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# A Test Method for Measuring the Ozone Emission of In-duct Air Cleaners

# by

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# **Thesis**

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

**Master of Science in Engineering** 

The University of Texas at Austin

December 2011

# **Acknowledgements**

I would like to thank my mother, father and sister for their never-ending love, support and encouragement. I would like to acknowledge my advisers, Dr. Jeffrey Siegel and Dr. Atila Novoselac, for their guidance and support. I would also like to thank Joshua Rhodes for his design work of the test apparatus. Lastly, I would like to thank the California Air Resources Board for their funding of this research.

December 2011

#### **Abstract**

# A Test Method for Measuring the Ozone Emission of In-duct Air Cleaners

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There are many U.S. health-related standards for ozone that aim to limit exposure to ozone. The potential for ozone emission from electrically connected air cleaners is well-known and has led to standards and regulations for portable indoor air cleaning devices, which emit ozone at measured rates of 0.056 – 13.4 mg hr<sup>-1</sup>. However, there is evidence that some in-duct air cleaners may actually emit more ozone than portable air cleaners, despite being exempt from most regulations due to the lack of a suitable test method for measuring ozone generation. To explore if in-duct cleaners actually do emit ozone, I investigated seven commercially available residential in-duct air cleaning devices. These devices used one of two broad technologies as means of air cleaning: UV light or electrical corona. The lowest measured emission rates came from two air cleaners that utilized UV light technology and were 0.309 ± 1.7 mg hr<sup>-1</sup>, which was likely below the detection limit of the apparatus and method, and 4.29± 1.5 mg hr<sup>-1</sup>. Three of the air cleaners tested, also with UV lamps, were of the same brand and model yet exhibited differing emission rates, ranging from 7.44± 1.6 mg hr<sup>-1</sup> to 15.8± 2.6 mg hr<sup>-1</sup> <sup>1</sup>. These three air cleaners were classified as medium emitters and also utilized UV light technology. The high median measured emission rates were measured from both an air cleaner utilizing electrical corona technology, 30.2 ± 4.0 mg hr<sup>-1</sup>, and UV light technology,  $29.4 \pm 3.9 \text{ mg hr}^{-1}$ . These experimental results confirm that some in-duct air cleaners are able to generate more ozone than some portable air cleaners and also suggest potential health risks to the indoor environment.

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# **Motivation and Background**

There are multiple health-related standards for ozone established by the U.S. government, such as the National Institute for Occupational Safety and Health, the Occupational Safety and Health Administration, the California Air Resources Board and the Environmental Protection Agency, which place limits on exposure to ozone. Investigations have shown associations between outdoor ozone concentration exposure and morbidity and mortality. Ozone can cause chest pain, coughing, shortness of breath, throat irritation, and exacerbate asthma (e.g. Bell et al., 2004; Hubbell et al., 2005; Ito et al., 2005; Jerrett et al., 2009; Levy et al., 2005). Ozone has also been found to be very chemically reactive (e.g. Weschler, 2000), which can lead to additional exposure to harmful reaction by-products (Weschler, 2006). Although intended for indoor air purification, some in-duct air cleaners may actually produce ozone during operation. (e.g. Viner et al., 1992). This raises concerns about their overall value for improving indoor air quality.

Ozone emission from some air cleaners is a well-known phenomenon. In 2007, the California Air Resources Board adopted a regulation placing a 50 ppb emission concentration limit on portable indoor air cleaning devices, relying on the test method described in Section 37 of Underwriters Laboratory Standard 867 to certify compliance. In-duct air cleaners, which are physically integrated within a central HVAC system, were exempt from the regulation because no suitable test method was available for measuring ozone from such devices. Several investigations demonstrate that some induct air cleaners may actually emit much more ozone than portable air cleaners (e.g. Bowser, 1999; Emmerich and Nabinger, 2000; Hanley et al. 1995; Viner et al. 1992). In principal, any electrically connected device may generate ozone. One prominent type of

technology used by in-duct air cleaners is the electrical corona, which has been found to generate ozone (e.g., Britigan et al., 2006; Viner et al. 1992; Waring et al., 2008). Another major technology used is ultraviolet light, which uses wavelengths below 253.7 nm for germicidal irradiation yet consequently also leads to ozone generation (Vig, 1985). Most in-duct air cleaning devices integrate one or both of these approaches, often in combination with charged plates, photocatalysts, and other technologies. Because of the diversity in electronic air cleaning, and the evidence that in-duct air cleaners may emit much more ozone than portable air cleaners, there is strong motivation for a test standard for in-duct air cleaning devices.

The primary focus of this study is to develop a test methodology for measuring the ozone emission rate of in-duct air cleaners. Bowser (1999) studied 15 homes with induct electrostatic precipitators and approximated emission rates ranging from roughly 15-73 mg h<sup>-1</sup> based on the rise in indoor concentrations of ozone. Viner et al. (1992) investigated two commercial in-duct electrostatic precipitators in a laboratory test duct and observed ozone emission rates ranging from 18-30 mg h<sup>-1</sup>, albeit at much lower flow rates than would typically be seen in residential HVAC systems. In this paper, I present a laboratory test method, which reflects residential installation and application for any induct electrically connected air cleaner that emits ozone. The purpose of this method is to allow for comparison of ozone emission from different air cleaners.

# **Experimental Methodology**

The ozone emission rate, E (mg h<sup>-1</sup>), of an air cleaner is shown in Equation 1,

$$E = Q(C_{downstream} - C_{upstream})$$
 (1)

where Q (m³ h⁻¹), is the average volumetric flow rate through the air cleaner and  $C_{downstream}$  and  $C_{upstream}$  are the average concentrations ( $\mu g$  m⁻³) of ozone downstream and upstream of the air cleaner, respectively. While this approach may seem very simple, there are several limitations with actually using it to measure the ozone emission rate of air cleaners. The primary limitation is ozone concentration dilution. At typical air flowrates for large residential HVAC systems, the ozone concentration rise across the air cleaner can be much smaller than the measurement uncertainty of an ozone analyzer. To address this limitation, variable speed fans are used in the test method described below to decrease the flow and increase the concentration difference to a value far above the minimum detection limit of the analyzer. This may introduce other concerns if ozone emission rate is dependent on flow and this is addressed in the method described below.

