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Final Report Describing Particulate and Carbon Monoxide Emissions From the Whitton S-127 Air Curtain Destructor

December 26, 2000

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Project #00-21

FOUNTAINHEAD
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December 26, 2000

Mr. Brian O'Connor
Managing Director
Whitton Technology Ltd.
4390 Cargo Way
Palm City, Florida 34990

RE: Transmittal of Final Emissions Report for the Whitton S-127 Air Curtain Destructor

Dear Mr. O'Connor:

Fountainhead Engineering, Ltd. (FOUNTAINHEAD) is pleased to submit the enclosed final report for the emissions testing performed on the Whitton S-127 refractory lined air curtain destructor conducted on October 10 and October 11, 2000 in Clarkston, Michigan. FOUNTAINHEAD performed three emission test runs with the S-Series technology and averaged the results. Methodologies and approaches are contained in the attached report.

The design of the Whitton S-Series air curtain destruction (ACD) incineration technology presents several challenges to representative emissions sampling. The largest obstacle to representative sampling is the lack of a single, measurable emission point due to its open combustion chamber or "box" design. The turbulence created by the operation of the air curtain, the make up air provided by the air curtain, the temperature of combustion and the resulting rising air creates an extremely turbulent flow over the operating ACD.

Traditional stack testing methods are not designed for sampling from a turbulent gas stream. However, with modifications the quantification or measurement of emissions from the ACD was documented for submittal to State regulators. To our knowledge this is the first time that the S-Series refractory lined incineration units have been subjected to this type of testing. The testing approach utilized can be reproduced following our initial testing methods described in the documentation report. The ability of others to reproduce the results by utilizing the testing protocol was an important factor considered when determining the test method(s). The project team did consider other approaches as well.

We assessed the performance of an ambient air quality testing approach, which would employ ambient air sampling techniques at a point downwind of the operating ACD to quantify particulate emissions. This approach would give an indication of the "impact" of potential contaminants (particulates), but could not be correlated back to a point source emission rate. In addition with the active loading of the unit by either a front-end loader or track backhoe (possibly configured with a grapple attachment) there could be additional particulate readings associated with the rolling stock which could not necessarily be differentiated from particulate emissions from the combusted wood waste incinerated by the ACD. Furthermore measurements may be influenced by the rolling stock feeding fuel into the ACD since the "downwind side" of the ACD would be opposite of the manifold and this happens to be the "loading side" of the ACD. This approach would not illustrate what's happening "above the box". This brings us to our next consideration, a "Canopy Hood Approach".

The initial sampling strategy consisted of assessing the temporary placement of a canopy hood to fully capture any emissions and direct them towards a single exhaust port. The directed emissions would then be sampled using USEPA Methods 1-5 and USEPA Method 10 for Carbon Monoxide. Although this would be a more traditional approach as it relates to "methods" testing the logistical difficulties appeared to be substantial.

The primary "logistical" difficulty is fueling the ACD unit. Fuel is added from the top of the ACD via a front loader or similar "rolling stock" as described previously which is opposite of the manifold. The canopy hood would block efficient fueling of the ACD. Although initially attractive from a simplistic point of view the data collected would be flawed when truly assessing normal operating conditions of the ACD.

The effects of the air curtain and its flow dynamic would be disrupted by the flow interference caused by the collection hood. The likely scenario would be a loss of flow balance, resulting in emissions escaping from the bottom of the canopy hood and would cause a decrease of combustion efficiency resulting from insufficient oxygen supply. The effect on measured emissions rates associated with decreased combustion efficiency from combustion units are well documented and for the ACD the results would probably include increased carbon monoxide readings and increased particulate capture due to the hood. This is not representative of actual operation or "in-field" conditions.

There are many problems associated with the "hood" approach. The initial attractiveness of trying to "force" the flow to one isolated sample point should be weighed against the quality of the data obtained. The data collected in this testing approach would not be able to be reliably reproduced under normal operating conditions associated with this technology in the field and would overestimate emission rates. This approach may be appropriate for "methods applications" but biased for data collection and interpretation. In addition the hood would not allow for normal feeding or loading of the wood waste and would therefore once again not be representative of an actual operating installation under normal operating conditions. The hood approach could not be judged adequate since it changes the operations of the entire system and has many logistical interruptions to the normal operating ACD system.

The next option assessed was "total enclosure". This approach would pace the ACD inside of a temporary enclosure, similar to that of a metal building with a single emission point (or stack) located at the top of the building. Special sliding doors would need to be fabricated and installed in this approach which would allow a front loader to fuel the unit from opposite the manifold. The obvious drawbacks to this approach are safety and health risks for personnel performing the test and operating the unit. As with the canopy approach the entire system dynamics would be altered in order to make the "methods" application more traditional. This would sacrifice an understanding of how the system would actually perform in the field and it would be difficult to replicate under normal operating conditions. In addition it be difficult to evaluate the quality of the data since the building or enclosure would impact the thermal dynamics of the ACD.

From a practical standpoint the heat generated by the accelerated combustion process would be significant and very dangerous to sampling personnel on the roof of the structure. There is a possibility of an oxygen deficient atmosphere inside the building from lack of sufficient makeup air, which could jeopardize the health of the operators and fueling team. In addition to the human factors, a building that would be large and high enough to effectively house the ACD unit operating at maximum efficiency without taking structural damage would not be effective in collecting and concentrating emissions to a single point as intended. Therefore, this approach may be appropriates from a "methods application" but biased from a data quality standpoint.

The goal of any testing should be to accurately confirm how the air curtain technology will perform once installed in the field and operating normally. None of these approaches accomplish this nor do any of these proposed compliance-testing approaches allow for any reliable Method 9 assessment. Method 9 in most regulatory schemes is the primary "method" associated with air curtain incineration devices. Other testing consistent with traditional incineration methods, as we have illustrated would result in significant data collection errors or comprise the quality of the data as it relates to normal operating conditions in the field.

All of the" enclosure" strategies suggested by various regulatory personnel have severe limitations and will not provide consistency with "approved methods". The Whitton S-Series technology for untreated waste wood streams should be subjected to Method 9 testing. If Method 9 illustrates or reveals inconsistency with permit conditions then other testing may be appropriate. USEPA Method 9 is recognized as reliable by the USEPA and is used widely for compliance and used by state and federal agencies throughout the United States not only for compliance but for enforcement as well. Method 9 seems a simple and likely Method to assess this technology and it has been codified as well so consistency with federal regulation is not a problem if one chooses to use this Method for compliance purposes.

Regulatory agencies fail to address the fact that the enclosure testing approaches will:

- Cause an applicant to actually alter the technology for compliance testing only;
- Construct enclosures that if not impossible to build are extremely dangerous and would only be used for some sort of compliance testing that really isn't recognized;
- Place the applicants (or applicants staff) in dangerous conditions to collect unreliable data;
- Cause the fuel loading system to be altered from normal operating conditions and would make it impossible to fuel the S-Series efficiently or consistent with the manufactures specifications; and,
- Enclosure testing approaches will disrupt the flow and combustion characteristics of the ACD, resulting in conditions that are not reflective of actual operating conditions, which would place the results in the un-useable category.

The general goal was to provide a reproducible testing protocol that would not adversely interfere with the normal operating conditions of the ACD and allow the owner-operator to follow the manufactures guidance for safe and effective operation of the ACD. Since enclosures would not allow the ACD to operate as designed, a sampling method had to be devised that would allow the ACD to operate normally and still give a representative emission rate.

The solution devised was to use USEPA Method 5 for particulates (which encompasses Methods 1-4), USEPA Method 10 for Carbon Monoxide, and USEPA Method 9 for Opacity. These Methods were used as written in 40 CFR Part 60, Appendix A, with noted exceptions. These are explained in the documentation report and are summarized below.

The most significant deviation results with the use of USEPA Method 1. This method is used to determine the acceptable location for the sample point locations. This method was designed specifically for sampling *confined* sources of emissions, specifically stacks. The average stack has significant lengths of straight runs and gas flows at a consistent velocity when a blower or fan is incorporated into the system. Air flow in a confined stack follows predictable patterns, and the Reynolds number generally significantly decreases the further you get from any disturbances (fans, bends, changes in diameter). This results in an even, non-turbulent, easily sampled flow stream. Method 1 spells out sampling port locations in respect to upstream and downstream disturbances, and provides recommendations as to the number of sample points required in order to obtain a representative sample. This method is the root, the cornerstone, of all stack sampling.

An ideal sampling point, according to Method 1, is a point 7 to 8 stack diameters downstream from a disturbance, and 2 stack diameters from any upstream disturbance. The absolute minimum allowed is 2-stack diameters downstream, and 1 stack diameter upstream. This is the exact dimensions of the stack structure constructed (in accordance to USEPA Method 5D for lengthening short stacks) used to sample the ACD.

Unfortunately, the ACD does not produce a predictable gas stream source. The combustion chamber of the ACD is chaotic in its operation, with cross drafts, up drafts, and down drafts. To apply traditional stack testing methods to accurately quantify emissions of this source will leave considerable room for interpretation. But since it is classified as an incinerator, it has to be assigned some sort of emission specific to its actual point of emission. This implies to most regulators that do not have a separate category for air curtain incinerators that an applicant is somehow required to apply "traditional" stack testing methods. For the purposes of this discussion, the actual point will have to be classified as *"emissions past all emission control devices"*. The air curtain, along with its air supply properties that simultaneously aid with efficient combustion is also functioning as an emission control device. Therefore, point source emissions are classified as *emissions above the air curtain*.

The air curtain is invisible to the naked eye while in operation. It cannot be seen other than as a disturbance of the flame tips or a particularly intense area of combustion. The digital images included with the documentation report illustrate the clarity or minimal opacity of the operating ACD. However, the air curtain is quite noticeable from a velocity pressure standpoint.

When the stack structure is lowered into the air curtain, the air curtain actually creates a zone of negative pressure within the stack, drawing air from above the stack backwards down to the air curtain for re-circulation into the ACD. When the stack structure is raised above the air curtain, velocity pressure (which is used to calculate the volumetric flow rate) drops to zero. As the stack structure is raised slightly higher, velocity pressure becomes positive, very slightly positive (.010 to .050 inches of water displaced). If the stack is raised higher yet, velocity pressure drops off and becomes almost completely undetectable.

This indicated to the emission testing team that the most representative area to sample the Whitton S-Series unit is at the point of highest velocity pressure. This is what the field team did during the test. The point of negative pressure was identified and the sampling apparatus was raised to the point where velocity pressure was maximized. Our check was that we had a point in between the positive and negative pressures where the flow was zero. This demonstrates that the airflow from the exit manifold was not being funneled into the sampling apparatus (which would dilute the sample and give artificially low results). We were consistently able to reproduce this result during repeated trails before actual testing with the same results and therefore provided evidence that we were sampling the actual emissions of the ACD directly above the emission control device. By sampling at the point of highest velocity pressure, we were attempting to capture the most particulates and sample gas that we could for the ACD. We felt that this approach when compared to all other potential approaches described previously was reasonable, the most cost effective and did not interfere with the manufacturers operating instructions of the ACD and were exactly representative of in field normal operating conditions. The testing has yielded reasonable results, especially for run number 3, which yielded the lowest carbon monoxide numbers (this was the third run of the day, when the ACD was sufficiently heated and loading of the unit during this testing was near continuous).

Given similar conditions with another Whitton S-Series ACD in another location using slightly different waste wood feedstock with equal or greater fueling parameters and with at least 4 hours of peak operating efficiency prior to sampling we could reproduce the results within a reasonable degree of error. Therefore the general goal of reproducible data that reflects normal operating conditions can be achieved. In addition the Method 9 testing performed during testing should provide additional evidence of good combustion and good particulate capture and control.

FOUNTAINHEAD believes that the emission testing methods performed on the ACD provide accurate data that can be reproduced. The test methods also provide emissions data that reflects actual field conditions under normal operating conditions without altering the manufactures specification of the combustion or control technology.

If you have any questions please contact Bruce Bawkon P.E. (734) 663-0883 or Milan Kluko at (312) 332-4434.

Sincerely,

Fountainhead Engineering, Ltd.

Milan Kluko

Fountainhead Engineering, Ltd.

Bruce Bawkon

Bruce W. Bawkon, P.E.

Cc: Dave DeRuiter, CHMM, DeRuiter Environmental, Inc.
Amy L. Miller CHMM, Fountainhead Engineering, Ltd.

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1.0 SUMMARY OF TEST RESULTS

The results of the emissions testing on the Air Curtain Destructor are as follows:

Run Number	Particulate (lbs/hr)	Carbon Monoxide (lbs/hr)	Opacity (%)
Run 1 (Startup)	**0.81**	**4.67**	**1.5**
Run 2	**3.08**	**27.62**	**6.3**
Run 3	**1.54**	**7.06**	**3.8**
Run 4	**1.81**	**26.27**	**6.1**
Averages*=	**2.14**	**19.98**	**5.4**

***** Averages of Runs 2, Run 3 and Run 4 only. Run 1 was an engineering test to quantify emissions during start up and collect initial flow data from the mobile stack test unit.

1.1 DESCRIPTION OF PROCESS

This mechanical combustion unit or MCU is a departure from typical combustion equipment upon which most air quality regulations have historically been developed. The S-Series MCU has a patented manifold design and it is engineered specifically to the dimensions of the combustion chamber. It has a specialized ceramic refractory lining that surrounds the combustion chamber. *Therefore it is quite different from other air curtain devices and incineration technologies*. This combustion system does not utilize a stack to transport combustion gases out of the primary or secondary furnace or boiler, which in turn passes into particulate and/or other air pollution control devices such as electric static precipitators (ESP's), bag houses or acid gas scrubbing systems. The primary combustion chamber is also not totally enclosed on four sides like most furnaces or boilers. These primary differences present some unique situations with the typical "air quality" approval process. This will be discussed in greater detail in Section 6 of this Technical Memorandum.

The engineering aspects of this unit rely on the fact that it is completely self-contained and the unit functions in a fashion that does not rely solely on an air delivery system blowing air across the unit for optimum emission control or combustion performance. The S-Series MCU relies on several systems with integrated supporting functions that enhance the operation of the MCU. This approach has refined the "air curtain concept". We will refer periodically to the S-127 series MCU but the technology for the other S-Series MCU are identical.

