www.airburners.com
E-Mail info@airburners.com

# Technical Memorandum dated February 14, 2002

## Introduction by Air Burners, LLC

A Study entitled **"Evaluation of Emissions from the Open Burning of Land-Clearing Debris Final Report" dated October 1996 was published in 1997"** ("EPA Study").

Acurex Environmental Corporation performed air quality assessments under contract to the United States Environmental Protection Agency, Office of Research and Development, Air Pollution Prevention and Control Division. A summary of this study is published at this US-EPA Web Site URL: http://www.epa.gov/ttn/atw/burn/brushburn1.pdf. It is also available here: EPA Study. The complete study can be ordered in hard copy from the National Technical Information Service (see last page of study).

US-EPA sponsored and this study is published on the EPA Web Site as an "official government document". It is frequently referenced as a supporting document to evaluate and assess the effectiveness and suitability of air curtain burners (air curtain destructors or incinerators) for most applications. Air Burners LLC believes that this study may be misleading based on an independent review of the study results and methods, as applied to full scale air curtain destruction devices. Air permits for our units often use this study as a primary source document and other regulatory compliance decisions are frequently made by county, state and other authorities regarding the use of air curtain destructors.

**Air Burners, LLC submits, that the EPA Study makes certain representations that are not applicable to full scale industrial air curtain burners and may be founded on erroneous assumption and flawed test methods and test interpretations by the authors of the study.**

Air Burners, LLC has published a report entitled **"Final Report Describing Particulate and Carbon Monoxide Emissions from the Air Burners (formerly Whitton Technology) S-127 Air Curtain Destructor**", dated December 26, 2000. This report is based on tests carried out by Fountainhead Engineering, Ltd. of Chicago, IL, leading environmental experts in the field of air emissions and related regulatory issues. This 67-page report is available here (It is password protected, and the reader will be prompted to request a password via e-mail).

In 2002, Air Burners, LLC asked Fountainhead Engineering, Ltd. to review the EPA Study and compare methodologies, data quality and results and then compare the Fountainhead Engineering Ltd. results with the results of the 1995 US EPA sponsored air quality assessment.

**The Technical Memorandum below suggests that the EPA Study did not follow approved and applicable US EPA Methods. The modifications were not documented, therefore the quality of the data cannot be objectively assessed. In addition, one of the study recommendations was, that testing on full-scale air curtain destructors be conducted and the results evaluated. The US EPA sponsored study should not be considered applicable to full scale air curtain destructors or considered representative of the effectiveness and performance of full scale industrial air curtain burners.**

# TECHNICAL MEMORANDUM

**TO:** Brian O'Connor, Air Burners, LLC

**FROM:** Bruce Bawkon, P.E. and Milan Kluko, Fountainhead Engineering, Ltd.

**DATE:** February 14, 2002

**SUBJECT:** Comparison of Test Methods and Results Between US EPA Evaluation of Emissions from the Open Burning of Land-Clearing Debris Final Report and the Final Emissions Report for the Whitton (Air Burners) S-127 Air Curtain Destructor

---

The primary purpose of this memorandum is to evaluate the results as well as compare testing procedures from two separate air quality tests which assessed the "effectiveness" of air curtain destructors to combust wood products and if the use of air curtain destructors (combusting wood debris and wood waste) minimize environmental impacts (emissions) versus combustion of wood without the aid of air curtain destructors.

## Background

The United States Environmental Protection Agency (USEPA) sponsored an air quality assessment to collect data from air curtain destruction devices. This study has been cited by several regulatory agencies when assessing the use of the S-127 aboveground air curtain destructor. The USEPA document that Fountainhead Engineering Ltd. (FOUNTAINHEAD) reviewed was "Evaluation of Emissions from the Open Burning of Land-Clearing Debris Final Report" dated October 1996. Acurex Environmental Corporation performed the evaluation under contract to the United States Environmental Protection Agency, Office of Research and Development, Air Pollution Prevention and Control Division. The testing for the USEPA open burning simulation was performed in 1995 under conditions simulating aspects of an air curtain destructor in a testing laboratory (referred to as a burn hut) which is an enclosed building modified for small scale open combustion simulation experiments. A test model air curtain was fabricated for this assessment. The unit measured 36 inches long 18 inches wide and 16 inches deep. A discussion of the methodologies and findings of the USEPA assessment are discussed in more detail later in this memorandum.