To measure ozone emission rate, the experimental apparatus shown in Figure 1 was developed. The apparatus is a closed loop system, constructed of both stainless and galvanized steel. Stainless steel was used only in the portions of the apparatus where ozone sampling occurred, as it is less reactive with ozone than galvanized steel. The upper portion is a 60 cm x 60 cm square stainless steel duct, 590 cm in length. The curved transition sections from the upper to lower duct are constructed of galvanized steel, with a  $60 \text{ cm} \times 60 \text{ cm}$  cross section at the junction with the upper and lower ducts

and 150 cm in height. The lower portion of the apparatus consists of two Trane Modular Variable Speed Air Handlers (Model No. 4TEE3F65B1000A) joined by a 48 cm x 60 cm galvanized steel duct, 210 cm long. The test section, in the upper portion of the apparatus, is 60 cm length duct segment where the air cleaners are installed. An AEROSTAR High Volume HEPA Filter (Filtration Group Inc. Item No. 40419) and an AEROSTAR Activated Carbon Filter (Filtration Group Inc. HEGA Series 1652, Item No. 17972) are installed within the upper portion, upstream of the test section for particle filtration and to diminish all ozone in the air stream, respectively. The two previously described air handlers, which supply the air flow and pressure distribution through the apparatus, are each controlled by an Evolution Controls Inc. Visual Control Unit (Model No. EVO/ECM-VCU-36-mp). A flow station is located in the lower portion of the apparatus, in the section of duct immediately following air handling unit #2. The flow station (Shortridge Instruments, Inc., VelGrid) is a square, 16 point, face velocity grid. The pressure difference is measured through the velocity grid by using a DG-700 Pressure and Flow Gauge. The flow rate was calculated by converting the flow station pressure measurement to the appropriate flow rate. This calibration method was done using The Energy Conservatory TrueFlow Air Handler Flow Meter and the DG-700 digital pressure gauge. Calibration of the flow meter occurred only once during the course of all air cleaner testing, and happened prior to any air cleaner testing.

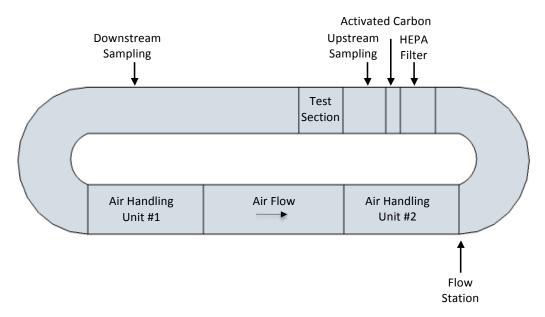


Figure 1. Test apparatus

The air is sampled both upstream and downstream of the test section through a sampling grid. The upstream sampling grid is located 15 cm before the test section and the downstream sampling grid is located 270 cm after the test section. The sampling grid, illustrated in Figure 2, consists of three vertical stainless steel rods, 55 cm in length with a 6 mm outer diameter and 1.5 mm wall thickness. Five 1 mm diameter holes were drilled 12 cm apart on each of the three rods, to measure an average ozone concentration over the entire cross section of the duct. The three rods are spaced evenly across the duct with one inserted at the centerline of the duct and the other two 20 cm on either side of center. A Swagelok cap is attached to each rod on the end inside of the duct. The rods are each held in place within the duct with a Swagelok Bulkhead Union. The segments of the sampling grid outside of the duct are a combination of three short 6 mm vertical stainless steel rods and two horizontal pieces, connected by

Swagelok Unions. From the top of the sampling grid, 6 mm Teflon tubing connects the sampling grid to remainder of the sampling system.

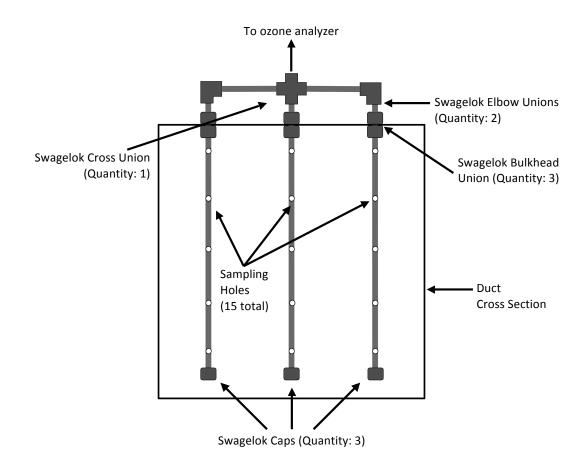


Figure 2. Sampling grid configuration

In order to use a single monitor to analyze both the upstream and downstream ozone concentrations, two Omega 2-way General Purpose Solenoid Valves (Normally Closed Model No. SV125; Normally Open Model No. SV133) were used to enable switching back and forth between upstream and downstream sampling. An Omega Programmable Timing Controller (Model No. PTC-15) controls these valves, controlling

whether the ozone monitor is analyzing upstream or downstream concentrations. A 2B Technologies Model 205 Dual Beam Ozone Monitor was used to measure the ozone concentration as measured through the sampling grid.

Additional measurements include temperature (Omega Thermistor, Model No. 44033) and relative humidity (Veris Industries HD Deluxe Humidity Transmitter, Model No. HD2NVSX), which are both located before the upstream sampling grid in the upper portion of the apparatus. The specific measurement devices used in the study are listed in Table 1 and all were connected to an instruNet Analog/Digital, Input/Output System (Model 100) which recorded data every 10 seconds.

**Table 1.** Instrumentation Used in the Test Apparatus

Measurement	Instrumentation	Accuracy/uncertainty	
Ozone concentration	2B Technologies Model 205	Accuracy ±1.0 ppb or 2% Lower limit of detection = 1 ppb	
Pressure	DG-700 Pressure and Flow Gauge	Accuracy ±0.15 Pa or 1%	
Flow rate	Shortridge Instruments, Inc. VelGrid	Accuracy ±7% <sup>1</sup>	
Relative humidity	Veris Industries HD Deluxe Humidity Transmitter	Accuracy at 25°C from 10- 80% RH ±1%	
Temperature Omega Precision Thermistor		Accuracy ±0.10ºC	

<sup>&</sup>lt;sup>1</sup>Based on accuracy of the calibration device (The Energy Conservatory TrueFlow Air Handler Flow Meter)

#### TEST PROCEDURE

To measure ozone emission rate, an air cleaner was inserted into the test section of the apparatus according to the manufacturer's recommended installation configuration. The variable speed fans were initially set to approximately 500 m<sup>3</sup> hr<sup>-1</sup>, the lowest constant flow by the apparatus. The fans were initially set at this low speed to ensure the air cleaners could attain an ozone concentration rise of at least 5 ppb. The minimum concentration difference of 5 ppb was chosen based upon the uncertainty assessment, which is discussed below in greater detail. Once the flow rate reached a steady state, the air cleaning device was then turned on and was given five minutes to reach steady state ozone concentration levels as measured by the ozone monitor. At this point sampling began, switching between the upstream and downstream sampling grids. One sampling period consisted of one upstream and one downstream sampling measurement. One full test consisted of two sampling periods. The sampling period lasted four minutes, two minutes of upstream measurement and two minutes of downstream measurement. As previously discussed, data was recorded every 10 seconds, meaning each measurement for a single grid sampling period consisted of 12 data points. The first two points of data were discarded from each set to allow for adequate flush of the sampling system from the previous grid sampling period. An entire test is eight minutes in length. This sampling period length for a single grid was chosen because 10 data points provided a robust average concentration and no variation was seen over the course of 100 seconds. Once a test was run at the lowest flow rate, fan speeds could be increased up until the minimum concentration difference of 5 ppb was reached or until the maximum achievable flow rate, 2200 m<sup>3</sup> hr<sup>-1</sup>, whichever occurs first.