There are several variations of the S-Series MCU manufactured by Whitton Technology. The S-127 MCU is 37'4" long, 11'9' wide and 10'3" in height. The S-121 model is 32'2" long, 11'9" wide and 10'3" in height. The S-127 weighs approximately 50,000 lbs. and the S-121 weighs 41,000 lbs. Whitton also manufactures an S-116 model, which is 27' long, 7' 5" wide, and 7' 5" in height and weighs 24,500 lbs. The majority of the discussions in this memorandum are directed towards the Whitton Technology “S-Series” machines and the S-127 specifications are used as the basis for most of the narrative describing the Whitton Technology ACD’s as well as potential emission and throughout calculations. These above ground, self-contained, refractory lined combustion units are designed to reduce waste stream volume and are primarily targeted for combustible material and waste wood waste streams. This technology is a lower cost alternative to wood chipping and tub grinding.

The S-127 MCU can combust waste wood, pallets, demolition debris, fiber products and landscape wastes in an environmentally safe fashion with maximum volume reduction and minimum opacity. The MCU is a fully self-contained engineered system. The S-127 system is capable of processing up to 18 tons per hour of “bulk” wood waste such large tree trimmings, pallets and other waste wood material while the S-121 system is capable of processing up to 15 tons per hour of waste wood feedstock.

The principle of the air curtain concept is optimized through the Whitton Technology design. High velocity air is directed across and downwards at a specific angle into the combustion area creating the air curtain on top and a rotational turbulence within the combustion chamber or “firebox”. The rotational turbulence provides an oxygen enriched environment within the combustion zone which accelerates the combustion process by raising the temperatures within the pit to 2,300°F to 2,800ºF (1,375ºC to 1,550ºC).

The average theoretical daily processing or throughput rate, based on a typical eight-hour day using 5,000 Btu per pound feedstock like wood waste, would be high as high 145 tons or 90 cubic yards per hour (or approximately 800 cubic yards per day), depending on the feedstock. Opacity and particulate emissions are extremely low during normal operating conditions. Complete combustion of the wood waste insures maximum volume reduction with maximum safety since this is being accomplished in a refractory-lined chamber that provides for very high operating temperatures while the rotational turbulence created by the patented air curtain manifold system provides an over oxygenated combustion environment.

The MCU is constructed on 10-inch square skids. The MCU can be moved or relocated at a site very simply by attaching hooks, cables etc., to either pad eyes or lift lugs and then lifting or dragging the entire unit along the ground by a front end loader, backhoe, crane or similar equipment. The Diesel engine is mounted on a channel rack. The entire front deck is covered with ¼" (6.35 mm) steel diamond plate. All welds are continuous fillet welds for overall strength. The entire structural unit receives two coats of primer and three coats of orange gloss enamel paint for optimum protection.

The forward equipment deck supports a four-cylinder diesel engine, 100-gallon fuel tank, the drive system and the fan. When viewing from the front of the unit, the patented 14" diameter air disbursement manifold is mounted on the top left side of the combustion chamber. The entire combustion box or chamber is comprised of refractory panels. The rear of the combustion chamber is constructed with refractory lined panel doors. The doors swing open in opposite directions for access to the interior of the unit for removal of residual ash. After cleaning, the doors are closed and the unit is ready to operate. Attachment A contains schematic drawings of the MCU.

The diesel engine, operating at 1,500 to 2,000 RPM (max. 2,400 RPM) drives the fan mechanism in order to achieve approximately 2,000 RPM's that generate a minimum airflow of 15,000 cubic feet per minute (CFM). This high velocity air is directed down the manifold through restricted outlets. The fan is designed so as to direct high velocity air down a *patented* air disbursement manifold that redirects the air over and down into the combustion pit.

Measurements from the S models verify that the unit can operate at a minimum average nozzle discharge velocity over 9,050 feet per minute (FPM) with minimum nozzle discharge airflow of 760 CFM per 12" nozzle length. Several of the readings during testing exceeded 9,050 with the highest reading being 11,559.58 FPM (October 1998). This results in complete combustion of all wood feedstocks while providing excellent particulate control.

The air curtain delivery system for this MCU acts as a "lid" over the firebox, trapping particulate while simultaneously providing excess oxygen to the combustion area thereby promoting a more intense and uniform fire and insures complete combustion of the feedstock (combustible material). The fan, operating at approximately 2,000 RPM's and 6" w.g. (1,490 Pa) minimum static pressure, produces in excess of 18,000 cubic feet (510 m^3) per minute of airflow. The manifold is equipped with patented "scuffers" that partition off the required amount of air through the entire length of the manifold so as to maintain a uniform discharge rate along the entire length of the firebox or combustion chamber. As mentioned previously, the vanes in the discharge nozzle produce discharge port exit velocities of 760 CFM per foot of nozzle length.

The system's effectiveness in entraining particulate under the continuously operating air curtain is designed to produce very minimal fugitive emissions into the atmosphere. Most authorizations in the United States require the operator to maintain opacity between 10 to 20 percent. In the United States obtaining authorization for operation of the MCU (in most states) has been reduced to a very simple process primary associated with wood waste and herbaceous waste streams.

The manifold system that produces and distributes the air curtain serves as a very effective particulate control mechanism while at the same time providing the equivalent of "over fire" and "under fire" air supply continuously promoting complete combustion. The velocity and aspect of the air introduced into the Whitton Technology S Series combustion chamber greatly enhances the primary objective of most incineration devices, which is complete combustion at very high temperatures. Temperatures achieved by this unit while burning wood, vegetative and similar combustible materials typically range between 1,600ºF to 2,300ºF. The refractory walls contain the heat within the combustion chamber so that 24" away from the outside of the refractory walls the ambient temperature is only slightly higher than the surrounding atmosphere.

The refractory panels and door frames are poured with a castable refractory of 4" (102 mm) rated at 2,800º F (1,540ºC). After curing, the castable thermal ceramic panels have a cold crushing strength of up to 5,000 PSI (352 kg/cm^2). Each panel weighs approximately 1,200 lbs. (544 kg) and is equipped with two steel pad eyes for easy removal and replacement. The two refractory panel doors weigh approximately 1,700 lbs. (771 kg) each. Four custom hinges support the doors.

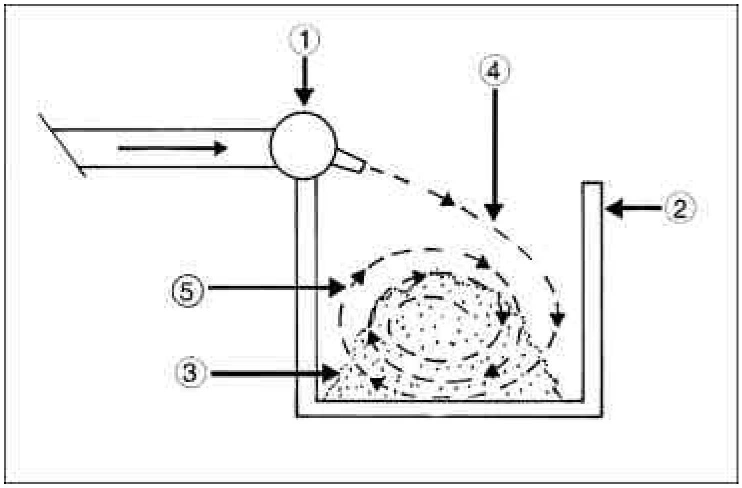
The intense oxygen flow coupled with the specific geometric design of the firebox essentially creates an after burner effect. By re-circulating the air under the curtain, residence time of the particulate is increased long enough for their effective combustion (pyrolization) with virtually no smoke or ash escaping. As a result of the extremely high temperatures and the high velocity airflow directed over, under and into the combustion chamber or “fire box” at precise angles, the MCU contains particulate emissions extremely efficiently while again promoting complete combustion of the fuel (feedstock).

The patented manifold system serves another important aspect besides particulate control in that it creates an after burner effect inside the combustion chamber to destroy potential fugitive emissions. The refractory lined unit provides exterior safety while in the interior the refractory maintains extremely high temperatures. Due to the continuous air curtain and associated turbulence inside the combustion chamber, extremely high temperatures are experienced while again achieving complete combustion.

1.2 THE PRINCIPLE OF AIR CURTAIN INCINERATION

The primary operating principle of an *air curtain* in this application is to control particulate emissions. Another advantage in this specific application is that it provides more oxygen for the fire that results in complete combustion. The introduction of a controlled high velocity air stream across the upper portion of the combustion chamber creates a powerful curtain of air excluding the major pathway for particulate and other fugitive emissions. When introduced during the combustion process, the super-heated air created in this process actually becomes a rotating mass of high temperature air averaging up to 2,300ºF (or 1,260ºC) that has been trapped in the combustion chamber.

The fuel input (waste material) and airflow can be modified rather simply. A reduction or increase in the air velocity from the air curtain manifold into the combustion chamber changes the aspect of the fire within the combustion chamber. Fuel modification is accomplished by changing the feed rate of the combustible material so that good combustion is achieved and maintained without the need for supplemental fuel sources such as natural gas. This also eliminates the need for over fire or under fire air in order to achieve maximum Btu production from the fire and insure complete combustion, which results in significant volume reduction. The sustained turbulence results in complete combustion of the loaded feedstock (waste material). The protective (air) curtain created by the rotating air significantly reduces fugitive emissions. Again the “S-Series system” provides redundant levels of pollution control, not redundant pieces of combustion or air pollution devices. The following simple diagram illustrates the fundamental operating principal of the self-contained refractory lined combustion unit MCU.



1. Air curtain system manifold showing nozzles that direct high velocity airflow into refractory lined combustion box.

2. Refractory lined walls used to both absorb and reflect heat back into the primary combustion area surround the combustion chamber or firebox.

3. Combustible material (feedstock) to be burned.

4. Airflow schematic forming high velocity "air curtain" that acts as a controlling device to trap fugitive particulate while providing increased oxygen for fire.

5. Representative airflow produced by air curtain refracting off of the chamber walls that over-oxygenates the fire maintaining high temperatures in the firebox that provides for more complete combustion of material.

1.3 OPERATION OF THE WHITTON TECHNOLOGY AIR CURTAIN DESTRUCTOR

The combustion chamber or firebox is loaded using a backhoe or front-end loader. A small skid steer loader with a grapple attachment can also be used for loading or "packing" the combustible material. Care should be given to the direction of prevailing winds and should be away from the loading side of the firebox. In order to understand how to load the firebox, you must first understand why it is important to do so in a specific manner. The normal starting procedure is to start a fire in the bottom of the firebox. A fire started in the bottom will climb to the surface igniting material on the way up. The procedure is relatively straightforward:

1. Load sufficient small, dry and clean brush or wood into the bottom of the firebox to a level of about 2 to 3 feet, making sure the entire bottom area of the firebox is covered.

2. Establish that there is sufficient small material (less than two inches in diameter) in the bottom, followed by larger diameter branches or untreated lumber. This should then be followed by larger material such as logs (six to ten inches in diameter) followed by larger diameter material and stumps. Sufficient time should be allocated in constructing this "second layer" and insuring that it is also well packed and that it is level across the firebox.

3. All material placed in the firebox should be tightly packed. If there are large air spaces between the combustible material it will not ignite efficiently and combustion will not accelerate and progress properly causing the initial fire in the combustion chamber to be difficult to maintain which could lead to excessive smoking during startup.

4. Feedstock in the firebox that will be ignited should be kept about two feet below the top of the firebox. Care should be taken to ensure material does not extend above the top of the firebox. The loading of material into firebox is always performed from the opposite side of the manifold.

5. A petroleum-based product is often used to aid with ignition. This is usually accomplished using 5 gallons of diesel fuel. A torch device is used to ignite the fuel that is spread over the feedstock or wood waste. Charcoal, fiber ignition logs or a propane ignition device can be used for lighting the fire.

   Once flames begin to appear above the manifold, engage the operating lever of the motor with the throttle at idle speed. As the fire begins to spread and temperatures increase the RPM's of the MCU should also be increased by approximately 200 RPM's. After the diesel plume has dissipated and the MCU startup plume is visible (i.e. white smoke) the engine speed is increased again by 200 RPM's. As RPMs are increased in increments of approximately 200 RPM's, visible opacity should be reduced to 10% (from approximately 20-25% during the initial 20 minute startup phase).

As the temperature of the fire in the combustion chamber increases, the engine speed is also increased to approximately 1,800 RPM's. Ultimately, the normal operating range of the S-127 MCU should be between 1,500 and 1,900 RPM's.

Adherence to the startup procedures described should achieve optimum operating temperatures in the combustion chamber and therefore opacity should not exceed a Ringelmann Smoke Number of 1.0 after 30 minutes of operation. Once again the opacity is used to verify good combustion and is a consistent verifiable measure of appropriate operating conditions.

It is imperative to observe what type of material should be added to the fire, when to add additional material, and where to place the material. This is a function of the dynamics of the fire and the procedure is refined through experience with the MCU. Material is slowly added for the first 60 minutes after engaging the air distribution system. It takes approximately one hour for the fire to reach maximum temperature. If hot spots develop in the fire, dense material such as stumps or shorter denser pieces of waste wood should be placed in these areas.

The fire across the top of the MCU should be relatively level and at no time should new material be stacked higher than the MCU manifold. The firebox must be loaded continuously throughout the day in order maintain sufficient operating temperatures. If the fire is not loaded continuously, the heat will subside which will result in excessive smoke and increased opacity. All loading should stop about two hours before the fire is to be extinguished. As the fire burns down the airflow through the manifold must be maintained and possibly slightly increased in order to keep the remainder of the material burning hot.

The volume of material that can be processed per hour is a function of density of the waste material, moisture content of the waste material, loading techniques and the time period in which optimum temperatures in the pit can be retained. Upon completion of the combustion stage (i.e. when an active hot fire is being continuously maintained), the waste material will be reduced in bulk by 95% leaving only 5% in volume as residual ash. System efficiency will be reduced once the residual ash build-up reaches approximately 2.5 to 3 feet (91 cm) in the bottom of the firebox. Typically after a few days of operation the ash will need to be removed from the system.

