cunningham, Fuel Laboratory Manager

5.0 QUALITY ASSURANCE AND QUALITY CONTROL

5.1 Documentation and Tracking

Bison uses a project number for document control and tracking for all projects. Each project that Bison works on is assigned a project number. All documentation pertaining to that project is filed in the same place under that project number. This assures all pertinent information can be found easily at a later date.

The tracking number for this project is **WMC208954**.

Bison's testing project leader signs an "Emission Source Test Certification" to document and authenticate that the testing was performed according to the methods and applicable MDEQ requirements.

Any changes or revisions to the Source Test Protocol are kept with the protocol and appended to the source test report. Any correspondence from MDEQ regarding the protocol is also appended to the source test report.

5.2 Sampling Protocol

Bison's test, laboratory, reporting, and quality assurance procedures conform to the requirements specified in the *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. III, Stationary Source Specific Methods*, published by the U.S. Environmental Protection Agency in August, 1977, as revised and amended (cat. #EPA-600/4-77-027b).

The individual test methods specify handling procedures for physical samples (liquids, traps, etc.). Bison follows the procedures outlined in the appropriate methods as described in EPA 40 CFR Part 60, Appendix A and Appendix B.

5.3 Quality Assurance

Bison's quality assurance program is designed to ensure that all source testing methods are followed and are performed by competent, experienced personnel. Bison's equipment is properly calibrated and maintained in good working order. Procedures for sample collection, recovery, and analysis are performed according to applicable EPA methods. Bison's practices conform to the procedures in the Environmental Protection Agency (EPA) *Quality Assurance Handbook for Air Pollution Measurement Systems*, Volume 3, EPA-600/4-77-0276, 1977, as amended.

Bison personnel calibrate equipment and instruments using standards when applicable or per the procedures of National Institute of Standards and Technology (NIST). Bison's equipment is manufactured to meet all applicable EPA criteria and parameters. Bison defines a calibration as the procedure of changing a measurement system or device to

match a constant or standard measurement system or device; an “audit” checks the variance between the value and a standard or a precalibration.

Emission testing quality assurance checks and quality controls (QA/QC) require three steps: before, during, and after field testing. “Before” QA/QC procedures are performed in Bison’s lab, “during” QA/QC checks are recorded on the field data sheets, and “after” QA/QC procedures are performed at Bison’s lab. These data can be found in the appendices. The following table describes Bison’s QA/QC, calibration and audit procedures and schedule.

Table 3: Equipment Calibration and Audit Procedures

Parameter or Unit	Schedule and Requirement	Method Reference	Report Location
Acetone / DI water	Blank analysis on the rinse solution and submitted the results in the pretest protocol.	Method 5, 3.2	Pretest protocol
Probe nozzle	Calibration according to reference.	Method 5, 5.1	Report appendix
Isolated Type S pitot tubes	Calibration prior to initial field use.	Method 2, 10.1	Report appendix
	Re-examined after each field use.	Method 2, 10.1.5.2.1	Report appendix
Temperature gauges	Audited on-site and/or after each field use.	Method 2, 10.3.1	Report appendix
Probe heater	Calibration prior to initial field use.	Method 5, 5.4	Report appendix
Barometer	Calibrated against Hg barometer.	Method 2, 10.4	Maintained at Bison office
Metering system	Calibration prior to use.	Method 5, 10.3.1	Report appendix
	Calibration after use.	Method 5, 10.3.2	Report appendix and report table
Analytical balance	Calibrated and/or audited each year by independent auditor.	na	Maintained at Bison office
	Audited during sample weighing.	na	Maintained at Bison office
Analyzers	Analyzer calibration error, ACE.	Method 7E, 8.5	Report appendix
	NO ₂ to NO conversion test.	Method 7E, 8.2.4	Report appendix
Sample system	Sample system bias check, SB.	Method 7E, 8.5	Report appendix
	Zero and calibration drift tests.	Method , 7E.8.5	Report appendix

5.4 Volumetric Sampling Equipment Calibrations

Volumetric Sampling by Dry Gas Meter (DGM)

Volumetric sampling by DGM must be initially calibrated across its full operating range then audited after each testing project. The post-test audit must be within 5% of its initial calibration. Should the DGM not be within the 5% criteria, the DGM factors must be used that will give the lowest sample volume. Calibration data can be found in an appendix to this report. The following table presents the results of the pre- and post-test DGM calibrations and audits.

Table 4: Meter Box Calibration Results

Bison Engineering Equipment Calibration Record				
Unit	Pre-Calibration	Post-Calibration	Results	Required
Meter Box 4, "Y"	1.04	1.013	0.03%	±5% from pre-calibration

Method 5, Section 5.3.3, states that, should the pre- and post-"Y" factor calibrations differ more than 5%, the lesser "Y" value shall be used in the calculations.

5.5 Instrument Calibration, Maintenance and Standards

Bison uses a field barometric pressure gauge that is calibrated prior to each field deployment against a mercury-in-glass standard barometer. Temperature calibrations are performed using a mercury-in-glass NIST-traceable thermometers.

Bison uses RATA-class calibration gases for all emission testing projects which are certified as EPA Protocol 1 gases and are purchased from Scott Specialty Gases. The calibration gas certifications are included in the appendix of this report.

Calibration adjustments of the analyzers are performed by sending the Protocol 1 gas directly to the analyzers. A system audit is performed before and after each test run by sending calibration gas to the probe and through the system to the analyzers. The results of these calibrations and audits can be found in the spreadsheets located in the appendices.

5.6 Data Acquisition, Reduction and Validation

Test data such as velocities, temperatures and isokinetic sampling are hand-recorded on field data sheets. The data is then entered into computer spreadsheets where QC/QA and emission calculations are performed according to the methods. An appendix of this report contains nomenclature and formulae for reference. All raw field data is supplied in an appendix to this report. The appendix contains some example calculations; additional examples will be supplied upon request.

Rounding of Significant Figures

If the first digit to be discarded is less than five, the last digit retained should not be changed. When the first digit discarded is greater than five, or if it is a five followed by at least one digit other than 0, the last figure retained should be increased by one unit. When the first digit discarded is exactly five, followed only by zeros, the last digit retained should be rounded upward if it is an odd number, but no adjustment made if it is an even number.

For example, if the emission standard is 90, then 90.357 would be rounded to 90, 90.639 would be rounded to 91, 90.500 would be rounded to 90, and 91.500 would be rounded to 92.

Standard	Number	Rounded To
90	90.357	90
90	90.639	91
90	91.500	92

5.7 Audit Request

Bison submitted an “audit request” in the protocol to be supplied by the enforcement agency. No audit samples were supplied for this testing project.