### **QUALITY ASSURANCE**

Uncertainties in the emission rate were assessed by propagating the uncertainties for each of the parameters in Equation 1, according to ASHRAE Guideline 2-2010. Additional testing was also conducted to determine sampling grid performance, and sampling valve losses. The uniformity of both the upstream and downstream grids was assessed by taking a 9-point measurement over the cross-section of the duct, directly with a short length of Teflon tubing from the ozone analyzer instead of through the sampling grid from Figure 2. The average of the 9-point sample was compared with the sampling grid measurement, which was used to verify both the sampling grid performance as well as losses associated with the longer sampling line length. Sampling valve losses were quantified by taking measurements directly from the grid to the analyzer, bypassing the valves. Again, these measurements were compared to the normal configuration measurements. Preliminary testing showed some variation in the measured emission rate for some air cleaners, and it was not clear if this was due to variation in the test method and apparatus, especially after periods of non-use, or in the air cleaners. This variation is discussed in greater detail below. A low, medium and high emitting air cleaner each repeated 10 identical tests to help assess this issue.

#### EXPERIMENTAL MATRIX

A summary of the seven air cleaners tested, the technology as specified by the manufacturer, and the broad technology categorization is provided in Table 2. Air cleaner AC1 utilizes UV light technology, consisting of just a single lamp. Air cleaners AC2, AC3 and AC4 are identical units; each of the same brand and model. This air cleaner classifies its unique technology as photohydroionization, which consists of a broad spectrum UV tube in a hydrated catalytic matrix cell and also reports low-level

ozone production (10 – 20 ppb). AC5 is an electrostatic precipitator and reports generating very low levels of ozone as well (5-10 ppb) from the use of electrical corona. AC6's broad technology categorization is UV light, but actually utilizes a combination of three UV light bulbs and a titanium dioxide catalyst. This air cleaner was specifically chosen for its claim of zero ozone generation during operation. The final air cleaner tested, AC7, utilizes what the manufacturer classifies as an advanced oxidation process and reports the ozone output as not applicable. This consists of a UV light and a photocatalyst target. These air cleaners were chosen for their diversity in technology used, sizes and configurations, and different ranges of manufacturer reported ozone generation levels.

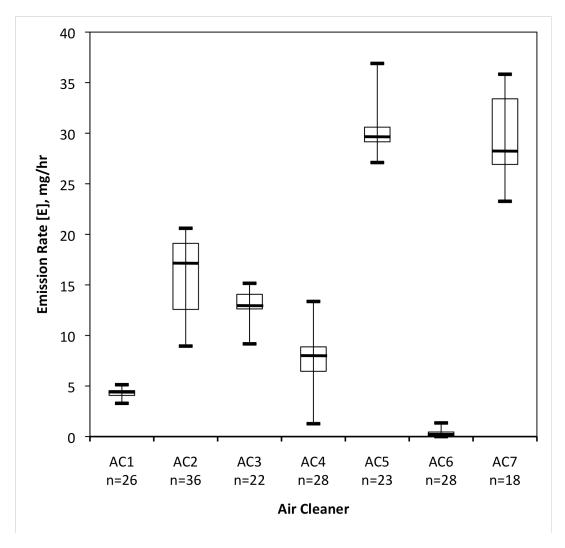
Table 2. Air Cleaners Tested

Air Cleaner	Manufacturer's Characterization of Technology	on of Categorization	
AC1	Germicidal UV system	UV light	
AC2 <sup>1</sup>	Photohydroionization	UV light	
AC3 <sup>1</sup>	Photohydroionization	UV light	
AC4 <sup>1</sup>	Photohydroionization	UV light	
AC5	Electrostatic precipitation	Electrical corona	
AC6	Photocatalytic oxidation	UV light	
AC7	<b>Advanced Oxidation Process</b>	UV light	

<sup>&</sup>lt;sup>1</sup>Same brand and model air cleaner

## **Results and Discussion**

Figure 3 shows the ozone emission rates measured for the seven air cleaners tested. The boxes show the range from the  $25^{th}$  and  $75^{th}$  percentile of emission rates with the median shown as a horizontal line within the box, while the whiskers illustrate the maximum and minimum emission rates measured for that air cleaner. Also noted in the figure is the number of tests run, n, for each air cleaner. A test is defined as an 8-minute sampling period at one consistent flow rate. Three of the air cleaners, AC2 –AC4, are of the same brand and model air cleaner. The lowest median measured emission rate was  $0.309 \pm 1.7$  mg hr<sup>-1</sup> for AC6 and was likely below the detection limit of the apparatus and method (see below). The high emission rates were  $30.2 \pm 4.0$  mg hr<sup>-1</sup> for AC5 and  $29.4 \pm 3.9$  mg hr<sup>-1</sup> for AC7. The high emission rates came from both types of air cleaners utilizing either the electrical corona, AC5, or UV light technology, AC7. The low and medium range emission rates were measured only from air cleaners that use UV light technology, including AC1 and AC6 as low emitters, and AC2-4 as medium range emitters.



**Figure 3.** Air cleaner emission rates and coefficients of variation (CV) measured over *n* test runs

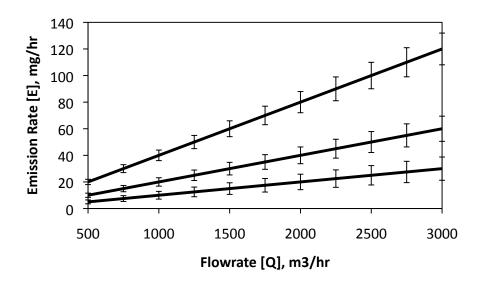
Because AC5 is the only device that used an electrical corona, this is the only logical emission rate to be used as a comparison to previously measured emission rates from in-duct air cleaners. The emission rate from AC5 is very comparable with what Viner et al. (1992) measured from two in-duct electrostatic precipitator air cleaners. The larger of the two units Viner et al. that tested was most similar to AC5, consisting of 28

corona wires and 112 plates, and was found to have an ozone generation rate of 21.6 mg hr<sup>-1</sup>, which is comparable to 30.2-± 4.0 mg hr<sup>-1</sup> measured of AC5. Bowser (1999) studied 15 homes with in-duct electrostatic precipitators and approximated emission rates ranging from roughly 15-73 mg h<sup>-1</sup> based on the rise in indoor concentrations of ozone, which AC5 also agrees with as it falls within this range. It is also relevant to compare the measured emission rates from these in-duct air cleaners to measured emission rates from previously measured portable air cleaning devices. Britigan et al. (2006) found portable air purifiers, using an electrical corona to emit 0.16-2.2 mg hr<sup>-1</sup> and dedicated portable ozone generators to emit as high as 42-220 mg hr<sup>-1</sup>. They also tested one portable air cleaner using UV light technology and measured an emission rate of 0.74 mg hr<sup>-1</sup>. The median emission rate of AC7, which utilized UV light technology, was much higher at 29.4-± 3.9 mg hr<sup>-1</sup>. Some of the in-duct air cleaners tested emit more ozone than portable units, which also may suggests that some in-duct air cleaners emit more ozone than the regulated amounts of portable units.