In 2000 an air quality assessment was performed on an actual S-127 unit, which documented the effectiveness of combusting wood debris using a full-scale commercially available air curtain destructor. This assessment documented in-field emissions testing developed specifically for the S-127 refractory lined (aboveground) air curtain destructor. The documentation report was entitled "Final Report Describing Particulate and Carbon Monoxide Emissions from the Air Burners (formerly Whitton Technology) S-127 Air Curtain Destructor", dated December 26, 2000. Fountainhead Engineering Ltd. of Chicago, Illinois conducted this air quality assessment. This report provides documentation for the emissions testing performed on the Air Burners-Whitton Technology S-127 refractory lined air curtain destructor. The testing was conducted on

October 10 and October 11, 2000 in Clarkston, Michigan. Methodologies, testing procedures and data evaluation are discussed in this memorandum.

## Executive Summary

Air curtain destruction (ACD) combustion technology by its design, presents several challenges to representative or traditional 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 generated by the combustion of wood feedstocks creates an extremely turbulent flow over the operating ACD. The aboveground ACD is an integrated combustion system with a particulate control device engineered into the system (i.e. the air curtain), which also aids in the complete combustion of wood debris. The characteristics of the ACD in providing complete combustion of wood debris while controlling particulate had not been measured during normal operating conditions. Therefore the primary objective of the 2000 assessment was to develop an initial database to quantify emissions rates from an S-Series Air Burners-Whitton Technology ACD. This data could then be presented to regulatory agencies in order to evaluate and compare the air quality results from an actual ACD to AP-42 estimates of "open burning" which were being used as a default value and possibly over estimating particulate emissions (when compared to open burning AP-42 standards). Since data on these units were not available, Whitton Technology (now Air Burners LLC) sponsored a study to collect data for this technology, which could be considered during permitting of S-Series ACD's manufactured by the company.

The 2000 study conducted air quality assessments on a commercially available ACD unit operating under normal operating conditions. The study provided a reliable reproducible methodology that allowed for constant and continuous emission monitoring during active

loading and combustion of wood feedstocks while analyzing five gases, measuring temperatures and sampling for particulate.

The 1995 USEPA air quality assessment tested a pilot-scale non-commercial air curtain unit specially fabricated to fit the dimensions of a combustion laboratory. This laboratory building appeared to be designed primarily for "stack testing" and similar emission testing and has been used for several other air quality assessments combusting a variety of materials. According to the Abstract for the 1995 assessment the study was attempting to identify and quantify a broad range of air pollutants that are discharged during "small-scale, simulated, open combustion of land clearing debris" while reporting "emissions relative to the mass of material combusted." According to the Abstract "the emphasis of analyses was placed on the quantification of hazardous air pollutants listed in Title III of the Clean Air Act Amendments of 1990."

The results of the 1995 assessment are discussed in this memorandum and compared to the 2000 in-field assessment of a commercial aboveground refractory lined air curtain destructor.

**Air Combustion Units**

The USEPA "simulated air curtain combustor" was constructed to burn wood debris in a relatively small combustion box for their experiment. The Air Burners (formerly known as Whitton Technology) S-Series Air Curtain Destructor (ACD) is an engineered combustion device with integrated control systems designed into the unit working together to achieve optimum combustion conditions while minimizing uncontrolled emissions. The Acurex fabricated unit was operated inside a burn hut with a controlled air inlet system that provided 1,540 to 1,603 cubic feet per minute of air. The combustion box dimensions were 36 inches long, 18 inches wide and 16 inches deep. The volume of the combustion chamber is approximately 6 cubic feet. A description of the manifold for the air curtain was not provided; however, the flow rate was reported at approximately 89 cubic feet per minute. The air turnover in the combustion box was 14.8 per minute, assuming complete mixing and based on the combustion box volume and air flow rate.