2.0 TESTING LOCATION AND PROJECT TEAM MEMBERS

On October 10-11, 2000 a test was performed on a new Whitton S-127 Air Curtain Destructor (ACD). The test site was located in Clarkston, Michigan.

The test was performed to identify the source characteristics and quantify emissions of particulate matter, carbon monoxide, oxides of nitrogen, and sulfur dioxide.

2.1 Contact Information in Regards to Test Data:

Milan Kluko, Fountainhead Engineering, Ltd. Phone (312) 332-4434
David DeRuiter, DeRuiter Environmental, Inc. Phone (850) 933-5622

2.2 Personnel On-Site During Testing:

Larry Tester, Genesis Air, Inc.
Scott Mignery, Genesis Air, Inc.
David DeRuiter, DeRuiter Environmental, Inc.
Milan Kluko, Fountainhead Engineering, Ltd.
Bruce Bawkon, Fountainhead Engineering, Ltd.
Tom Snyder, Dart Industries, Owner of the S-127 Air Curtain Destructor

3.0 PROCESS DESCRIPTION

3.1 Air Curtain Destructor (ACD)

The Whitton Technology Air Curtain Destructor (ACD) was developed for disposal of waste wood and landscape wastes with maximum volume reduction and minimum opacity. The Whitton technology uses high velocity air is directed across and downwards at specific angles into a refractory lined combustion chamber creating an air curtain on top of the chamber while also sustaining a significant rotational turbulence within the combustion area. This rotational turbulence provides an oxygen enriched environment within the combustion zone which accelerates the combustion process by raising the temperatures in the chamber to approximately 2000 degrees Fahrenheit and promotes complete combustion. The air curtain integrated into this operation acts as a lid over the combustion chamber minimizing fugitive emissions during the combustion process. The Whitton technology S-Series air curtain technology uses patented airflow velocity and aspects to achieve particulate capture. The Whitton air curtain technology serves as the primary integrated air pollution or particulate controlling technology for this refractory lined system. A more detailed description was included in Section 1.

The average theoretical daily processing, or throughput rate, based on an eight-hour day using 5,000 Btu per pound feedstock like wood waste, would be as high as 145 tons or 90 cubic yards per hour.

3.2 Operating Conditions During Testing

The ACD was fully stoked and allowed to reach operating temperature prior to beginning testing. The feed rate throughout testing averaged approximately 90 cubic yards per hour based on field information provided by Fountainhead Engineering, Ltd.

4.0 SAMPLING AND ANALYSIS METHODS

The emission testing was performed in accordance with the methods described in 40 CFR, Part 60, Appendix A. The following are descriptions of the methods used.

4.1 Sampling Methodology

Due to the unconfined and turbulent nature of emissions resulting from the operation of the Air Curtain Destructor (ACD) Unit, some USEPA (United States Environmental Protection Agency) Test methods were modified. Specific modifications per method are discussed in Section 4.2.

Sample gas and particulates were collected over the combustion area using a mobile sampling unit consisting of a platform lift with a 10' support leading to a stack structure. The stack structure was 4 feet in length and 14" in diameter. Straightening vanes were installed at the bottom of the structure. The Method 5 sampling train was suspended from the mobile sampling unit, and the nozzle was located in the center of the stack structure.

There were twelve traverse points over the top of the ACD unit. Using USEPA Method 1 the Project Team selected sample point locations. The entire top of the ACD unit was treated as the edges of a rectangular stack.

The vertical location of sampling was determined by positioning the stack structure in the air curtain produced by the manifold. When the stack structure was placed into the air curtain itself, velocity pressure became negative due to draft effects. This served as positive identification of the vertical location of the air curtain in relation to the actual sample point. The entire stack structure was then raised out of the air curtain to an area where velocity pressure was maximized (approximately 8-12" above the air curtain). This was the point of sampling.

A schematic of the sampling train used is provided in Appendix C: Process and Sampling Schematics**.**

4.2 Summary of Modified USEPA Methods

USEPA Method 1 – Sample and Velocity Traverses for Stationary Sources

USEPA Method 1 was used to determine appropriate sample point locations. These points are then used to sample the stack gas for temperature, moisture content, and stack gas velocity.

The modification to USEPA Method 1 was to treat the entire open area at the top of the ACD as a large rectangular stack. Also, the number of sample points was reduced to twelve rather the recommended sixteen points due to terrain and sample train movement considerations. A diagram of sample traverse locations is located in Appendix C: Process and Sampling Schematics.

USEPA Method 2 – Determination of Stack Gas Velocity and Volumetric Flow Rate

EPA Method 2 was used to measure the velocity pressure and temperature of the stack gas exiting the unit. A calibrated S-type pitot tube with an inclined manometer and temperature meter were used to obtain the specific data.

A differential pressure gauge with greater sensitivity was used due to low range gas velocities.

The stack structure was used only for turbulence reduction and flow confinement purposes. Its diameter was not used in any volumetric flow rate calculations.

USEPA Method 5D – Determination of Particulate Matter Emissions from Positive Pressure Fabric Filters

A section of this Method was applied to compensate for the unconfined nature of the source. A temporary stack structure was constructed according to Figure 5D-1 of this method, equipped with flow straightening vanes to decrease turbulence and a single sample port. The nozzle of the Method 5 sampling train was located at the center of the stack structure.

4.3 Summary of Test Methods Used as Written

USEPA Method 3A- Gas Analysis for the Determination of Dry Molecular Weight

The stack gas is sampled and analyzed for oxygen, carbon dioxide, carbon monoxide, and nitrogen content. These percentages are used to determine the dry molecular weight of the stack gas. An ECOM S+ provided this information for carbon dioxide and oxygen. A Thermo 48C (NDIR) provided this information for carbon monoxide.

USEPA Method 4- Determination of Moisture in Stack Gas

As part of the pollutant measurement method, stack gas samples are collected during each run. These samples are taken from the ductwork by application of the Method 5 sampling train consisting of a sample nozzle, heated sample probe, sample line, impingers in an ice bath, vacuum pump, and dry gas meter. The condensed moisture is measured and the sample gas volume is used to calculate the percent moisture.

USEPA Method 5 – Determination of Total Particulate Matter

Total Particulate concentrations were measured by the application of Method 5. Method 5 procedures withdrew PM emissions isokinetically from the source and then collected them on a pre-weighed filter. The samples collected were then prepared for analysis in accordance with Method 5. Larry Tester of Genesis Air, Inc, performed sample analysis.

USEPA Method 9 – Visual Determination of the Opacity of Emissions from Stationary Sources

Method 9 requires that a Certified Observer of Visible Emissions make a reading of estimated opacity above the source. David DeRuiter of DeRuiter Environmental, Inc, performed opacity readings.

USEPA Method 10 – Determination of Carbon Monoxide Emissions From Stationary Sources

Method 10 involves the extraction of an integrated gas sample, which is conditioned and analyzed by an NDIR (nondispersive infrared analyzer) for carbon monoxide. The specific Model used a Thermo 48C High Level Gas Filter Correlation (GFC) CO Analyzer set on the 0-1000 ppm Range.

Analysis of Combustion Gases (SO2, NO, NO2, CO, O2)

An integrated gas sample was extracted and monitored continuously using an ECOM S+ five-gas analyzer. The ECOM S+ is a microprocessor based portable emission analyzer utilizing electrochemical sensors and gas conditioning systems. This information was collected for informational purposes to help quantify potential emissions from the ACD and was not used in any carbon monoxide calculations.

4.4 Quality Assurance

As part of the test requirements, certain quality assurance procedures were followed so that a quality emission test would be guaranteed. The following calibrations were performed as part of this quality assurance:

Calibration Units	Parameter
Dry Gas Meter	Y Factor
Probe Nozzles	Diameter
Pitot Tube	Geometric Specifications
Temperature Sensors	Degrees (+ or -)
NDIR detector	EPA Protocol Calibration Gas (0 and 452.5 ppm)
Chemical Detectors	EPA Protocol Calibration Gas (0 and 452.5 ppm)

All calibrations were found to be acceptable and within the required limits. The results of these calibrations can be found in Appendix D: Calibration Data.

5.0 DISCUSSION OF TEST RESULTS

5.1 Start up

Run 1 is representative of operating conditions during the first 30 minutes of operation after even combustion has been attained and the Air Curtain Destructor (ACD) is not up to full operating temperature. Sampling was done at a point in the center of the ACD, and no traverses were made. The sampling was executed at a constant flow rate.

The results are presented below and full test data is presented in Appendix A: Method Calculations and Test Data.

Run Number	Particulates (lb/hr)	Carbon Monoxide (lb/hr)	Opacity (%)
Run 1 (Start Up)	**0.81**	**4.67**	**1.5%**

5.2 Normal Operating Conditions

Run 2, Run 3, and Run 4 are representative of emissions of the ACD while at efficient operation. The results are presented in the table below and full test data is presented in Appendix A: Method Calculations and Test Data.

Run Number, Date, Time	Particulates (lb/hr)	Carbon Monoxide (lb/hr)	Opacity (%)
Run 2 10-10-2000, 1432 Start	**3.08**	**27.62**	**6.3**
Run 3 10-10-2000, 1636 Start	**1.54**	**7.06**	**3.8**
Run 4 10-11-2000, 1210 Start	**1.81**	**26.27**	**6.1**
Averages	**2.14**	**19.98**	**5.4**

5.3 Opacity

Opacity averaged 5.4% during the testing period. There is very little opacity when the ACD is in full operation, with typical readings being in the 5-10% range. Opacity readings tended to increase during the charging of the ACD with fuel to levels ranging from 15-25%. This increased opacity would continue for approximately 1-2 minutes due to agitation of partially combusted materials, but would then fall to normal levels of 5-10% after re-equilibrating. Opacity data sheets are located in Appendix B: Field Data Sheets.

5.4 Sulfur Dioxide and Nitrogen Oxide

Emissions of sulfur dioxide and nitrogen oxide were minimal.

Sulfur dioxide readings of approximately 1 part per million (ppm) were obtained during Run 3, but there was no sulfur dioxide present during the other runs. This reading is considered a trace amount and was not included in emissions calculations.

Nitrogen oxide was also detected in a trace amount of approximately 1-4 ppm at various stages of the testing. This concentration reading was not consistent and was not included in emissions calculations.

Data sheets are presented in Appendix B: Field Data Sheets.

5.5 Errors Discussion

There is a significant variance in the carbon monoxide data between Runs 2 and Run 4 as compared to Run 3. A possible cause for this is the increased combustion efficiency of the ACD after continued operation. Both Run 2 and Run 4 were performed approximately 1.5 hours after initial startup, while Run #3 was performed after the ACD had been in operation for nearly 5 hours. Regardless, all three runs were counted in the average for carbon monoxide emissions.

The weather conditions at the time of sampling were near standard conditions. Wind direction was predominantly from the northwest, blowing across the ACD at a 45 degree angle length to width at speeds between 4-16 knots. The ACD was shielded from these winds by surrounding topography and semi trailers stored on the site. The effects of wind shear across the top of the ACD, especially in the sample zone, are judged to be minimal. Weather data is presented in Appendix B: Field Data Sheets.

The isokinetic sampling rates (the velocity at the sampling nozzle compared to the velocity of the stack gas) were slightly high (109.5%, 110.5%, and 117.2%) for Run 2, Run 3 and Run 4, respectively. Depending on the particle size distribution, this tends to understate the particulate loading, especially for particulates of larger diameter. Given the relatively low pounds per hour emissions rate, these higher isokinetic rates are not considered a significant error and will not have a major impact on total emissions calculations. The particulate sample filter was sent to AAC Trinity Laboratories in Farmington Hills, Michigan for particle size distribution analysis. The results will be published as an addendum to this report when they become available.

Appendix A: Method Calculations and Test Data

Method 5 Calculation Sheet, Run Summary
Method 5 Calculation Sheets
Method 10 Sample Collection

	Method 5 Calculation Sheet				
Burner Test		Test Date: 10/10/00 & 10/11/00			
Input Parameters	Run 01	Run 02	Run 03	Run 04	Average*
Stack Dimensions, inches =	105 x 330	105 x 330	105 x 330	105 x 330	105 x 330
Area of Stack, sq ft =	240.6	240.6	240.6	240.6	240.6
Pitot Tube Coefficient (CP), unitless =	0.84	0.84	0.84	0.84	0.84
Stack Gas Temp (TS), ° R =	683.2	763.6	747.8	748.6	753.3
Dry Gas Meter Temp (TM), Ave. °R	525.2	526.4	525.7	533.9	528.7
Ave. Sq Root Velocity Head, in HOH =	0.091	0.144	0.117	0.122	0.128
Ave. Dry Gas Meter Orifice Pressure, in HOH =	3.00	1.20	0.773	0.828	0.934
Barometric Pressure (BP), in Hg =	30.11	30.11	29.93	30.18	30.07
Stack Gas Static Pressure (delta H), in HOH =	0.00	0.00	0.00	0.00	0.00
Absolute Stack Gas Pressure (PS), in Hg =	30.11	30.11	29.93	29.90	29.98
Moisture Collected, ml =	20.0	25.8	24.2	28.3	26.1
Volume of Water Vapor, cu. ft.	0.95	1.22	1.15	1.34	1.24
Stack Gas Moisture, % =	3.25	2.77	3.13	3.45	3.12
Mole Fraction of Dry Stack Gas =	0.967	0.972	0.969	0.965	0.969
Carbon Dioxide in Stack Gas, % =	0.2	0.2	0.2	0.2	0.2
Oxygen in Stack Gas, % =	20.5	20.4	20.5	20.5	20.5
Carbon Monoxide in Stack Gas, % =	0.0	0.0	0.0	0.0	0.0
Nitrogen in Stack Gas, % =	79.3	79.4	79.3	79.3	79.3
Stack Gas Dry Molecular Weight, lb/lb mole (MWD) =	28.85	28.85	28.85	28.85	28.85
Stack Gas Molecular Weight, lb/lb mole (MW) =	28.50	28.55	28.51	28.48	28.51
Dry Gas Meter Cal Factor, Y =	0.993	0.993	0.993	0.993	0.993
Sample Volume, dry cubic feet (VM) =	28.208	42.887	35.498	37.495	38.627
Sample Volume, dry standard cubic feet (VMstd) =	28.736	43.400	35.719	37.463	38.861
Particulate Weight, milligrams =	2.8	10.7	5.4	10.1	8.7
Nozzle Diameter (DN), inches =	0.505	0.505	0.505	0.505	0.505
Calculations					
Stack Gas Velocity (VS), feet/second =	5.84	9.75	7.86	7.82	8.48
Stack Gas Volumetric Flow Rate, acfm =	84258	140685	113527	112824	122345
Stack Gas Volumetric Flow Rate (QS), scfm(dry) =	63116	94756	77327	78400	83494
Isokinetic Sampling Rate (Piso), % =	522.7	109.5	110.5	117.2	112.4
PM Loading, Probe & Filter (CAN), grains/dscf =	0.0015	0.0038	0.0023	0.0025	0.0029
PM Emission Rate, lbs/hour =	0.812	3.083	1.543	1.813	2.146
PM Emission Rate, lbs/1000lbs of stack gas =	0.0062	0.0157	0.0096	0.0112	0.0122
(*) average represents Runs 2, 3, & 4 only					