#### **MEASUREMENT UNCERTAINTY AND DETECTION LIMIT**

Figure 3 shows the range of the results, rather than the uncertainty for an individual measurement. The uncertainty in the emission rate is driven by the accuracy of the instruments, namely the measurements of ozone concentration and flow rate as shown in Equation 1 and discussed in the methodology. This presents a limitation to the approach in that for some air cleaners, the concentration difference at a very low air flowrates is still small enough to have substantial uncertainty. Figure 4 illustrates this as it presents emission rates at concentration differences of 5, 10, and 20 ppb measured at flow rates between 500 – 3000 m<sup>3</sup> hr<sup>-1</sup>. The uncertainty at the same emission rate, such as 20 mg hr<sup>-1</sup>, is 5.8 mg hr<sup>-1</sup> with a low concentration difference of 5 ppb as compared to

2.0 mg hr<sup>-1</sup> at a high concentration of 20 ppb. As the concentration difference increases, the uncertainty of the emission rate decreases. To have reasonable uncertainties for low ozone-emitting devices, the flow has to be reduced below what is practical in the test apparatus and also no longer represents reasonable operating conditions. A reasonable uncertainty for this test method is defined as 30%, which corresponds with the suggested threshold emission rate, described below.



**Figure 4.** Emission rates and uncertainties at ozone concentration differences of 5, 10 and 20 ppb

At some minimum emission rate a chamber test, much like that of UL 867, should be used to determine ozone emission rate. Such a test has the advantage of much higher accuracy as ozone concentrations are much higher and there is no flow measurement to add to uncertainty. Based on the uncertainty of the devices we used in this investigation (see Table 1), a minimum emission rate of 5 mg hr<sup>-1</sup>, corresponding to the apparatus's lowest flow of 500 m<sup>3</sup> hr<sup>-1</sup> and a concentration difference of 5 ppb, is

suggested for this threshold. Such an air cleaner would have an uncertainty of 30% or 1.5 mg hr<sup>-1</sup>. A chamber test would be a reasonable approach to providing greater accuracy at low flows, however it does not reflect actual in-duct installation of the air cleaner.

Another approach to assessing the smallest ozone emission rate that can be measured by the apparatus is to determine a method of quantification limit (MQL). The methods used among programs within the EPA for defining the MQL range from nonspecific to very specific. The method used for our purposes, and as defined by the Office of Prevention, Pesticides, and Toxic Substances, involves running the lowest "calibration standard" several times (+7) and multiplying the standard deviation by 6-10 to determine the MQL. In the absence of a true calibration standard, I will instead use the lowest emitting air cleaner tested. To ensure this low emitter is generating an ozone concentration above the noise of the ozone analyzer, a second method based on the Office of Research and Development – National Exposure Laboratory is used, which defines the MQL as the lowest calibration standard that can generate a coefficient of variation <15%. Based on the median emission rates of the air cleaners and coefficients of variation, AC1 is the calibration standard at 4.3 mg hr<sup>-1</sup>, given a coefficient of variation of 10%. Using the standard deviation of AC1's emission rate based on all tests run on this device, the method quantitation limit is 2.5 mg hr<sup>-1</sup>, suggesting that air cleaners with emission rates below this threshold may be detectable but are not quantifiable with the apparatus. An example of an unquantifiable emission rate is AC6, with a measured emission rate of 0.309 ± 1.7 mg hr<sup>-1</sup>. Turning to a chamber test when the emission rate falls below the MQL has the same benefits and drawbacks of discussed above with determining the threshold.

#### **EMISSION RATE VARIATION**

The analysis above ignored any real difference in emission rate that might be caused by test conditions. Viner et al. (1992) and Boelter and Davidson (1997) previously investigated the effect of air flow rate on the ozone generation rate from electrostatic precipitators and both found it to be independent of air flow rate. Because this test method differs from those used in these investigations, and because I also investigate air cleaners utilizing UV light, a flow variance test was run on each air cleaner. This entailed beginning a test at the apparatus's lowest flow rate, 500 m<sup>3</sup> hr<sup>-1</sup>, and increasing the flow rate over at least three increments until a minimum concentration difference of 5 ppb was achieved or the highest flow rate of the apparatus was achieved, whichever occurred first. At each flow rate a full 8-minute test was run.

Measurements show some evidence of variation in ozone emission rates. This variation may be due to the test method and apparatus or variation in the air cleaner. Figure 3 also displays the coefficient of variation for each air cleaner, based upon all tests run on the device. It is important to highlight the difference in coefficients between AC2, AC3 and AC4. As previously stated, these are all the same brand and model of air cleaner, yet have different measured emission rates and coefficients of variation that range from 0.11 to 0.35. A series of 10 identical tests performed on AC1, AC4 and AC5 were used to further investigate the variance issue, as previously introduced in the methods. The coefficient of variation for AC1, a low emitter, went from 0.10 for all tests to 0.12 for the 10 identical tests. Similarly, the coefficient of variation for AC5 saw very little change, as it was 0.08 overall and 0.07 for the 10 identical tests. The greatest difference in the coefficient of variation was seen in AC4 which was 0.35 overall, but lowered to 0.12 for the 10 identical tests. This evidence

lends to contributing the variation to the air cleaner, but certainly does not rule out the test method and apparatus.

Figure 5 shows the average emission rates of AC7 found over two successive flow variation tests, and AC5 emission rates found over three successive flow variation tests. For AC7 it appears that the emission rate at low flow rates, 35.0±2.8 mg hr<sup>-1</sup> at 500 m<sup>3</sup> hr<sup>-1</sup>, varies from the emission rate at high flow rates, 25.1±6.5 mg hr<sup>-1</sup> at 1220 m<sup>3</sup> hr<sup>-1</sup>. While these results still lie within the bounds of uncertainty, there is still some suggestion that the ozone generation rate may be dependent on flow.