There was no engineering assessment conducted to establish whether or not this "simulated air curtain combustor" would operate in a similar manner to a commercial (full size) air curtain destructor system specifically designed for wood combustion. This simulation did not document engineering assessments on the air delivery system, the air flow inside the combustion box or other aspects of the combustion process that are critical to efficient combustion and control of emissions.

The Air Burners system Model S-127 ACD is a full size combustion unit. The firebox dimensions are 27 feet (length) 8 feet 4 inches (width) and 8 feet 1 inch (depth). During the emissions testing, the S-127 was operated outside under commercial or normal operating conditions. The volume of the S-127 combustion chamber is 1,811 cubic feet. The fan is able to produce a minimum flow rate of 15,000 cubic feet per minute. This is ten times greater flow rate than the US EPA test of their "simulated air curtain combustor." The S-127 air curtain delivery system is patented and uses specific distribution of air for constant delivery throughout the length of the manifold. Calculation of the air turnover rate of 8.3 per minute for the S-127 assumes complete mixing.

**Comparison of Air Combustion Units**

The significant differences associated with theses two tests are that the US EPA constructed a "simulated air curtain combustor" that was not a full-scale unit. Also, airflow exchanges from the fan system used in the US EPA test were significantly greater than the S-127 system. The Acurex report states that the air "flow was adjusted to enhance the combustion rate, avoid entraining of ash out of the refractory lined pit, and to achieve a vortex shaped flame and smoke pattern…."

Subjectively adjusting the air flow based on visual observations of the flame and ash entrainment may have resulted in optimizing the combustion process; however the reported particulate emissions based on mass of debris combusted was approximately 100 times greater in the US EPA test. This may illustrate a lack of understanding of airflow distribution and delivery. The attached calculations show that the average US EPA particulate emissions were 10.09 g/kg versus 0.075 g/kg for the S-127 test. Particulate emissions based on the volume of exhaust gases were virtually the same (8.50 average mg/m$^3$ for the US EPA test and 9.59 average mg/m$^3$ for the S-127 test.

---

## Sample Collection Methods

The Acurex system used a pyramidal, metal deflector shield located 3 to 4 feet above the simulated air curtain destructor combustion unit. In order to transport a sample of air for analysis from the combustion hut to the sampling shed, a 6.6-inch outside diameter stove pipe was located directly over the deflector shield and ducted to the sampling shed. The Dichotomous Sampler for collection of $PM_{10}$ was located in the Sample Hut.

The Dichotomous Sampler was operated in accordance with the operating manual and provisions of EPA's "Reference Method for Determination of $PM_{10}$ in the Atmosphere."

The particulate removal device for the continuous emission monitors (CEM) was also located in the Sample Hut. Volatiles were sampled with a Teflon line inserted through a hole in the back of the burn hut. CEM samples were extracted from a sampling manifold in the duct and pulled from the burn hut into the sample shed under a vacuum by an induced draft fan. The Hazardous Air Pollutants Mobile Laboratory (HAPML) was used for the continuous monitoring of the fixed combustion gases (THC, $O_2$, $CO_2$ and CO).

The emission test for the S-127 air curtain destructor sampled gas and particulates over the entire combustion area using a mobile sampling unit consisting of a platform lift with a 10 ft. support leading to a stack structure. The stack structure was 4 ft. in length and 14 inches 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 US EPA Method 1, the Project Team selected sample point locations. The entire top of the ACD unit was treated as the edge of a rectangular stack. In field conditions of an actual production unit versus simulation, the S-127 test incorporated continuous sampling during loading.

The vertical location of sampling was determined by positioning the stack structure in the air curtain produced by the S-127 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 sampling point was determined by raising the entire stack structure out of the air curtain to an area where velocity pressure was maximized (approximately 8-12" above the air curtain). A modification to US EPA Method 1 was implemented 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. The testing can be replicated with more or less sample points and testing allowing for verification of test results. Also, sampling and analysis of emission over a two day time period resulted in similar and verifiable emission rate, providing positive correlation of the test method design.