Facility:	T. Snyder	Meter Box #:	C-2		Amb. Temp:	60
Location:	Burner	Y Factor:	0.993		B. P.:	30.11
Run #:	1	Meter Delta H@:	1.855		Assumed Moist:	2
Date:	10/10/00	Pitot Coef:	0.84		Probe Temp Set:	250
Operators:	lt, dd, sm	Leak Rate-Str:	<0.001	@ 15 in. Hg	Filter Temp Set:	250
Run Start:	1242	Leak Rate-End:	<0.001	@ 5 in. Hg	Stack Diameter:	na
Run Stop:	1312	Filter ID:	L-14		Stack Dimensions:	105 x 330
Run Time:	30	Nozzle size:	0.505		Static Press:	0.00
Traverse Point	Velocity Head	Sq Rt of Vel	Stack Temp	Gas Meter Temp		
1	0.011	0.105	285	65	Sample Vol End:	887.015
2	0.008	0.089	281	65	Sample Vol Start:	858.807
3	0.008	0.089	250	65	Total Sample:	28.208
4	0.008	0.089	186	66	Water Vol, ml:	20.0
5	0.008	0.089	167	66		
6	0.007	0.084	170	66	Filter Final Wt, g:	0.3609
7	na	#VALUE!	na	na	Filter Tare Wt, g:	0.3583
8	na	#VALUE!	na	na	Weight Gain, g:	0.0026
9	na	#VALUE!	na	na		
10	na	#VALUE!	na	na	Probe Rinse Final Wt, g:	67.7895
11	na	#VALUE!	na	na	Probe Rinse Tare Wt, g:	67.7893
12	na	#VALUE!	na	na	Weight Gain, g:	0.0002
Averages:	0.008	0.0911	223.2	65.5		
					Blank wt, g =	0.0000
					Total Wt, g =	0.0028
					Total Wt, mg =	2.8

Facility:	T. Snyder	Meter Box #:	C-2		Amb. Temp:	60
Location:	Burner	Y Factor:	0.993		B. P.:	30.11
Run #:	2	Meter Delta H@:	1.855		Assumed Moist:	2
Date:	10/10/00	Pitot Coef:	0.84		Probe Temp Set:	250
Operators:	lt, dd, sm	Leak Rate-Str:	<0.001	@ 15 in. Hg	Filter Temp Set:	250
Run Start:	1434	Leak Rate-End:	<0.001	@ 5 in. Hg	Stack Diameter:	na
Run Stop:	1544	Filter ID:	L-14		Stack Dimensions:	105 x 330
Run Time:	72	Nozzle size:	0.505		Static Press:	0.00

Traverse Point	Velocity Head	Sq Rt of Vel	Stack Temp	Gas Meter Temp		
1	0.025	0.158	376	65	Sample Vol End:	930.202
2	0.010	0.100	365	65	Sample Vol Start:	887.315
3	0.010	0.100	295	65	Total Sample:	42.887
4	0.025	0.158	245	65	Water Vol, ml:	25.8
5	0.020	0.141	296	65		
6	0.010	0.100	195	65	Filter Final Wt, g:	0.3735
7	0.010	0.100	155	67	Filter Tare Wt, g:	0.3630
8	0.012	0.110	188	67	Weight Gain, g:	0.0105
9	0.026	0.161	145	68		
10	0.055	0.235	518	68	Probe Rinse Final Wt, g:	62.3265
11	0.035	0.187	524	68	Probe Rinse Tare Wt, g:	62.3263
12	0.030	0.173	341	69	Weight Gain, g:	0.0002
Averages:	0.022	0.1436	303.6	66.4		
					Blank wt, g =	0.0000
					Total Wt, g =	0.0107
					Total Wt, mg =	10.7

Facility:	T. Snyder	Meter Box #:	C-2		Amb. Temp:	62
Location:	Burner	Y Factor:	0.993		B. P.:	29.93
Run #:	3	Meter Delta H@:	1.855		Assumed Moist:	2
Date:	10/10/00	Pitot Coef:	0.84		Probe Temp Set:	250
Operators:	lt, dd, sm	Leak Rate-Str:	<0.001	@ 15 in. Hg	Filter Temp Set:	250
Run Start:	1636	Leak Rate-End:	<0.001	@ 5 in. Hg	Stack Diameter:	na
Run Stop:	1759	Filter ID:	L-14		Stack Dimensions:	105 x 330
Run Time:	72	Nozzle size:	0.505		Static Press:	0.00
Traverse Point	Velocity Head	Sq Rt of Vel	Stack Temp	Gas Meter Temp		
1	0.010	0.100	299	64	Sample Vol End:	965.811
2	0.015	0.122	317	64	Sample Vol Start:	930.313
3	0.025	0.158	230	66	Total Sample:	35.498
4	0.010	0.100	230	66	Water Vol, ml:	24.2
5	0.015	0.122	282	66		
6	0.025	0.158	265	66	Filter Final Wt, g:	0.3672
7	0.010	0.100	247	66	Filter Tare Wt, g:	0.3620
8	0.010	0.100	299	66	Weight Gain, g:	0.0052
9	0.015	0.122	317	66		
10	0.010	0.100	320	66	Probe Rinse Final Wt, g:	63.5642
11	0.010	0.100	320	66	Probe Rinse Tare Wt, g:	63.5640
12	0.015	0.122	327	66	Weight Gain, g:	0.0002
Averages:	0.014	0.1172	287.8	65.7		
					Blank wt, g =	0.0000
					Total Wt, g =	0.0054
					Total Wt, mg =	5.4

Facility:	T. Snyder	Meter Box #:	C-2		Amb. Temp:	63
Location:	Burner	Y Factor:	0.993		B. P.:	30.18
Run #:	4	Meter Delta H@:	1.855		Assumed Moist:	5
Date:	10/11/00	Pitot Coef:	0.84		Probe Temp Set:	250
Operators:	lt, dd, sm	Leak Rate-Str:	<0.001	@ 10 in. Hg	Filter Temp Set:	250
Run Start:	1210	Leak Rate-End:	<0.001	@ 5 in. Hg	Stack Diameter:	na
Run Stop:	1330	Filter ID:	C-17		Stack Dimensions:	105 x 330
Run Time:	72	Nozzle size:	0.505		Static Press:	0.00
Traverse Point	Velocity Head	Sq Rt of Vel	Stack Temp	Gas Meter Temp		
1	0.015	0.122	385	71	Sample Vol End:	1005.519
2	0.015	0.122	324	72	Sample Vol Start:	968.024
3	0.015	0.122	275	72	Total Sample:	37.495
4	0.015	0.122	316	72	Water Vol, ml:	28.3
5	0.015	0.122	325	73		
6	0.010	0.100	292	74	Filter Final Wt, g:	0.3728
7	0.020	0.141	385	75	Filter Tare Wt, g:	0.3632
8	0.020	0.141	326	75	Weight Gain, g:	0.0096
9	0.015	0.122	225	75		
10	0.015	0.122	233	76	Probe Rinse Final Wt, g:	62.8951
11	0.010	0.100	182	76	Probe Rinse Tare Wt, g:	62.8946
12	0.015	0.122	195	76	Weight Gain, g:	0.0005
Averages:	0.015	0.1219	288.6	73.9		
					Blank wt, g =	0.0000
					Total Wt, g =	0.0101
					Total Wt, mg =	10.1

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Sample Calculation for Carbon Monoxide Concentrations
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Carbon Monoxide (lbs/Hour) = Parts per million (ppm) X Molecular Weight X 1.55368×10^{-7}
X Flow Rate (Dry Standard Cubic Feet)

Appendix B: Field Data Sheets, Per Run

Method 5 Particulate Field Data Sheets
Method 10 Carbon Monoxide Data Sheets
ECOM Data Sheets
Method 9 Opacity Data Sheets
Weather Data

Run 1 Data Sheets
Start Up

Facility:	Tom Snyder ~~Needles~~	Meter Box #:	C-2	Amb. Temp °F:	60
Location:	Clarkston	Y Factor:	0.993	Bar. Press, in Hg:	30.11
Run#:	01	Meter Delta H@:	1.855	Assumed Moisture, %:	2
Date:	10/10/00	Pitot Coef:	0.84	Probe Temp Set, °F:	250
Operators:	LS, SM, DD	Nozzle Diam:	0.505	Filter Temp Set. °F:	250
Run Start:	1242	Leak Rate CFM, Start:	<0.001 @ 15 in Hg	Stack Diameter., in.:	—
Run End:	1312	Leak Rate CFM, End:	<0.001 @ 5 in Hg	Stack Dimen, lXw, in.:	
Run Time:	30	Filter ID:	L-14	K= 25 Static Press., in WC:	0.00

	Traverse Point #	Clock Time	Stack Temp, °F	Velocity Head inches WC	Orifice Press inches WC	Sample Vol, Cu Ft 858.807	Gas Meter Temp. °F	Probe Temp, °F	Filter Temp, °F	Imp Exit Temp, °F	Sample Vac in, Hg
8	1	1242	~~285~~	0.011	3.0	864.0	65	251	251	44	2
20	2	1247	281	0.008	3.0	868.3	65	250	251	44	2
6	3	1252	250	0.028	3.0	873.0	65	250	250	44	2
4	4	1257	186	0.008	3.0	877.3	66	251	250	44	2
18	5	1302	167	0.006	3.0	883.2	66	251	251	46	2
46	6	1307	170	0.007	3.0	887.018	66	251	250	48	2
	7										
	8										
	9										
	10			Run 01 Engr. test to set parameters							
	11										
	12										
	13			K = 52 @ 0.505" nozzle							
	14										
	15										
	16										
	17										
	18										
	19										
	20										
	21										
	22										
	23	CO =									
	24										
	25										

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CO Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Startup
Date 10-10-2000
Ambient Conditions See notes
Barometric Pressure 1017

Time	Traverse Point	CO
1242	center	9
1247		20
1252		6
1257		4
1302		18
1307		46 ppm ✓

Time	Traverse Point	CO

Time	Traverse Point	CO

Notes: $\bar{x} = 17$

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ECOM Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Start up, constant Flow
Date 9-10-00
Ambient Conditions See notes
~~Temperature Start~~
~~Temperature Finish~~
Barometric Pressure 1017

Time	Traverse Point	O2	CO	NO	NO2	SO2	Nox	CO2
1300	Center	20.7	16.7	0	0	0	0	0

Notes: X Probe centered in stack, constant Flow. Reading taken @ 17 minutes.

VISIBLE EMISSIONS FORM

Company: DEI

Date: 10-10-2000

Observer: Dave DeRuiter

Signiture: [illegible]

Stack- Distance: 60'

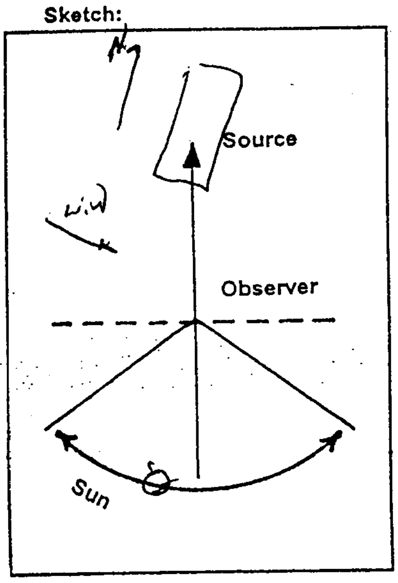
Height: 10'

Wind- Speed: Light

Direction: NW

Sky Type:

Sketch:



Remarks:

Start up

Light smoke white

1300

	0	15	30	45		0	15	30	45
0	0	5	0	5	30				
1	5	0	0	0	31				
2	0	0	5	0	32				
3	0	5	0	0	33				
4	0	0	0	0	34				
5	0	0	0	5	35				
6	0	5	0	0	36				
7					37				
8					38				
9					39				
10					40				
11					41				
12					42				
13					43				
14					44				
15					45				
16					46				
17					47				
18					48				
19					49				
20					50				
21					51				
22					52				
23					53				
24					54				
25					55				
26					56				
27					57				
28					58				
29					59				

$\frac{35}{24}$

Set #	Time Start	Time End	Sum	Ave.	Set #	Time Start	Time End	Sum	Ave.
1	1300	1306	35	1.45%	6				
2					7				
3					8				
4					9				
5					10				

$\frac{35}{24} = 1.45\%$

Run 2 Data Sheets

Facility:	Tom Snyder	Meter Box #:	C-2	Amb. Temp °F:	61
Location:	Banner	Y Factor:	0.993	Bar. Press, in Hg:	30.11
Run#:	02	Meter Delta H@:	1.855	Assumed Moisture, %:	5
Date:	10/12/00	Pitot Coef:	0.84	Probe Temp Set, °F:	280
Operators:	LT, SM, OD	Nozzle Diam:	0.505	Filter Temp Set. °F:	280
Run Start:	1424	Leak Rate CFM, Start:	<0.001 @ 12 in Hg	Stack Diameter., in.:	NA
Run End:	1544	Leak Rate CFM, End:	0.001 @ 5 in Hg	Stack Dimen, lXw, ft:	8' x 28'
Run Time:	72	Filter ID:	L-15	Static Press., in WC:	0.02

K=54

CO

	Traverse Point #	Clock Time	Stack Temp, °F	Velocity Head Inches WC	Orifice Press inches WC	Sample Vol, Cu Ft	Gas Meter Temp. °F	Probe Temp, °F	Filter Temp, °F	Imp Exit Temp, °F	Sample Vac in, Hg	
						887.315						
13	1	1424	276	0.025	1.3	892.6	65	251	248	55	1	
18	2	40	265	0.010	0.54	894.8	65	250	250	51	1	
24	3	46	295	0.010	0.54	896.6	65	251	257	51	1	
	4	52	245	0.025	1.3	900.1	65	251	251	52	1	
	5	1502	296	0.020	1.1	903.3	65	249	251	52	1	
	6	1508	195	0.010	0.54	906.7	65	250	251	52	1	36
	7	1514	155	0.010	0.54	909.1	67	250	251	52	1	42
	8	20	188	0.052	0.63	912.0	67	249	249	50	1	48
	9	26	185	0.026	1.4	915.7	68	250	249	48	1	54
	10	1540	518	0.055	3.0	921.1	68	251	250	49	1	
	11	32	524	0.035	1.9	926.0	68	250	250	48	1	
	12	38	341	0.030	1.6	930.202	69	251	250	48	1	
	13											
	14				14.34							
	15				1.20							
	16											
	17											
	18											
	19											
	20											
	21											
	22											
	23											
	24	1	4	7	10							
	25	2	5	8	11							
		3	6	9	12							

DeRuiter Environmental, Inc.

PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

CO Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number: Run #2
Date: 10-10-2000
Ambient Conditions: —
Barometric Pressure: —

	Time	Traverse Point	CO
	1432	1	13
	1438		18
	1444		24
	1448		20
	14:50		41
TRAV	14:52		40
1456	1458	4	76
	1500	4	115
	1502	4	189
	1504	5	142
	1506	5	165
	1508	5	250
	1510	6	119
2	1512	6	8
TRAV	1514	6	14
	1520	7	48.5
start	1522	7	24.2
318	1524	8	25.8
	1526	8	14.8
	1528	8	62.7
	1530	9	134.5
	1532	9	109.6
start	1534	9	103.8
1540	1542	10	116.1
	1544	10	54.6
	1546	11	60.8

Time	Traverse Point	CO
1548	11	72.7
1550	11	66.3
1552	12	69.7
1554	12	64.2
1556	12	42.4

Time	Traverse Point	CO

Notes:

DeRuiter Environmental, Inc.

PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

ECOM Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Run #2
Date
Ambient Conditions
Temperature Start
Temperature Finish
Barometric Pressure

Time	Traverse Point	O2	CO	NO	NO2	SO2	Nox	CO2
14:45	2	20.9	2	0	0	0	0	0
14:48	2	20.8	4	1	0	0	1	0
1450	3	20.9	3					
14:52	3	20.9	3					
14:58	4	20.9	13					
15:00	4	20.9	25					
15:02	4	20.9	28					
15:04	5	20.8	32					
15:06	5	20.8	37					
15:08	5	20.8	45					
15:10	6	21.0	11					
15:12	6	21.0	5					
15:14	6	20.9	4					
1520	7	20.9	11					
1522	7	20.9	4					
1524	8	20.9	7					
1526	8	20.9	5					
1528	8	20.9	8					
1530	9	20.9	16					
1532	9	20.9	23					
1534	9	20.9	21					
1542	10	20.9	3					
1544	10	20.6	19	2			2	
1546	11	20.6	17	2	~~X~~0	1	2	

Traverse change restart 1456

~~1514~~

Restart 1518

Restart

Hot point

Notes: Traverse pt #1 not included due to sample transport time

DeRuiter Environmental, Inc.

PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

ECOM Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Run #2
Date
Ambient Conditions
Temperature Start
Temperature Finish
Barometric Pressure

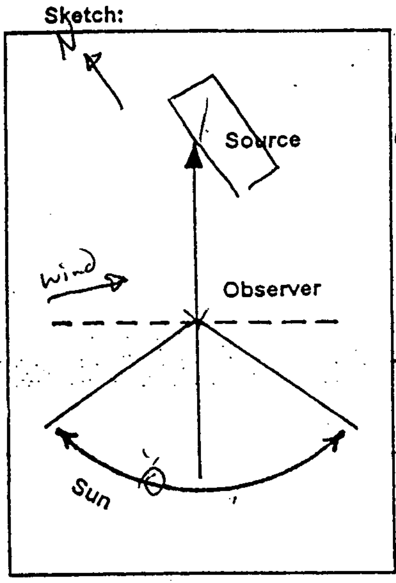
Time	Traverse Point	O2	CO	NO	NO2	SO2	Nox	CO2
1548	11	20.8	14	1			1	
1550	11	20.8	12	1			1	
1552	12	20.0	10	1			1	
1554	12	20.9	11	1			1	
1556	12	24.9	10	1			1	

Notes:

VISIBLE EMISSIONS FORM

Company:	DEI
Date:	10-10-200
Observer:	Dave DeRuiter
Signiture:	[signature]
Stack- Distance:	60'
Height:	10'
Wind- Speed:	Light
Direction:	W
Sky Type:	Clear

Sketch:



Remarks:

Run #2

Opacity Raises to 5-15 when material is loaded. This lasts @ 2 minutes

⊘ denotes fueling

1500

TRAV #4

1521 Fueling

1527

1546

	0	15	30	45		0	15	30	45
0	0	0	5	0	30				
1	0	0	5	5	31				
2	5	5	5	5	32				
3	0	5	5	5	33				
4	0	0	0	5	34				
5	5	0	5	5	35				
6	0	5	5	5	36				
7	0	5	⊘10	5	37				
8	10	15	10	5	38				
9	5	5	5	10	39				
10	⊘5	10	5	5	40				
11	5	5	⊘5	10	41				
12	0	5	⊘5	10	42				
13	5	5	5	10	43				
14	⊘15	25	15	10	44				
15	0	15	15	10	45				
16	5	15	15	15	46				
17	15	10	15	20	47				
18	15	15	15	10	48				
19	10	5	10	5	49				
20	10	0	10	5	50				
21	0	5	5	5	51				
22	10	10	5	5	52				
23	5	10	10	5	53				
24	0	10	5	10	54				
25	5	5	10	5	55				
26	10	5	5	5	56				
27	5	5	10	5	57				
28	5	10	5	5	58				
29	10	5	5	5	59				

-85 / 28
3.04%

150 / 24
6.25%

295 / 24
12.12%

155 / 24
6.46%

125 / 20
6.25%

Set #	Time Start	Time End	Sum	Ave.	Set #	Time Start	Time End	Sum	Ave.
1	1500	1506	85	3.04%	6				
2	1521	1526	150	6.25%	7				
3	1527	1533	295	12.12%	8				
4	1546	1552	155	6.46%	9				
5	1553	1559	125	6.25%	10				

Run 3 Data Sheets

Facility:	Snyder	Meter Box #:	C-2	Amb. Temp °F:	62
Location:	Burner	Y Factor:	0.993	Bar. Press, in Hg:	29.93
Run#:	03	Meter Delta H@:	1.855	Assumed Moisture, %:	5
Date:	10/10/00	Pitot Coef:	0.84	Probe Temp Set, °F:	280
Operators:	KJ, JM, BD	Nozzle Diam:	0.505	Filter Temp Set. °F:	280
Run Start:	1636	Leak Rate CFM, Start:	<0.001 @ 10 in Hg	Stack Diameter., in.:	—
Run End:	1759	Leak Rate CFM, End:	<0.001 @ 4 in Hg	Stack Dimen, lXw, in.:	
Run Time:	72	Filter ID:	C-16	Static Press., in WC:	0.00

Traverse Point #	Clock Time	Stack Temp, °F	Velocity Head inches WC	Orifice Press inches WC	Sample Vol, Cu Ft	Gas Meter Temp. °F	Probe Temp, °F	Filter Temp, °F	Imp Exit Temp, °F	Sample Vac in, Hg	
					930.313						
1	1636	299	0.010	0.54	933.0	64	246	249	50	1	6
2	42	317	0.015	0.81	936.1	64	248	280	50	1	12
3	48	230	0.025	1.4	939.7	66	248	280	51	1	18
4	58	230	0.010	0.54	942.3	66	248	251	52	1	24
5	1704	282	0.015	0.81	945.4	66	248	257	53	1	30
6	10	265	0.025	1.4	949.2	66	248	256	54	1	36
7	20	247	0.010	0.54	952.1	66	249	255	55	1	42
8	26	291	0.010	0.54	954.6	66	250	252	54	1	48
9	32	317	0.015	0.81	957.6	66	250	252	51	1	54
10	41	320	0.010	0.54	960.3	66	251	251	50	1	00
11	47	320	0.010	0.54	962.8	66	251	251	50	1	06
12	53	327	0.015	0.81	965.811	66	251	280	50	1	12
13											
14				9.20							
15				0.773							
16											
17											
18											
19											
20											
21											
22					Blower @	11000 CFM					
23											
24											
25											

DeRuiter Environmental, Inc.
PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

CO Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Run #3
Date 10-10-2000
Ambient Conditions —
Barometric Pressure —

1636 Start

Time	Traverse Point	CO
1638	12	6.6
1640	12	6.5
1642	11	11.3
1644	11	23.1
1646	11	11.2
1648	10	43.3
1650	10	30.6
1652	10	26.6
1654	10	23.1
~~1656~~ 1700	9	3.2
1702	9	1.5
1704	8	2.0
1706	8	7.1
1708	8	11.9
1710	7	16.1
1712	7	21.0
1714	7	21.2
1716	7	24.3
1722	6	1.9
1724	6	1.1
1726	6	1.8
1728	5	6.4
1730	5	8.2
1732	5	9.1
1734	4	25.9
1736	4	43.9

Start 1658

Start 1720

1741

Time	Traverse Point	CO
1738	4	31.3
1743	3	4.21
1745	3	1.5
1747	3	7.1
1749	2	32
1751	2	45
1753	2	50.5
1755	1	48.1
1757	1	59.9
1759	1	59.1

Time	Traverse Point	CO

Notes:

DeRuiter Environmental, Inc.

PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

ECOM Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Run #3
Date 10-10
Ambient Conditions
Temperature Start
Temperature Finish
Barometric Pressure

1636 start

Time	Traverse Point	O2	CO	NO	NO2	SO2	Nox	CO2
1638	12	20.9	1					
1640	12	20.9	1					
1642	11	20.9	1					
1644	11	20.9	1					
1646	11	20.9	1					
1648	10	20.8	13					
1650	10	20.7	8	1			1	
1652	10	20.7	5	1			1	
1654	10	20.7	4	1			1	
1700	9	20.7	2	1			1	
1702	9	20.9	0					
1704	8	20.9	0					
1706	8	20.9	1					
1708	8	20.9	1					
1710	7	20.9	1					
1712	7	20.8	3	1			1	
1714	7	20.8	3	1			1	
1716	7	20.8	3	1			1	
1722	6	20.9	0					
1724	6	20.9	0					
1726	6	20.9	0					
1728	5	20.9	1					
1730	5	20.9	1					
1732	5	20.9	1					

Start 1658

Start 1720

Notes:

DeRuiter Environmental, Inc.

PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

ECOM Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number
Date
Ambient Conditions
Temperature Start
Temperature Finish
Barometric Pressure

Restart #1

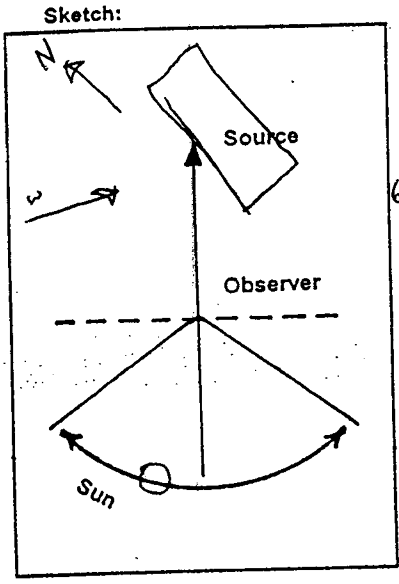
Time	Traverse Point	O2	CO	NO	NO2	SO2	Nox	CO2
1734	4	20.9	2					
1736	4	20.9	5					
1738	4	20.9	6					
1743	3	20.9	4					
1745	3	20.9	4					
1747	3	20.9	3			1		
1749	2	20.9	2			1		
1751	2	20.9	4			0		
1753	2	20.9	4			1		
1755	1	20.9	8			1		
1757	1	20.9	7			1		
1759	1	20.9	10			1		

Notes:

VISIBLE EMISSIONS FORM

Company:	DEI
Date:	10-10-2001
Observer:	Dave DeRiter
Signiture:	[signature]
Stack- Distance:	60
Height:	10'
Wind- Speed:	Light
Direction:	NW
Sky Type:	Clear

Sketch:



Remarks:

Run #3

1645 TRAV 1 12-10

	0	15	30	45		0	15	30	45
0	5	0	5	0	30				
1	5	10	5	5	31				
2	0	5	5	5	32				
3	5	0	5	0	33				
4	0	5	5	10	34				
5	5	5	0	5	35				
6	5	0	5	5	36				
7	0	5	5	0	37				
8	5	5	5	5	38				
9	5	0	5	0	39				
10	10	5	5	5	40				
11	5	0	5	5	41				
12	5	5	5	0	42				
13	0	5	5	5	43				
14	0	0	5	5	44				
15	0	5	5	5	45				
16	5	0	5	5	46				
17	5	5	5	5	47				
18	5	5	10	5	48				
19	0	5	5	0	49				
20	5	0	5	5	50				
21	5	5	5	0	51				
22	5	5	5	0	52				
23	5	5	5	0	53				
24	5	5	0	5	54				
25					55				
26					56				
27					57				
28					58				
29					59				