These results again raise the question of whether a chamber test would be a better solution. If a chamber test were used, because there is no flow rate variation, emission rates would actually be higher in a chamber than they would be in a duct. This would result in an over-prediction of ozone emission as compared to typical operation. AC5 presents a stronger case that emission rate is independent of flow, given the results shown in Figure 5. There is less overall variation among the emission rates over a range of flow rates than was seen with AC7.

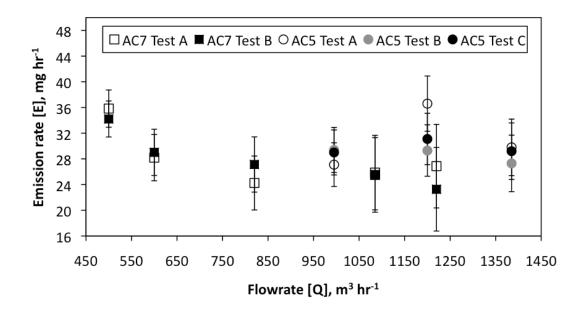


Figure 5. Emission rates of AC5 and AC7 based upon successive flow variance tests

AC2, AC3, and AC4 also exhibited behavior that suggested that emission rate was independent of flow rate. One issue, which is not directly addressed in the testing, is that in residential HVAC systems a consistent flow rate is not continuously being supplied. The HVAC system may cycle between on (flow) and off (no flow) periods, but some air cleaners stay on regardless of the HVAC system cycling. During the periods when no flow is being supplied and the air cleaner is still on, potentially high concentrations of ozone will develop in the duct in the area surrounding the air cleaner.

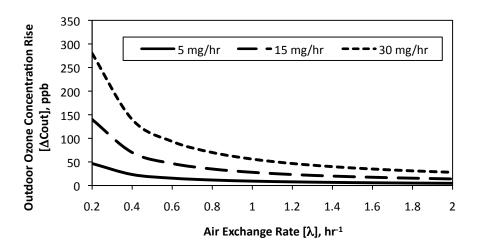
#### **IMPLICATIONS OF OZONE EMISSION**

Thus far, indoor ozone concentrations have been measured and presented and health implications from outdoor ozone exposures have discussed. However, no connection between these two has been made. To put the emission rates measured from the air cleaners into context, Figure 6 shows the equivalent outdoor ozone

concentration increase, the amount the outdoor concentration of ozone would need to increase to equal the same indoor concentration increase due to an air cleaner. Following the same approach as Waring et al. (2008), the equivalent outdoor ozone concentration increase,  $\Delta C_{\rm out}$  is defined as

$$\Delta C_{\text{out}} = \frac{E/V}{p\lambda} \tag{2}$$

where E, ozone emission rate, was assumed as either 5, 15 or 30 mg hr<sup>-1</sup>, V, the average volume of a home based upon the American Housing Survey (U.S. Census Bureau, 2011), was assumed as 339 m<sup>3</sup>, the ozone penetration factor, p, was assumed as 0.79 (Stephens et al., 2011), and the air exchange rate,  $\lambda$ , was varied between 0.2 and 2.0 hr<sup>-1</sup>. The solid line represents a low emitting device, 5 mg hr<sup>-1</sup>, the larger dashed line represents a medium emitter, 15 mg hr<sup>-1</sup>, and the small dashed line represents a high emitter, 30 mg hr<sup>-1</sup>.



**Figure 6.** Air cleaner ozone emission rate shown as equivalent rise in outdoor ozone concentration

For a typical residential air exchange rate of 0.5 hr<sup>-1</sup> (Murray and Burmaster, 1995), the outdoor ozone concentration would need to increase by 19 to 112 ppb in order to achieve a steady-state indoor ozone concentration equivalent to that in the same home with an operating in-duct air cleaner. The effect is greatest for high emitting air cleaners. These predicted increases are significant, based on Bell et al. (2004), which found that a 10 ppb increase in the outdoor ozone concentration from the previous week was associate with a 0.52% increase in daily mortality and a 0.64% increase in cardiovascular and respiratory mortality. Gent et al. (2003) found that a 50 ppb increase in the previous-day, 8-hour ozone level increased the likelihood of chest tightness and shortness of breath by 33% and 30%, respectively. There may be potential for an increase in health problems due to the increased ozone concentrations indoors as the result of operating in-duct air cleaners.

Table 3 is adapted from Britigan et al. (2006) and reviews existing U.S. health-related standards for ozone, which apply to outdoor ozone concentrations. While Figure 6 illustrated outdoor concentration rise, this increase may actually be a high enough levels to be equivalent to overall outdoor concentrations. Again assuming an air exchange rate of 0.5 hr<sup>-1</sup>, a high ozone emitting air cleaner produces an equivalent outdoor concentration rise over 100 ppb, which exceeds both the EPA NAAQS and California AAQS 8-hr exposure limits. The actual impact on indoor ozone concentrations is complicated by varying deposition loss rates, as well the loss of ozone and the formation of ozone byproducts. However, the results are suggestive that ozone emitting air cleaners can present potential health problems within the indoor environment.

**Table 3.** Health-Based Standards for Ozone Levels Established By the U.S. Government

Agency	Standard	Exposure Time	Concentration Level (ppb)
EPA <sup>a</sup>	NAAQS <sup>b</sup>	1-hr average	120
EPA	NAAQS	8-hr average	80
$OSHA^c$	$PEL^d$	8-hr average	100
CARB <sup>e</sup>	California AAQS	1-hr average	90
CARB	California AAQS	8-hr average	70
CARB	Stage 1 smog alert		200
CARB	Stage 2 smog alert		350
CARB	Stage 3 smog alert		500

<sup>&</sup>lt;sup>a</sup> Environmental Protection Agency

### **PARAMETRIC TESTING**

Experimental results demonstrate that some in-duct air cleaners emit enough ozone to raise concern about potential health effects. However, there are parameters

<sup>&</sup>lt;sup>b</sup> National Ambient Air Quality Standard

<sup>&</sup>lt;sup>c</sup> Occupational Safety and Health Administration

<sup>&</sup>lt;sup>d</sup> Permissible Exposure Limit

e California Air Resources Board

that were not investigated during these tests, which may actually cause even greater emission rates. Viner et al. (1992) found that ozone emissions from in-duct electrostatic precipitators were constant at low humidities yet decreased by 25% as humidity rose from 50 to 80% relative humidity. Put into perspective, the EPA recommends that relative humidity be kept below 60% to control mold (EPA Guide to Mold, Moisture, and Your Home). Liu et al. (2000) found that the temperature had a small impact on ozone generation. A temperature increase from 20 to 50 °C resulted in an ozone concentration rise from 30 to 45 ppb. Potentially, the greatest effect on ozone generation may be due to dust loading, as observed by Dorsey and Davidson (1994). An electronic air cleaner was used to filter Arizona road dust and a 4.6 fold increase in ozone emission rates was observed after the electrical coronas had become soiled over a weeklong period. The accumulation of dust to the corona discharge wire increased the corona current, and as Viner et al. (1992) observed, corona current is linearly proportional to ozone production rates. Additionally, all of the aforementioned conditions relate to ozone generation from electrical coronas but not from UV light. To explore these effects on ozone generation a series of parametric tests should be conducted on the air cleaners to determine this variable dependence. To cover a range of conditions likely to be encountered in a typical residential home, test at both a low (20-30% RH) and high (50-70% RH) relative humidity, at both low (10°C) and high (50°C) temperatures, and when the air cleaners have been naturally and artificially loaded with dust should be conducted.