US EPA Method 5D – Determination of Particulate Matter Emissions from Positive Pressure Fabric Filters 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.

Method 5 procedures were used to withdraw 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.

---

US EPA Method 10 – Determination of Carbon Monoxide Emissions From Stationary Sources was used to extract an integrated gas sample, which was 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) was 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.

**Comparison of Sample Collection Methods and Air Quality Results**

The US EPA test collected gases from a "simulated air curtain combustor" within an enclosed structure that contained the combustion exhaust gases. The S-127 emission test collected the combustion exhaust gases from a full size ACD operated outside under typical commercial conditions. A comparison of CO, NO and $PM_{10}$ indicate that the concentrations based on volume of exhaust gas are similar for both units. However, a comparison of the same emissions based on mass of wood debris combusted indicates that the S-127 ACD is more efficient since the concentrations based on mass is ***consistently and significantly lower***.

As noted previously, the US EPA test used a "simulated air curtain combustor" that was operated with a much higher (more than double) air exchange rate in the combustion box. It appears that excess air flow in the US EPA "simulated air curtain combustor" may have contributed to diluting the concentration of CO, NO and $PM_{10}$ in the exhaust gas since the ratio of the mass of emissions generated to the mass of material combusted in the US EPA "simulated air curtain combustor" are significantly higher than the mass ratios for S-127 ACD. The US EPA test does confirm that the concentrations of CO, NO and $PM_{10}$ observed in the S-127 ACD test can be verified in the USEPA "simulated air curtain combustor" test. Although, the concentrations of emissions (CO, NO and $PM_{10}$ ) based on volume of gas compare between the USEPA "simulated air curtain combustor" and the S-127 ACD, the operation and combustion processes are significantly different. The similarity in these values are due to the fact that the 1995 study was able to create an optimal combustion environment by forcing excess air into the burn hut however this objective failed to effectively control particulate emission which is the major difference between the bench-scale ACD and the full scale model commercial model. The oxygen-enriched environment created in the combustion chamber also uses the deflection of the air curtain to control particulate emissions through precise directional application of air distributed uniformly along the manifold system (without pressure drop). In the 1995 USEPA assessment the excess air introduced into the burn hut is used primarily to promote turbulent air mixing which will provide an environment for complete combustion but without regard for emission control. The engineering of the two unites cannot realistically be compared nor can their emission control technologies.

The Air Burners manifold system is patented and was developed thorough years of research and engineering analysis. The bench scale "air curtain combustor" for the 1995 test was fabricated for this one time test. The units design and operation are very different and this is a primary reason why particulate emissions on the S-127 are very low while achieving high temperatures, good turbulence under the air curtain with the result being complete combustion of wood wastes.

Although it is possible to construct a bench scale ACD that operates similarly to the full size ACD, there is no information in the USEPA report to substantiate a realistic comparison. The Air Burners patented systems rely on precise engineering designs to ensure a constant and uniform delivery of airflow throughout the manifold system while creating high temperatures and sufficient rotational turbulence allowing for complete combustion.

The USEPA consultants could have and should have explained their sampling methodologies in more detail and discussed in more detail potential errors in sample data or how the data was to be interpreted in light of these method modifications and test “simulations”, but chose not to provide any discussions in the documentation report. The reader is provided references (Pages 20 and 21) that appear to draw upon previous limited studies of open uncontrolled burning of lawn clipping, leaves and tree branches (Reference 2), wood burning fireplaces, “third world cook stoves” (Reference 4) trench air curtain destructors, pilot-scale trench incinerators, as well as uncontrolled open burning from forest fires, biomass burning and open burning characterizations of other simulations (i.e. combustion of scrap tires, evaluations of heated roofing asphalt, simulated open burning of non-metallic automobile shredder fluff and characterization of simulated open combustion of fiberglass materials) where the principal investigators in this air curtain simulation study were also principal investigators in many of the previous references mentioned in the USEPA study. Inclusion of the aspects of these studies with a discussion of their relevance would be useful. Inclusion of some of these references is confusing and appears to offer some sort of substantiation to study conclusions. The reader is not provided with a comparison.