1700 9-7 Trav 2

1724 6-4 Trav 3

1743 Trav 4

110/28 3.93%

90/24 3.75%

100/24 4.17%

85/24 3.54%

15.39%/4 → 3.84%

Set #	Time Start	Time End	Sum	Ave.	Set #	Time Start	Time End	Sum	Ave.
1	1645	1651	110	3.93	6				
2	1700	1706	90	3.75%	7				
3	1724	1730	100	4.17%	8				
4	1743	1749	85	3.54%	9				
5					10				

Run 4 Data Sheets

Facility:	T. Sully [illegible]	Meter Box #:	C-2	Amb. Temp °F:	63
Location:	Burner	Y Factor:	0.943	Bar. Press, in Hg:	30.18
Run#:	05	Meter Delta H@:	1.855	Assumed Moisture, %:	5
Date:	10/11/02	Pitot Coef:	0.80	Probe Temp Set, °F:	250
Operators:		Nozzle Diam:	0.505	Filter Temp Set. °F:	250
Run Start:	1210	Leak Rate CFM, Start:	0.001 @ 10 in Hg	Stack Diameter., in.:	—
Run End:	1330	Leak Rate CFM, End:	0.001 @ 5 in Hg	Stack Dimen, lXw, in.:	
Run Time:	72	Filter ID:	C-17	Static Press., in WC:	0.00

Traverse Point #	Clock Time	Stack Temp, °F	Velocity Head inches WC	Orifice Press inches WC	Sample Vol, Cu Ft	Gas Meter Temp. °F	Probe Temp, °F	Filter Temp, °F	Imp Exit Temp, °F	Sample Vac in, Hg
					968.024					
1	1210	385	0.015	0.81	971.0	71	268	250	52	1
2	16	324	0.015	0.81	974.0	72	266	250	49	1
3	22	275	0.015	0.84	977.1	72	268	250	49	1
4	30	316	0.015	0.84	981.2	72	266	250	49	1
5	36	325	0.015	0.84	984.5	73	261	250	50	1
6	42	292	0.010	0.54	987.1	74	260	251	50	1
7	51	389	0.020	1.1	991.1	75	266	250	51	1
8	57	376	0.020	1.1	994.3	75	266	251	51	1
9	1303	215	0.015	0.84	997.5	75	265	250	51	1
10	12	233	0.015	0.84	1000.6	76	260	250	53	1
11	18	182	0.010	0.54	1003.5	76	262	250	51	1
12	24	145	0.015	0.84	1005.519	76	260	250	51	1
13										
14				9AA						
15										
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										

DeRuiter Environmental, Inc.

PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

CO Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Run #4
Date 10-11-2000
Ambient Conditions
Barometric Pressure

	Time	Traverse Point	CO
1210	1212	1	35
	1214	1	19.6
	1216	1	38
	1218	2	24
	1220	2	13
	1222	2	7
	1224	3	12
	1226	3	11
	1228	3	14
1230	1232	4	49
	1234	4	25
	1236	4	12
	1238	5	16
	1240	5	11
	1242	5	15
	1244	6	23
	1246	6	35
	1248	6	44
1251	1253	7	72.6
	1255	7	69.9
	1257	7	75.8
	1259	8	89.0
	1301	8	117
	1303	8	67
	1305	9	132.8
	1307	9	229

	Time	Traverse Point	CO
	1309	9	150
Start	1314	10	126.3
1312	1316	10	123.3
	1318	10	82.3
	1320	11	174
	1322	11	117
	1324	11	179.8
	1326	12	197.9
	1328	12	183.6
	1330	12	175.3

Time	Traverse Point	CO

Notes:

DeRuiter Environmental, Inc.

PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

ECOM Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Run #4
Date 10-11-2000
Ambient Conditions x
Temperature Start x
Temperature Finish x
Barometric Pressure X

Start 1210

Start 1230

1251

Time	Traverse Point	O2	CO	NO	NO2	SO2	Nox	CO2
1212	1	20.2	20	4			4	
1214	1	20.2	24	4			4	
1216	1	20.4	37	3			3	
1218	2	20.6	18	1			2	
1220	2	20.7	15	1			1	
1222	2	20.8	7	1			1	
1224	3	20.8	12	1			1	
1226	3	20.8	12	1			1	
1228	3	20.9	10	1			1	
1232	4	20.6	39	2			2	
1234	4	20.7	32	2			2	
1236	4	20.8	11	1			1	
1238	5	20.8	13	1			1	
1240	5	20.9	15	1			1	
1242	5	20.8	9	1			1	
1244	6	20.4	10	1			1	
1246	6	20.4	15	2			2	
1248	6	20.5	19	3			3	
1253	7	20.4	50	3			3	
1255	7	20.6	46	2			2	
1257	7	20.5	52	3			3	
1259	8	20.6	72	2			2	
1301	9	20.5	92	2			2	
1303	9	20.6	72	2			2	

Notes:

DeRuiter Environmental, Inc.

PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

ECOM Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Run Number Run #4
Date 10-11-2000
Ambient Conditions x
Temperature Start x
Temperature Finish x
Barometric Pressure x

Time	Traverse Point	O2	CO	NO	NO2	SO2	Nox	CO2
1305	9	20.6	83	2			2	
1307	9	20.4	148	3			3	
1309	9	20.9	100	1			1	
Start 1312 1314	10	20.9	90	1			1	
1316	10	20.9	99	1			1	
1318	10	20.9	68	1			1	
1320	11	20.8	111	1			1	
1322	11	20.9	85	1			1	
1324	11	20.8	151	1			1	
1326	12	20.8	144	1			1	
1328	12	20.9	125	1			1	
1330	12	20.9	126	1			1	

Notes:

VISIBLE EMISSIONS FORM

Company:	DEI
Date:	10-11-2000
Observer:	Dave DeRiter
Signiture:	[signature]
Stack- Distance:	20'
Height:	10'
Wind- Speed:	Light
Direction:	NW
Sky Type:	Clear

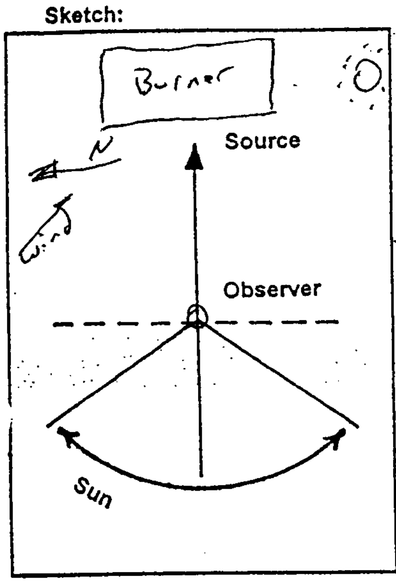
1216 TRAV 1 1-3

1235 TRAV 2 4-6

1257 TRAV 3 7-9

1320 TRAV 4 10-12

Sketch:



	0	15	30	45		0	15	30	45
0	5	10	5	5	30				
1	10	5	5	10	31				
2	5	10	5	5	32				
3	5	10	10	5	33				
4	5	5	5	5	34				
5	5	5	10	10	35				
6	5	10	5	5	36				
7	5	5	5	5	37				
8	5	10	5	15	38				
9	5	5	5	10	39				
10	10	5	10	5	40				
11	5	10	5	5	41				
12	15	10	10	10	42				
13	0	5	5	5	43				
14	5	5	5	10	44				
15	5	5	10	5	45				
16	10	5	10	10	46				
17	10	5	10	5	47				
18	10	5	5	5	48				
19	5	5	0	5	49				
20	5	0	5	5	50				
21	5	0	5	5	51				
22	0	5	10	5	52				
23	5	5	0	5	53				
24	5	0	5	5	54				
25					55				
26					56				
27					57				
28					58				
29					59				

- 185 / 28 6.61%

- 180 / 24 7.50%

- 155 / 24 6.46%

- 95 / 24 3.96

24.53 / 4 6.13%

Remarks:

Run #4

Set #	Time Start	Time End	Sum	Ave.	Set #	Time Start	Time End	Sum	Ave.
1	1216	1222	185	6.61%	6				
2	1235	1241	180	7.50%	7				
3	1257	1303	155	6.46%	8				
4	1320	1326	95	3.96%	9				
5					10				

Weather Data

DeRuiter Environmental, Inc.
PO Box 248, Marcellus, Michigan 49067 (616) 646-0403

Weather Data
Airburner Test in Clarkston, Michigan
for Whitton Technologies

Time	Wind Direction and Speed (Knots)	Temperature (Degrees F)	Relative Humidity (%)	Barometric Pressure (mPa)
10-Oct-00				
1200	NW 5-9	56	32	1018
1230	NW 8-10	57	45	1017
1320	NW 12-16	59	35	1017
1410	W 5-10	57	42	1017
1530	NW 13-16	59	35	1016
1620	NW 6-10	61	35	1016
1820	NW 4-6	55	44	1016
11-Oct-00				
1140	N 4-6	57	22	1027
1320	NW 2-3	65	40	1027
1350	NW 4-6	65	35	1027

Appendix C: Process and Sampling Schematics

Diagram of Sampling Train
Diagram of Sampling Points

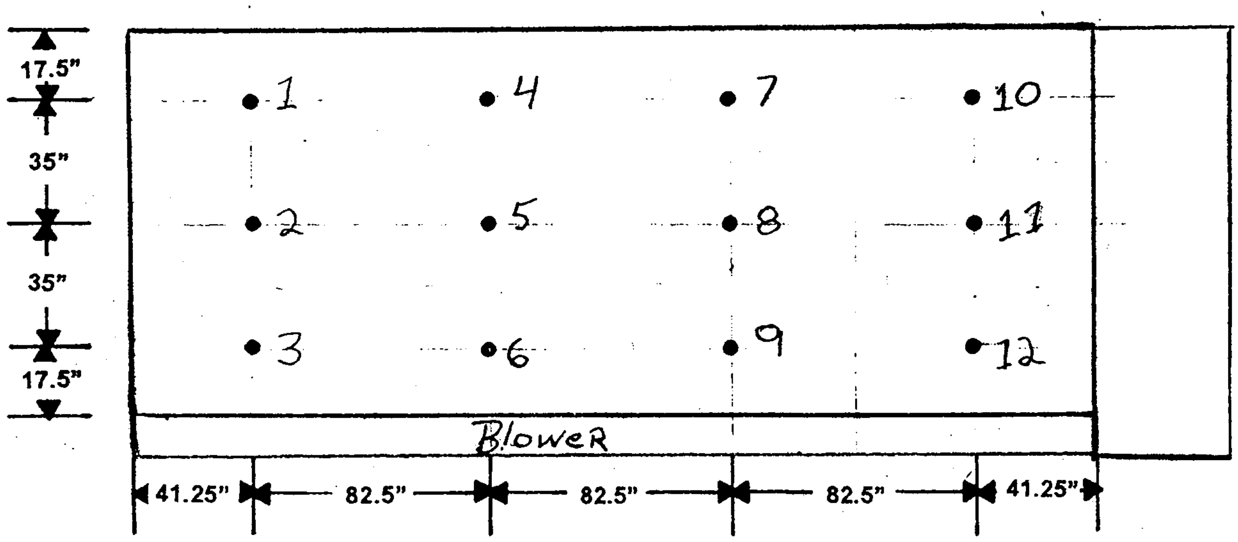
GENESIS AIR, INC.
Emission Testing Services

8412 Kreuter NE
Rockford, MI 49341
(616)874-9536
fax(616)874-2938

Project:	By: lwt	
Subject:	Date:	
	Page: 1 of 1	

Velocity & Sample Traverse Points

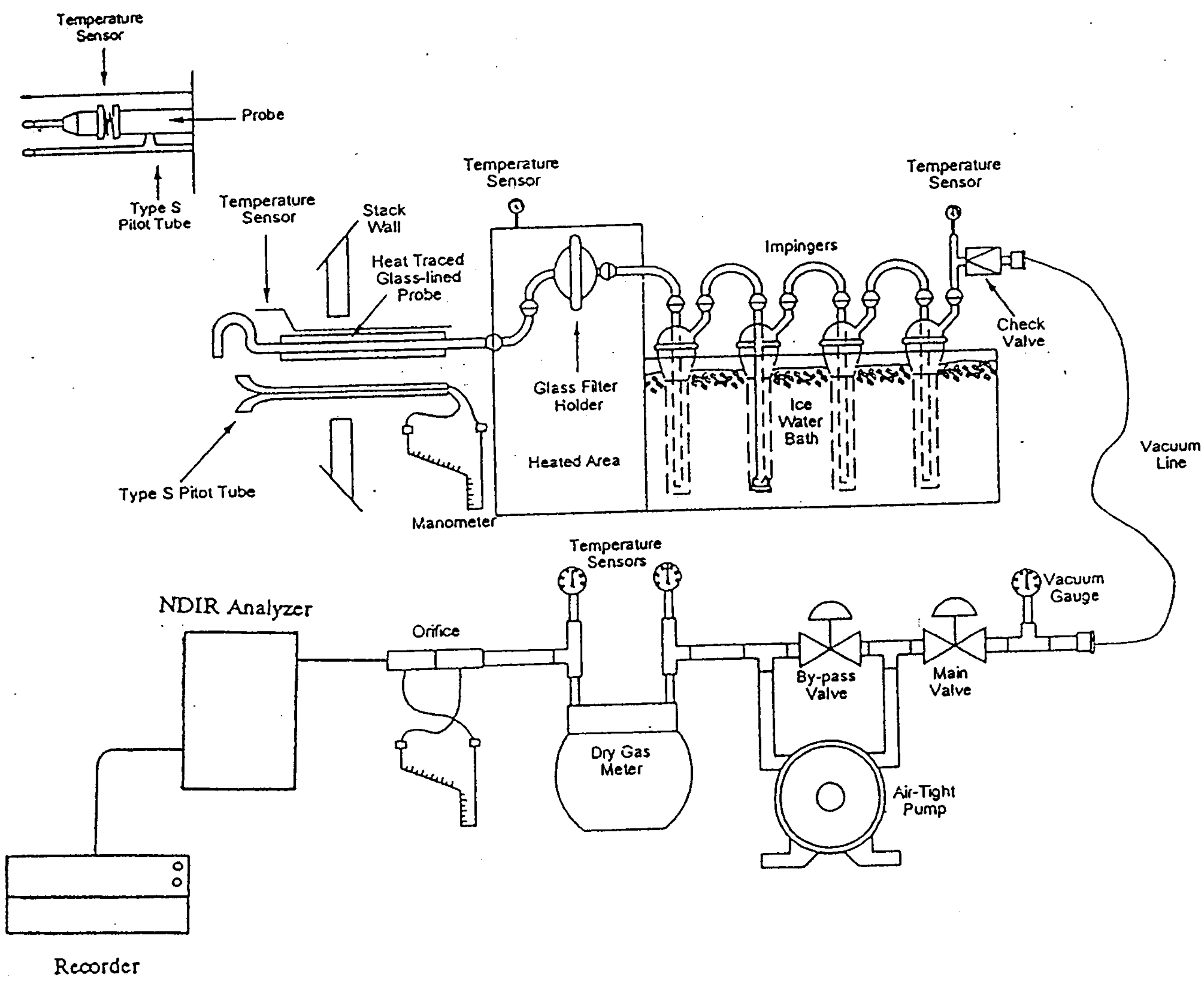
Project 00-21



GENESIS AIR, INC.
Emission Testing Services

8412 Kreuter NE
Rockford, MI 49341
(616)874-9536
fax(616)874-2938

Project:	By: lwt	
Subject:	Date:	
-	Page: 1 of 1	



USEPA Method 5 Sampling Train

Appendix D: Calibration Data

Method 5 Impinger Data
Meter Box Calibration
Orifice Calibration Spreadsheet
Type S Pitot Tube Inspection Data Sheet
Probe Nozzle Diameter Calibration Data Sheet
NDIR Calibration
ECOM Calibration
Method 9 Certification, David DeRuiter