# **Conclusions**

This investigation provides experimental results that demonstrate in-duct air cleaners emit enough ozone to be of concern. Seven air cleaners were investigated to determine their ozone emission rates, while being operated. The lowest measured emission was from a photocatalytic oxidation (PCO) air cleaner containing a UV lamp and was  $0.309 \pm 1.7 \text{ mg hr}^{-1}$ , which was likely below the detection limit of the apparatus and method. The next lowest emission was from a UV lamp and was  $4.29 \pm 1.5 \text{ mg hr}^{-1}$ . Three of the air cleaners tested, also PCO devices containing UV lamps, were of the same brand and model yet exhibited differing emission rates, ranging from  $7.44 \pm 1.6 \text{ mg hr}^{-1}$  to  $15.8 \pm 2.6 \text{ mg hr}^{-1}$ . The highest median measured emission rates were measured from both an air cleaner utilizing electrical corona technology,  $30.2 \pm 4.0 \text{ mg hr}^{-1}$ , and PCO with UV lamp technology,  $29.4 \pm 3.9 \text{ mg hr}^{-1}$ . Regardless of the technology, even low emitting air cleaners result in outdoor equivalent ozone concentration rises which have the potential to lead to adverse health effects. Therefore, this investigation suggests caution in the use of ozone emitting in-duct air cleaners in indoor environments.

# **Appendix A: Expanded Test Protocol**

**1. Purpose.** This protocol is intended to provide a more complete procedure for evaluating the ozone generation from electrically-connected in-duct air cleaning devices. The test method and data processing procedure are discussed in greater detail below. Emission rate, E, quantified the ozone generation rate of air cleaners in the experiments described in this paper. The emission rate, E, was derived from the airflow rate, E, and the measured ozone concentration difference, E. The number of tests run, E, E, E in a mean emission rate. In addition to the data collected for calculating E, relative humidity and temperature were also recorded during a test. Collection and processing protocol for each of these data sets is described herein.

#### 2. Test Method.

- **2.1. Airflow Rates for Tests.** Tests shall be run for airflow rates as specified in Section 2.1.1 or Section 2.1.2.
  - **2.1.1.** The air cleaner shall be first tested at 500 m<sup>3</sup> hr<sup>-1</sup> or manufacturers' lowest recommended air flow rate, whichever is higher. In the event that 500 m<sup>3</sup> hr<sup>-1</sup> is above the manufacturers' highest recommended air flow rate, the highest recommended air flow rate can be used.
  - **2.1.2.** If at 500 m<sup>3</sup> hr<sup>-1</sup> the concentration difference between upstream and downstream measurements is greater than 5 ppb, then increase the airflow by 5% and repeat. If a concentration difference greater than 5 ppb is still achieved, increase the airflow in continued 5% increments until a concentration difference of 5 ppb is met. If a concentration difference of 5 ppb is not achieved at lowest airflow, test the device with UL 867.

- **2.1.3.** Test an air cleaner at a minimum of three flows that range from 500 m<sup>3</sup> hr<sup>-1</sup> or manufacturers' lowest recommended air flow rate, whichever is higher, to the flow rate determined in 2.1.1. Flow rates should be spaced equally over the flow range.
- **2.2. Test Procedure.** The following steps shall be taken to ensure a complete test for one air cleaning device.
  - a. Insert air cleaning device into the test section of the test apparatus, see Figure
  - 1 of Experimental Methodology. Secure the device and the enclosure of test apparatus.
  - b. Set the fans of the air handling units to desire flow rate and wait for steady flow to be achieved.
  - c. Turn on air cleaning device and wait 5 minutes for a steady concentration to be measured downstream by the ozone analyzer. Once achieved, begin sampling ozone concentrations through sampling grids. The automated valves will switch back and forth between upstream and downstream measurements at equal intervals. Intervals shall be two minutes and a sampling period shall consist of at four intervals, two upstream and two downstream. The first 20 seconds of data from each two minute interval shall be discarded before assessment of emission rate.
- **3. Reporting Results.** Airflow rate and ozone concentration measurements are recorded and used to calculate the emission rate of the air cleaner under investigation. The procedure for data collection and processing follows. Additional measurements of temperature and relative humidity are recorded as well.
- 3.1. Emission Rate Data Collection and Processing.

- **3.1.1. Components.** The components of the emission rate are ozone concentration difference between the downstream and upstream sampling points and the airflow rate across the air cleaner.
- **3.1.2. Ozone concentration measurements.** Begin by turning on and allowing the ozone monitor to stabilize, approximately 20 minutes, prior to collecting measurements. The front menu of the ozone analyzer has four options Dat, Avg, Cfg, and Lmp. Using the selector knob navigate to Dat, which will present a submenu of Xmt, Log, and End. Navigate to Log, where you will be then be asked if you want to overwrite the data stored in the logger. By selecting Yes the previously stored data will be discarded, so be sure you have already downloaded this data (instructions follow) before continuing. To begin logging select **Yes**, which will return you to the main. The last step before begin data collection is to select the back arrow,  $\leftarrow$ , to return to the front menu display. This selection must be done simultaneously with flipping the timer switch on so that concentration measurements and the timer controlling the sampling valves are in sync. Ozone concentration measurements are now being recorded by the ozone analyzer and shall continue for the desired length of testing. Once the desired amount of testing has been completed the, you must now stop data collection. From the front menu of the analyzer, again select **Dat** and then **End**, from the submenu. On the PC the analyzer is connected to via an interface serial cable, open the 2B Technologies - Dual Beam Data Display software, located on the desktop. On the software select the menu option "Start" under the Data Capture menu item. Next, on the ozone monitor front menu select **Dat** and then Xmt, which will send the recorded data to the program. Once completed select "Stop" on the software. You will then be prompted to save the data as a text file

(.txt). The file naming convention used is: [Air cleaner number(i.e. AC1)]\_[Test type]\_[Date].txt. The test type is used to classify what type of test was run. Names used were "Initial", "Full test", and "One Flow". Steps to process the data from the text file follows.