The Summary and Conclusions in Section 4.0 of the USEPA assessment (Page 20) was essentially one paragraph. This section stated that their tests “did not provide conclusive evidence of the effectiveness of air curtain blowers in reducing emissions.” There were unfortunately no discussions on why test methods selected were appropriate, acceptable or how the simulated design for air curtain testing was derived or how the airflow and mixing properties were established (or were representative of commercial devices). No engineering aspects of how the simulated manifold system was developed for the bench scale air curtain system were discussed. Airflow delivery through "the manifold" that creates the air curtain is extremely important. Based on the limited information provided the simulation of the manifold system operating for the USEPA/Acurex test did not have characteristics similar to actual commercial units nor did it reflect real world operating conditions.

The USEPA assessment may have been successful in directing the "emissions" from a bench scale model into a sample transport duct for collection of air samples similar to a "stack test" however the configuration and location of the air quality sampling equipment as well as the sampling techniques raise technical issues that were not fully explained in the USEPA assessment. The bench scale (simulated) air curtain destruction device did not accurately reflect the S-Series (or any commercial aboveground refractory device) under normal in-field operating conditions due to the fact that external devices were used to "simulate turbulence" within the burn hut. In practice this turbulence would occur or be contained within the air curtain combustion chamber itself. This turbulence in the form of an air curtain needs to be provided at precise angles at uniformed velocity throughout the manifold system so that reflection of the air curtain off of the combustion box surfaces (walls) inside of the unit over provides excess oxygen for complete combustion at high temperatures while controlling emissions by entraining particulate matter between the burning feedstock and the bottom of the air curtain.

The USEPA study participants did not strictly follow approved USEPA Methods. The Methods for the 1995 tests were modified, as were the Methods for our assessment. However the 2000 study provides a rationale on why certain methods were selected and how these methods may have been modified or calibrated for the S-Series air curtain assessment. The USEPA assessment does not explain the modifications to Methods or explain issues associated with sampling procedures or how data quality could be impacted as a result of the modifications. For instance the USEPA assessment modified PM10 test methods, but there was no explanation of how the Method was modified. A modified USEPA test method TO-13: Particulate and Semi Violate Organic Sampling was used. Specifically this test was performed using an extremely low flow rate of 1ft/min (versus the target flow rates of 7 to 9.8 ft/min). The Method allows for lower velocities but with some loss in data quality objectives and using a flow rate seven times lower than the accepted range was probably not envisioned by USEPA and would not be considered reliable. The reader is not provided the opportunity to assess rationale or understand if this significantly impacts the data since no discussion is offered in either the text or appendix. Also based on the physical constraints of the burn hut Method TO-13 required modification. What were these modifications? It was also stated that draft Method 5 procedures (referred to as Draft Method 3542 in the USEPA assessment) were modified however attempts to follow draft sample collection procedures were made including sample train recovery “to the greatest extent feasible.” There was no explanation provided and no documentation of modification rationale provided as to whether the Methods were followed or not. This information or at least a discussion on what impact these “deviations” from approved Methods would have on the data collected would have illustrated the relative accuracy of the data collected using this or any modified method.

As mentioned previously the fabrication of the simulated “air curtain combustor” for the USEPA assessment did not reflect actual operating conditions associated with commercial available air curtain destructors and especially not the S-Series. One of the findings of the USEPA study concluded, “Measurements of a variety of pollutants in the emissions of full-scale models of this device operating under realistic work site conditions would (also) be helpful.” We agree and this was essentially why the October 2000 testing was conducted.