10/10/00 + 10/11/00

	Method 5 Impinger Data			Project #:	0021
	Imp #1	Imp #2	Imp #3	Imp #4	Imp #5
Run #1	DI Water	DI Water	Empty		Silica Gel, g
ml end	20	100	0		0.0
ml start	~~100~~ 0	100	0		0.0
total ml	20	0	0		0.0
				Total, ml =	20.0
	Imp #1	Imp #2	Imp #3	Imp #4	Imp #5
Run #2	DI Water	DI Water	Empty		Silica Gel, g
ml end	11	110	0		3.8
ml start	0 ~~100~~	100	0		0.0
total ml	11	11	0		3.8
				Total, ml =	25.8
	Imp #1	Imp #2	Imp #3	Imp #4	Imp #5
Run #3	DI Water	DI Water	Empty		Silica Gel, g
ml end	15	102	0		7.2
ml start	0 ~~100~~	100	0		0.0
total ml	15	2	0		7.2
				Total, ml =	24.2
	Imp #1	Imp #2	Imp #3	Imp #4	Imp #5
Run #4	DI Water	DI Water	Empty		Silica Gel, g
ml end	15	110	0		3.3
ml start	0 ~~100~~	100	0		0.0
total ml	15	10	0		3.3
				Total, ml =	28.3
Comments:					

Meter Box Calibration			
Post Test 3 Point			
Date: 10/19/00			
Meter Box ID: C-2			
Orifice Set ID: HY40-73			
GA Personnel: LT			
Critical Orifice ID:	**40**	**55**	**73**
Critical Orifice Coef:	0.2398	0.4596	0.8212
Run #	3	1	2
Met Box Inlet Leak:	ok	ok	ok
Cr. Orifice Inlet Leak:	ok	ok	ok
DGM Final, cf:	15.319	8.502	13.780
DGM Start, cf:	13.780	5.552	8.502
Difference, cf:	1.539	2.95	5.278
DGM Temp., Srt, °F	63	61	62
DGM Temp., End,°F	63	62	63
DGM Temp., ave °F	63.0	61.5	62.5
Run Time, minutes:	5.0	5.0	5.0
Orifice ΔH, in HOH:	0.30	1.20	3.70
Amb. Temp., ° F:	68	68	68
Barometric Press,. inHOH:	30.01	30.01	30.01
Pump Vacuum, mmHg:	24.0	22.0	19.0
K' Factor:	0.237	0.457	0.821
Vm (std), dscf:	1.559	3.003	5.396
Vcr(std), dscf:	1.548	2.982	5.358
DGM Cal Factor, Yi:	0.993	0.993	0.993
Yi, ≤ ±0.02 from ave?:	ok	ok	ok

DGM.CAL.3

ORIFICE CALIBRATION SPREADSHEET - APEX INSTRUMENTS
ENGLISH REFERENCE METER UNITS

DATE:	3/16/99	CALIBRATION METER S/N:	707179	LEAK CHECK:	OK
MODEL:	HY40-73	METER CONSTANT, Yc:	1.0008	FILENAME:	F:\DATAFILE\CALIBRAT\CAL_MENU.DSK\ORIF
OPERATOR:	VHJ	BAROMETRIC PRESSURE:	29.8 (in. Hg)	REVISED:	6/8/95

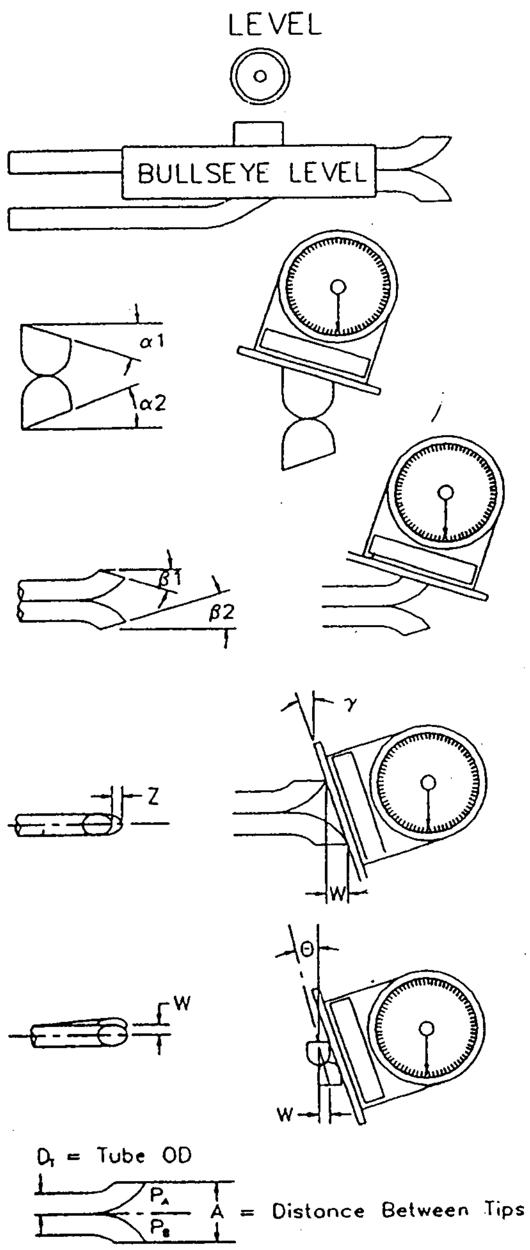
RUN NUMBER	ORIFICE IDENT.	AMBIENT TEMP. (deg. F)	ACTUAL VACUUM (in. Hg)	THEORETICAL CRITICAL VACUUM (in. Hg)	DRY GAS METER READINGS INITIAL (cu. ft.)	FINAL (cu. ft.)	NET (cu. ft.)	DRY GAS METER AVG. TEMP. INITIAL (deg. F)	FINAL (deg. F)	AVG. (deg. F)	METER DELTA H (in. H20)	TEST DURATION (minutes)	ENGLISH K FACTOR VALUE	K FACTOR VARIATION (percent)
1	40	76	25.0	14.1	0.000	7.010	7.010	70	73	72	0.30	22.5	0.2398	-0.0
2	40	76	25.0	14.1	7.010	14.859	7.849	73	77	75	0.30	25.0	0.2400	0.1
3	40	76	25.0	14.1	14.859	20.216	5.357	77	79	78	0.30	17.0	0.2396	-0.1
AVG.												AVG.	0.2398	
1	48	76	24.0	14.1	0.000	12.247	12.247	79	80	80	0.65	26.5	0.3507	0.0
2	48	76	24.0	14.1	12.247	37.953	25.706	80	82	81	0.65	55.5	0.3505	-0.0
3	48	76	24.0	14.1	37.953	45.150	7.197	82	82	82	0.65	15.5	0.3507	0.0
AVG.												AVG.	0.3506	
1	55	77	23.0	14.1	0.000	6.371	6.371	82	82	82	1.10	10.5	0.4592	-0.1
2	55	77	23.0	14.1	6.371	21.248	14.877	82	82	82	1.10	24.5	0.4596	-0.0
3	55	77	23.0	14.1	21.248	33.111	11.863	82	83	83	1.10	19.5	0.4600	0.1
AVG.												AVG	0.4596	
1	63	78	22.0	14.1	0.000	6.333	6.333	83	82	83	2.00	8.0	0.6005	0.5
2	63	78	22.0	14.1	6.333	19.348	13.015	82	84	83	2.00	16.5	0.5978	0.1
3	63	78	22.0	14.1	19.348	27.594	8.246	84	84	84	2.00	10.5	0.5941	-0.6
AVG.												AVG	0.5974	
1	73	78	19.0	14.1	0.000	16.228	16.228	84	85	85	3.70	15.0	0.8210	-0.0
2	73	78	19.0	14.1	16.228	31.953	15.725	85	86	86	3.70	14.5	0.8215	0.0
3	73	79	19.0	14.1	31.953	40.082	8.129	86	86	86	3.70	7.5	0.8211	-0.0
AVG.												AVG	0.8212	

I certify that orifice set number HY40-73 was tested in accordance with the US EPA Method 5 standards.
See the Code of Federal Regulations, title 40, part 60, Appendix A, Method 5, Item 7.2.

Signature Vc A Date 3-16-99

ORIFICE CALIBRATION SPREADSHEET - APEX INSTRUMENTS

TYPE S PITOT TUBE INSPECTION DATA SHEET



Parameter	Value	Allowable Range
Assembly Level?	✓	Yes
Holes Damaged?	✓	No
Obstructed?	✓	No
$\alpha 1$	✓	$-10° < \alpha 1 < +10°$
$\alpha 2$	✓	$-10° < \alpha 2 < +10°$
$\beta 1$	✓	$-5° < \beta 1 < +5°$
$\beta 2$	✓	$-5° < \beta 2 < +5°$
γ	✓	
θ	✓	
A	✓	for 1/4" OD, 0.526 to 0.750 for 3/8" OD, 0.788 to 1.125
$Z = A \sin \gamma$	✓	$Z = \leq 0.125"$
$W = A \sin \theta$	✓	$W = \leq 0.031"$
P_A	✓	for 1/4" OD, 0.263 to 0.375 for 3/8" OD, 0.394 to 0.563
P_B	✓	for 1/4" OD, 0.263 to 0.375 for 3/8" OD, 0.394 to 0.563
$P_A - P_B$	✓	-0.063 to 0.063"
D_T	✓	0.188 to 0.375"

Certification

I certify that the Type S pitot tube/probe ID # GC-P11 meets or exceeds all specifications, criteria and/or applicable design features and is hereby assigned a pitot tube calibration factor C_p of 0.84

Certified By: [signature] 9/10/00

Personnel (Signature/Date)

Team Leader (Signature/Date)

PROBE NOZZLE DIAMETER
CALIBRATION DATA SHEET

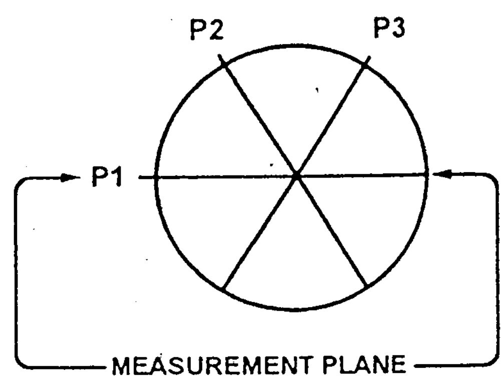
Date	Calibrated By	SS Nozzle ID #	Nozzle Diameter (inches) D1	D2	D3	Hi - Lo ΔD	D_{avg}
09/10/00	LT	GS-4 (1/8)	0.120	0.120	0.120	<0.001	0.120
"	"	GS-5 (3/16)	0.179	0.179	0.179	<0.001	0.179
"	"	GS-6 (1/4)	0.243	0.244	0.244	0.001	0.244
"	"	GS-8 (5/16)	0.301	0.301	0.301	<0.001	0.301
"	"	GS-12 (3/8)	0.373	0.374	0.373	0.001	0.373
"	"	GS-14 (7/16)	0.434	0.435	0.434	0.001	0.434
"	"	GS-16 (1/2)	0.505	0.505	0.505	<0.001	0.505

Where:

D1, D2, D3 = Three different nozzle diameters at 60 degrees to each other, each measured the nearest 0.001 inches

ΔD = Maximum distance between any two diameters, must be $\leq$ 0.004 inches.

D_{avg} = (D1 + D2 + D3) / 3



INSTRUCTIONS

1. Inspect the nozzle for nicks, dents and corrosion. If these are found, they should be corrected before calibration.
2. Place a reference mark on the nozzle. Place the nozzle at the center of figure, aligned with point P1. Measure and record D1.
3. Rotate the nozzle so that the reference mark is aligned with point P2. Measure and record D2.
4. Rotate the nozzle so that the reference mark is aligned with point P3. Measure and record D3.
5. Calculate ΔD and D_{avg}.