**3.1.3. Flow rate measurement.** The flow rate measurement, as discussed in Experimental Methodology, is based a pressure measurement which is then converted to an appropriate flow rate. The processing and conversion of this measurement is discussed below in greater detail. For each sampling period, record the pressure measurement to be used to calculate the flow rate.

## 3.1.4. Raw Data Processing.

**3.1.4.1 Ozone Concentration.** The text file saved from the ozone monitor needs to be imported into an Excel file to extract the data. In Excel select the menu options DATA > GET EXTERNAL DATA > IMPORT TEXT FILE. You are then prompted with selecting a file, choose the appropriate data to be processed. Next, you are prompted with a 3-step menu. Select in Step 1 that the Data Type is Delimited, in Step 2 that the Delimiter is Comma, and finally that the Column Data Format is General. Selecting Finish will import the data into the Excel file. The first two columns are only of importance, the first being the data point, and the second being the concentration measurement (ppb). Copy these two columns and paste into the Results Template File, in the Data Point and Concentration columns..

**3.1.4.2. Flow Measurement**. The recorded pressure measurements are next converted to a flow rate. The flow station was calibrated using The Energy Conservatory TrueFlow Air Handler Flow Meter, and from the

calibration curve the following conversion was used to calculate flow rate:

Flow rate [Q] =120.12\*SQRT(Pressure Measurement [P])

The flow meter pressure is recorded and then the flow rate, Q, is calculated.

### 3.1.5. Calculations

**3.1.5.1. Emission Rate.** The emission rate is the product of the ozone concentration difference and the flow rate, both of which have been measured and recorded. The average concentrations for the upstream and downstream measurements are first calculated. Adjacent to the raw concentration data are the calculations for emission rate. The average upstream concentration and average downstream concentration for the sampling period are used to calculate and the difference, DeltaC. Below this calculation is the flow rate measurement, previously introduced, and finally the calculated emission rate following the equation:

Emission Rate [E] = Flow rate [Q] x Concentration Difference  $[\Delta C]$ 

**3.1.5.2. Uncertainty.** The uncertainty of the emission rate is calculated and recorded. The absolute uncertainty,  $\delta C$ , of the concentration difference,  $\Delta C$ , is calculated using the following equation:

$$\delta C = SQRT(c_{up}^2 + c_{down}^2)$$

where  $c_{up}$  and  $c_{down}$  are the uncertainty of the concentration measurement, which for this test method is the accuracy of the ozone analyzer, 1 ppb. The relative uncertainty is defined as:

Relative Uncertainty =  $\delta C/\Delta C$ 

The relative uncertainty of the flow rate is comes from the accuracy of calibration method and The Energy Conservatory TrueFlow Air Handler Flow Meter, which is defined as:

$$q/Q = 7\%$$

where q is the absolute uncertainty of the flow rate and Q is the flow rate. Finally, the absolute uncertainty of the emission rate, e, is calculated as:

$$e = E \times SQRT[(q/Q)^2 + (\delta C/\Delta C)^2]$$

where E is the emission rate for which the uncertainty is being calculated and q/Q is the relative uncertainty of the flow rate and  $\delta C/\Delta C$  is the relative uncertainty of the concentration difference.

- **3.2. Additional Data Collection.** Temperature, relative humidity and the electricity usage of the air cleaner were also recorded during a test. The sensors used for temperature and relative humidity measurements are connect to the instruNet data acquisition system. Following the connection of the sensors to the data acquisition system, the outputs from the sensors are able to be recorded on the connected PC. Each sensor is connected to a designated channel of the data acquisition system. Opening the instruNet software program, located on the PC desktop, allows you to see each channel of the data acquisition system. The appropriate configurations are discussed below to record accurate readings. For this testing data was manually recorded in the laboratory lab notebook. The electricity usage (i.e. Power, voltage and current) was also manually measured during a test.
  - **3.2.1. Temperature.** The temperature within the apparatus is measured by a thermistor, which is connected to a data acquisition system. The data acquisition system allows you to configure the corresponding channel of the thermistor as a

temperature measurement. By configuring the channel in this manner, you will notice that the real time measurement in the instruNet software is now in  ${}^{\circ}\text{C}$ .

- **3.2.2. Relative Humidity.** The instruNet data acquisition system does not have a designated relative humidity configuration like it does for temperature. However, for the channel that the relative humidity sensor is connected to a voltage measurement is displayed. This voltage reading ranges from 0-5 V and corresponds linearly with a relative humidity measurement of 0-100%.
- **3.2.3. Electricity Usage.** A Kill A Watt Electricity Usage Monitor was used to measure the voltage, current and watt draw of an air cleaner during a test. These measurements were taken as a way to monitor the performance of the air cleaner, as a fluctuation in one of these may alter the emission rate measurement.

**Appendix B: Summary of Experimental Data** 

Air Classes	Dete	Time of Took	Flow Rate	Emission Rate	Uncertainty
Air Cleaner	Date	Type of Test	m³/hr	mg/hr	mg/hr
AC1	25-Aug-11	Initial Trial	493	3.75	1.4
AC1	12-Oct-11	Full Test - 1	512	4.55	1.5
AC1	12-Oct-11	Full Test - 1	563	4.24	1.6
AC1	12-Oct-11	Full Test - 1	612	4.22	1.8
AC1	12-Oct-11	Full Test - 1	841	4.34	2.4
AC1	12-Oct-11	Full Test - 1	512	4.34	1.5
AC1	12-Oct-11	Full Test - 2	512	4.47	1.5
AC1	12-Oct-11	Full Test - 2	563	4.00	1.6
AC1	12-Oct-11	Full Test - 2	612	4.85	1.8
AC1	12-Oct-11	Full Test - 2	841	4.47	2.4
AC1	12-Oct-11	Full Test - 2	512	3.61	1.5
AC1	12-Oct-11	Full Test - 3	512	3.81	1.5
AC1	12-Oct-11	Full Test - 3	563	4.67	1.6
AC1	12-Oct-11	Full Test - 3	612	4.51	1.8
AC1	12-Oct-11	Full Test - 3	841	4.66	2.4
AC1	12-Oct-11	Full Test - 3	512	4.53	1.5
AC1	12-Oct-11	One Flow Repeat	490	3.82	1.4
AC1	12-Oct-11	One Flow Repeat	490	4.06	1.4
AC1	12-Oct-11	One Flow Repeat	490	4.36	1.4
AC1	12-Oct-11	One Flow Repeat	490	4.49	1.4
AC1	12-Oct-11	One Flow Repeat	490	4.68	1.4
AC1	12-Oct-11	One Flow Repeat	490	5.13	1.4
AC1	12-Oct-11	One Flow Repeat	490	3.29	1.4
AC1	12-Oct-11	One Flow Repeat	490	4.14	1.4
AC1	12-Oct-11	One Flow Repeat	490	4.10	1.4
AC1	12-Oct-11	One Flow Repeat	490	4.56	1.4
AC2	25-Aug-11	Initial Trial	493	8.95	1.5
AC2	1-Sep-11	Full Test - 1	493	11.6	1.6
AC2	1-Sep-11	Full Test - 1	556	11.4	1.8
AC2	1-Sep-11	Full Test - 1	612	11.4	1.9
AC2	1-Sep-11	Full Test - 1	1095	13.2	3.2
AC2	1-Sep-11	Full Test - 1	1224	12.2	3.6
AC2	13-Sep-11	Full Test - 2	490	11.4	1.6
AC2	13-Sep-11	Full Test - 2	490	12.8	1.7
AC2	13-Sep-11	Full Test - 2	610	12.6	1.9
AC2	13-Sep-11	Full Test - 2	1095	12.8	3.2