The objective was to develop testing procedures to accommodate this technology knowing some of the challenges with testing this technology. To our knowledge the October 2000 assessment is the first time that your S-Series refractory lined incineration units or any similar aboveground units have been subjected to this type of testing. Our testing approach can be reproduced following testing methods described in the December 2000 documentation report. It is important to document and explain how several USEPA Methods were applied to this technology along with Method 9 Opacity Testing so that application and documentation hopefully minimize data errors but also achieve project-testing objectives based on accepted technical guidance found in USEPA Methods. In the 2000 air quality assessment the application and modification of the Methods are explained unlike the 1995 UEPA sponsored assessment. The goal for the 2000 air quality assessment at a minimum would be for replication of our test methods, which achieve similar results for this specific technology. Before developing our methodologies for the S-Series ACD the project team did consider other approaches as well. We will discuss the advantages and disadvantages with "stack" testing methodologies and explain the rationale associated with the selection or modification of approved methods.

A comparison of sample collection methods, analytical results and combustion unit design was presented in this Technical Memorandum for both assessments. We believe it was important to establish how these test methods were applied or modified for an air curtain destructor versus traditional stack sampling protocols as well as discuss the methods used by USEPA.

As the Project Team has discussed, traditional stack testing methods are not designed for such a turbulent source. However when comparing the two assessments the primary difference is that a "bench scale model" of an air curtain destructor was fabricated for the USEPA assessment to simulate "generic" air curtain conditions without documenting, if this simulated approached accurately reflected commercial technologies available at the time of testing or if this bench scale design accurately reflected specific principles or technology of the commercial aboveground refractory air curtain destruction systems in the United States. The specific engineering design of a system is extremely important to document, in order to determine if the ACD system is achieving complete combustion while also controlling emissions better than combustion without the aid of an aboveground refractory lined air curtain destruction system.

Small Method modifications were made to accommodate the Air Burners technology (i.e. combustion without a single emission point or stack). The traverse point selected for sampling with the mobile stack used USEPA Method 1 and treated the entire combustion unit or firebox as a large (square) stack in order to apply USEPA Method 5 that withdrew samples isokinetically. USEPA Method 9 (for visible emissions) was conducted during all air quality testing and provided verification of very low visible emissions which correlate or are consistent with the results of the Modified Method 5 results applied during the same testing period.

The airflow into the combustion chamber or firebox in the S-Series requires precise directional control and during operation would be instantaneously changed or “dynamically controlled” based on the conditions of fire (i.e. more airflow or less air flow as wood is consumed or new wood is added). Specifically combustion characteristics (i.e. the fire) in the combustion chamber changes throughout the combustion cycle, as wood is combusted in the chamber since there is significantly more mass at the beginning of the combustion processes than at the end. This would necessarily dictate a change in the airflow and this increase or decrease in airflow (delivered through the manifold system) would correlate directly to the combustion characteristics or stage of the fire in the combustion chamber.

The bench scale simulated air curtain destructor fabricated for this test inside the “burn hut” did not accurately reflect representative operations of commercial air curtain devices or other similar air curtain devices for many reasons, including the use of “two residential type of electric fans placed in the hut ensuring thorough mixing.” We previously contrasted the differences in the bench-scale ACD verses the Air Burners ACD as well as test methodologies. The USEPA report stated, "Emission of some pollutants decreased slightly while other were unchanged or in a few cases appeared to increase." The USEPA study also recommended "Measurements of a variety of pollutants in the emissions of full-scale models of this device operating under realistic work site conditions would also be helpful." The S-Series testing performed in 2000 was designed to develop reliable methods in order to more accurately measure actual emissions from a full size commercially available air curtain destructor.

The results of the October 2000 air quality assessment performed on the Air Burner S-127 was presented and reviewed to USEPA Region 3. This data was subsequently accepted in order to permit S-Series ACD's in West Virginia. The state law was changed to allow for the S-Series to be permitted after results of the 2000 air quality assessment. The USEPA conducted a site visit of the West Virginia installation and issued a positive compliance (field) report confirming the performance standards for the S-Series and that the ACD was operating within the emissions standards set by the state of West Virginia. The basic methodology developed for the 2000 air quality assessment was recently used by the United Kingdom (UK) for a far more comprehensive air quality assessment of the S-127. The results of the UK air quality study will be extremely useful as additional verification of the performance of the S-Series ACD and this data should be reviewed once it is made available by the UK and compared to other similar air quality assessments on air curtain destructors.

* * * * *