Checked By: [signature] 09/10/00 ____________________

Personnel (Signature/Date) Team Leader (Signature/Date)

TEMPERATURE SENSOR CALIBRATION DATA SHEET

DATE 9/10/00 THERMOCOUPLE NO. GA.01

PERSONNEL LT REFERENCE:

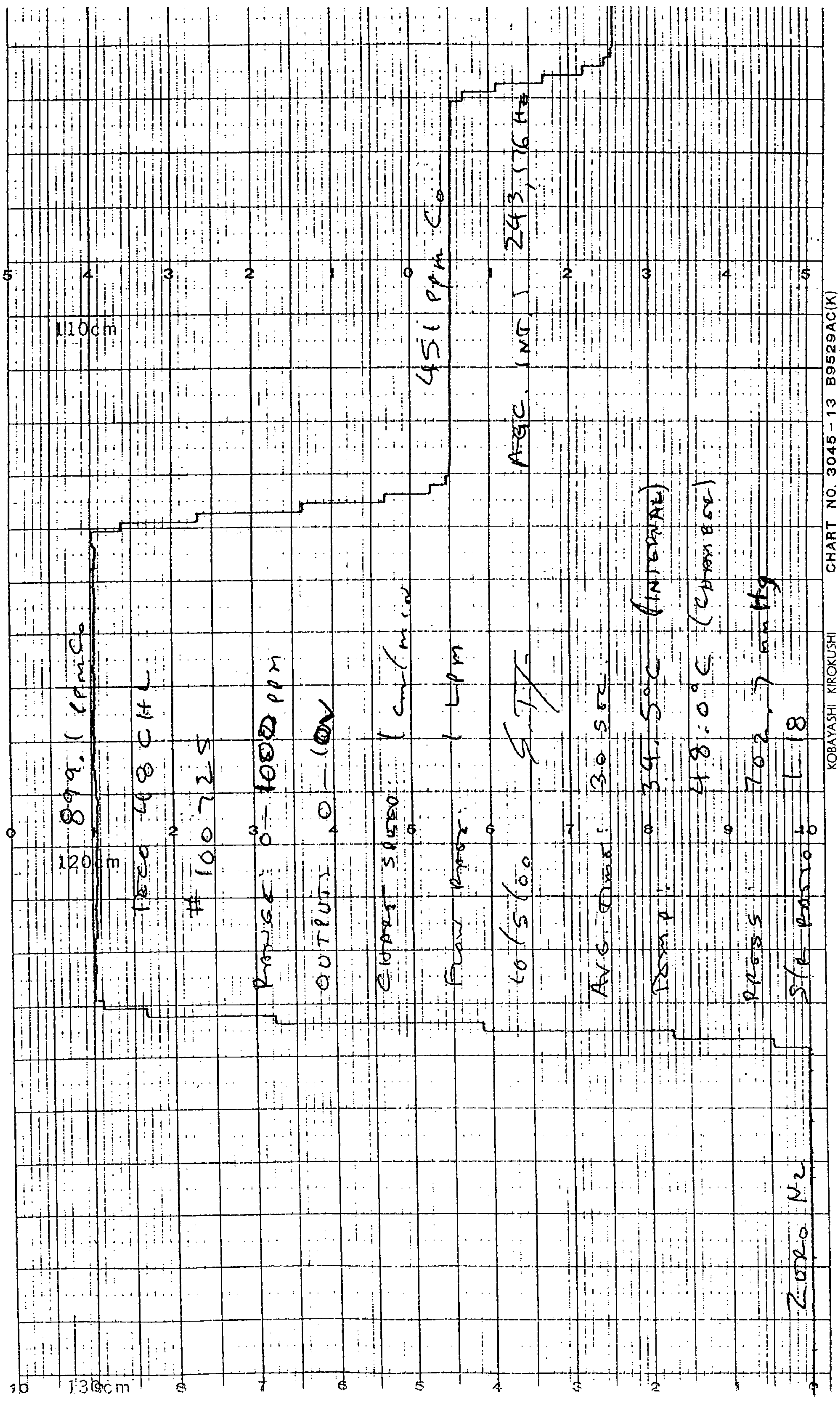
AMBIENT TEMPERATURE 69 °F ASTM MERCURY-IN-GLASS ID # —

NIST REFERENCE TC ID # JC06597

Date	Reference Point Number	Source (Specify)	Reference Thermometer Temperature °F	Thermocouple Display Temperature °F	Absolute Temperature Difference %
9/10	1	Stack	32	32	0.0%
	2	"	212	211	0.5
	3				
9/10	1	probe	32	32	0.0
	2	"	212	211	0.5
	3				
9/10	1	Filter Box	32	32	0.0
	2	"	212	211	0.5
	3				
9/10	1	Meter	32	32	0.0
	2	"	212	212	0.0
	3				
9/10	1	Imp Exit	32	33	3.1
	2	"	212	214	0.9
	3				
	1				
	2				
	3				
	1				
	2				
	3				

Checked By: [signature] 9/10/00

Personnel (Signature/Date) Team Leader (Signature/Date)


110cm
120cm
130cm
899.1 ppm Co
#100725
Range: 0-1000 ppm
Output: 0-10V
Chart speed: 1 cm/min
Flow rate: 1 Lpm
Avg time: 30 sec
Temp: 34.5°C (Internal)
48.0°C (Chamber)
Press: 762.7 mmHg
S/R ratio: 1.18
Zero N2
451 ppm Co
AGC Int 1 243,176 Hz
KOBAYASHI KIROKUSHI
CHART NO. 3045-13 B9529AC(K)

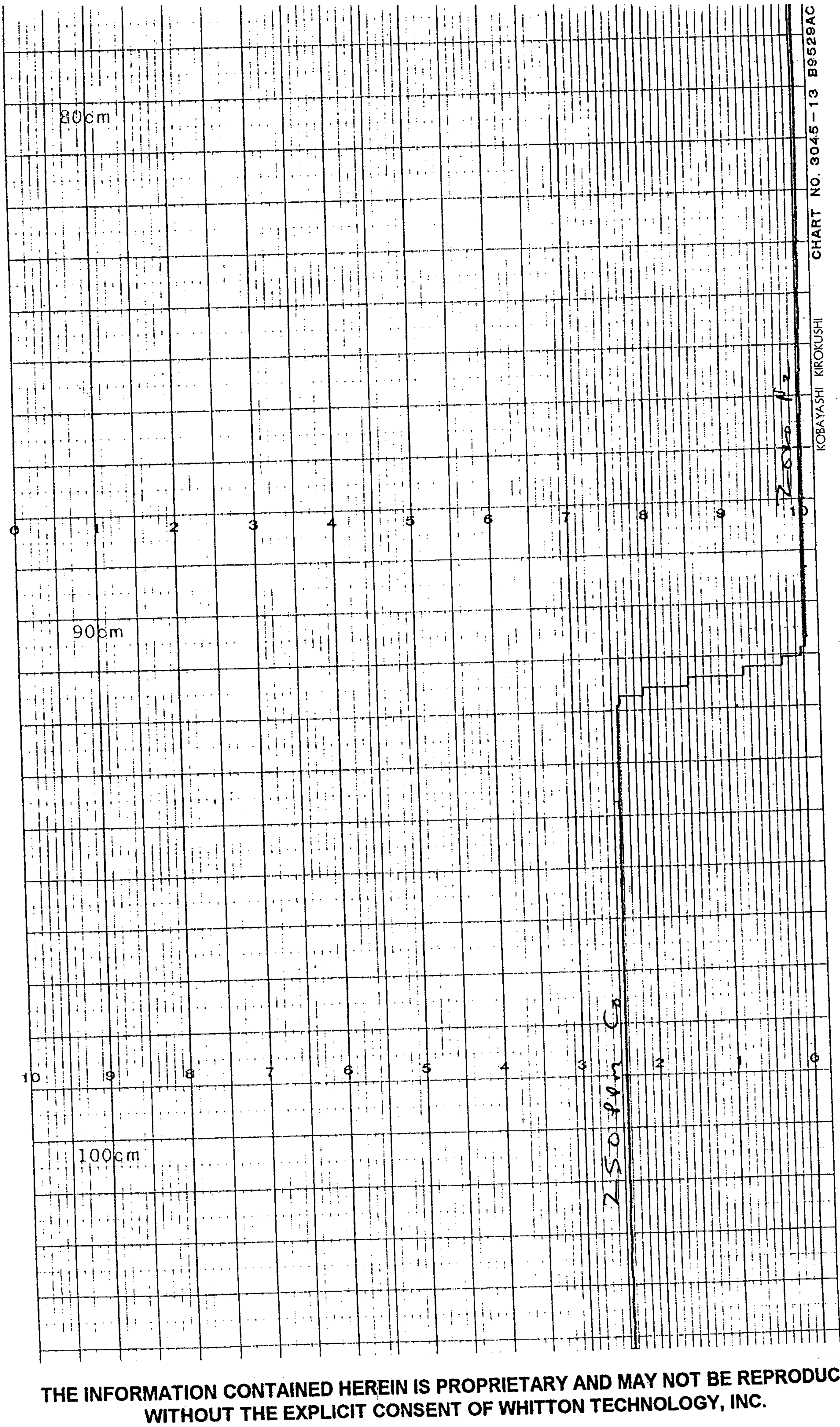


CHART NO. 3045-13 B9529AC
KOBAYASHI KIROKUSHI
80cm
90cm
100cm

```
****************
* ECOMS - Plus *
****************
Date          Time
27.01.00   19:14:56
Fuel type :
 Natural gas
T.Room        70 °F
T.Gas         71 °F
O2          21,0 %
CO             0 ppm
NO             0 ppm
NO2            0 ppm
SO2            0 ppm
Lambda   -----
CO2      ----- %
Eff      ----- %
Losses   ----- %
Draught  ----- in.w.g
Smoke dot ----
Oil deriv. ----
Standa  ----- % O2
S+ #: 4269
CLEAN AIR ENGINEERING
RENTALS
1-800-553-5511
www.cleanair.com
```

Ambient Air

```
****************
* ECOMS - Plus *
****************
Date          Time
27.01.00   19:22:20
Fuel type :
 Natural gas
T.Room        71 °F
T.Gas         71 °F
O2           0,0 %
CO           150 ppm
NO             0 ppm
NO2            0 ppm
SO2            0 ppm
Lambda   -----
CO2      ----- %
Eff      ----- %
Losses   ----- %
Draught  ----- in.w.g
Smoke dot ----
Oil deriv. ----
Standa  ----- % O2
S+ #: 4269
CLEAN AIR ENGINEERING
RENTALS
1-800-553-5511
www.cleanair.com
```

150 CO

```
****************
* ECOMS - Plus *
****************
Date          Time
27.01.00   19:30:45
Fuel type :
 Natural gas
T.Room        72 °F
T.Gas         72 °F
O2           0,0 %
CO             1 ppm
NO           211 ppm
NO2            7 ppm
SO2            0 ppm
Lambda   -----
CO2      ----- %
Eff      ----- %
Losses   ----- %
Draught  ----- in.w.g
Smoke dot ----
Oil deriv. ----
Standa  ----- % O2
S+ #: 4269
CLEAN AIR ENGINEERING
RENTALS
1-800-553-5511
www.cleanair.com
```

211 NO

```
****************
* ECOMS - Plus *
****************
Date          Time
27.01.00   19:46:35
Fuel type :
 Natural gas
T.Room        70 °F
T.Gas         71 °F
O2          20,8 %
CO             0 ppm
NO             0 ppm
NO2          274 ppm
SO2            0 ppm
Lambda   -----
CO2      ----- %
Eff      ----- %
Losses   ----- %
Draught  ----- in.w.g
Smoke dot ----
Oil deriv. ----
Standa  ----- % O2
S+ #: 4269
CLEAN AIR ENGINEERING
RENTALS
1-800-553-5511
www.cleanair.com
```

274 NO2

```
****************
* ECOMS - Plus *
****************
Date          Time
27.01.00   19:57:39
Fuel type :
 Natural gas
T.Room        71 °F
T.Gas         71 °F
O2           0,0 %
CO             0 ppm
NO             7 ppm
NO2            1 ppm
SO2          220 ppm
Lambda   -----
CO2      ----- %
Eff      ----- %
Losses   ----- %
Draught  ----- in.w.g
Smoke dot ----
Oil deriv. ----
Standa  ----- % O2
S+ #: 4269
CLEAN AIR ENGINEERING
RENTALS
1-800-553-5511
www.cleanair.com
```

220 SO2

```
****************
* ECOMS - Plus *
****************
Date          Time
27.01.00   20:01:11
Fuel type :
 Natural gas
T.Room        71 °F
T.Gas         71 °F
O2           3,1 %
CO             1 ppm
NO             6 ppm
NO2            1 ppm
SO2            6 ppm
Lambda   -----
CO2      ----- %
Eff      ----- %
Losses   ----- %
Draught  ----- in.w.g
Smoke dot ----
Oil deriv. ----
Standa  ----- % O2
S+ #: 4269
CLEAN AIR ENGINEERING
RENTALS
1-800-553-5511
www.cleanair.com
```

3% O2

Ecom S+ OCNXS
Asset# 4269
calibrated
10-5-00

WISCONSIN
DEPT. OF NATURAL RESOURCES

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Tommy G. Thompson, Governor
George E. Meyer, Secretary

PO Box 7921
101 South Webster Street
Madison, Wisconsin 53707-7921
TELEPHONE 608-266-2621
FAX 608-267-3579
TDD 608-267-6897

May 10, 2000

Mr. David DeRuiter
DeRuiter Environmental Inc
PO Box 248
Marcellus MI 49067

Dear Mr. DeRuiter:

Please be advised that you have successfully completed our recent Visible Emissions Evaluation course.

Having participated in the smoke evaluation sessions, you met the following certification criteria:

1. The average deviation for the sets of 25 black and 25 white smoke emissions was less than 7.5%.

2. The deviation of each reading was 15% or less.

This certification is valid until 10/11/2000.

Sincerely,

Andy Seeber

Andy Seeber, Environmental Engineering Specialist
Bureau of Air Management

Enclosure

Appendix E: Digital Images (from Emissions Testing)

Figure No. 1
Whitton Technology, Inc. S-Series Air Curtain Destructor
Refractory Lined Combustion Chamber

Figure No. 2
Whitton Technology, Inc. S-Series Air Curtain Destructor
Initial Combustion, Air Manifold at Left

Figure No. 3
Whitton Technology, Inc. S-Series Air Curtain Destructor
Blower and Air Manifold

Figure No. 4
Whitton Technology, Inc. S-Series Air Curtain Destructor
Operating at Full Capacity, No Visible Emissions

Figure No. 5
Whitton Technology, Inc. S-Series Air Curtain Destructor
Operating at Full Capacity, No Visible Emissions

Figure No. 6
Whitton Technology, Inc. S-Series Air Curtain Destructor
Operating at Full Capacity, No Visible Emissions