AC2	13-Sep-11	Full Test - 2	1095	11.7	3.2
AC2	13-Sep-11	Full Test - 2	1120	13.2	3.5
AC2	13-Sep-11	Full Test - 2	1225	12.2	3.6
AC2	13-Sep-11	Full Test - 2	1225	16.0	3.6
AC2	13-Sep-11	Full Test - 2	490	12.5	1.6
AC2	27-Sep-11	Full Test - 3	490	18.3	1.9
AC2	27-Sep-11	Full Test - 3	490	20.2	2.0
AC2	27-Sep-11	Full Test - 3	610	20.6	2.2
AC2	27-Sep-11	Full Test - 3	1095	12.7	3.2
AC2	27-Sep-11	Full Test - 3	1095	13.8	3.2
AC2	27-Sep-11	Full Test - 3	1120	19.7	3.7
AC2	27-Sep-11	Full Test - 3	1225	17.2	3.7
AC2	27-Sep-11	Full Test - 3	1225	19.4	3.7
AC2	27-Sep-11	Full Test - 3	490	17.6	1.9
AC2	27-Sep-11	Full Test – 4	288	18.4	1.9
AC2	27-Sep-11	Full Test – 4	475	18.1	2.6
AC2	27-Sep-11	Full Test – 4	714	18.4	3.7
AC2	27-Sep-11	Full Test – 5	288	18.1	1.9
AC2	27-Sep-11	Full Test – 5	475	19.0	2.6
AC2	27-Sep-11	Full Test – 5	714	19.7	3.7
AC2	27-Sep-11	Full Test – 6	288	19.9	2.0
AC2	27-Sep-11	Full Test – 6	475	19.2	2.6
AC2	27-Sep-11	Full Test – 6	714	19.1	3.7
AC2	27-Sep-11	Full Test – 7	288	19.7	2.0
AC2	27-Sep-11	Full Test – 7	475	17.2	2.6
AC2	27-Sep-11	Full Test – 7	714	19.6	3.7
AC3	1-Sep-11	Initial Trial	493	9.17	1.5
AC3	29-Sep-11	Trial	490	10.4	1.6
AC3	29-Sep-11	Trial	490	12.9	1.7
AC3	29-Sep-11	Trial	490	13.0	1.7
AC3	13-Oct-11	Full Test - 1	512	12.6	1.7
AC3	13-Oct-11	Full Test - 1	598	12.6	1.9
AC3	13-Oct-11	Full Test - 1	821	11.4	2.5
AC3	13-Oct-11	Full Test - 1	1084	12.5	3.2
AC3	13-Oct-11	Full Test - 1	1218	12.8	3.6
AC3	13-Oct-11	Full Test - 1	512	13.7	1.7
AC3	13-Oct-11	Full Test - 2	512	13.1	1.7
AC3	13-Oct-11	Full Test - 2	598	12.9	1.9
AC3	13-Oct-11	Full Test - 2	821	13.1	2.5
AC3	13-Oct-11	Full Test - 2	1084	12.6	3.2
AC3	13-Oct-11	Full Test - 2	1218	13.1	3.6

AC3         13-Oct-11         Full Test - 2         512         14.4         1.8           AC3         13-Oct-11         Full Test - 3         512         15.2         1.8           AC3         13-Oct-11         Full Test - 3         598         14.2         2.0           AC3         13-Oct-11         Full Test - 3         821         14.8         2.5           AC3         13-Oct-11         Full Test - 3         1218         12.1         3.5           AC3         13-Oct-11         Full Test - 3         512         14.9         1.8           AC3         13-Oct-11         Full Test - 3         512         14.9         1.8           AC4         6-Oct-11         Full Test - 1         614         1.89         1.7           AC4         6-Oct-11         Full Test - 1         109         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 2         489         5.53         1.5           AC4         6-Oct-11         Full Test - 2         614						
AC3         13-Oct-11         Full Test - 3         598         14.2         2.0           AC3         13-Oct-11         Full Test - 3         821         14.8         2.5           AC3         13-Oct-11         Full Test - 3         1084         15.0         3.2           AC3         13-Oct-11         Full Test - 3         1218         12.1         3.5           AC3         13-Oct-11         Full Test - 3         512         14.9         1.8           AC4         6-Oct-11         Full Test - 1         489         1.27         1.4           AC4         6-Oct-11         Full Test - 1         827         3.24         2.4           AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         614         7.61         1.8           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         119	AC3	13-Oct-11	Full Test - 2	512	14.4	1.8
AC3         13-Oct-11         Full Test - 3         821         14.8         2.5           AC3         13-Oct-11         Full Test - 3         1084         15.0         3.2           AC3         13-Oct-11         Full Test - 3         1218         12.1         3.5           AC3         13-Oct-11         Full Test - 3         512         14.9         1.8           AC4         6-Oct-11         Full Test - 1         489         1.27         1.4           AC4         6-Oct-11         Full Test - 1         614         1.89         1.7           AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         119	AC3	13-Oct-11	Full Test - 3	512	15.2	1.8
AC3 13-Oct-11 Full Test - 3 1084 15.0 3.2  AC3 13-Oct-11 Full Test - 3 1218 12.1 3.5  AC3 13-Oct-11 Full Test - 3 512 14.9 1.8  AC4 6-Oct-11 Full Test - 1 489 1.27 1.4  AC4 6-Oct-11 Full Test - 1 614 1.89 1.7  AC4 6-Oct-11 Full Test - 1 1079 4.00 3.1  AC4 6-Oct-11 Full Test - 1 1079 4.00 3.1  AC4 6-Oct-11 Full Test - 1 1199 5.02 3.4  AC4 6-Oct-11 Full Test - 1 489 5.40 1.4  AC4 6-Oct-11 Full Test - 1 489 6.53 1.5  AC4 6-Oct-11 Full Test - 2 489 6.53 1.5  AC4 6-Oct-11 Full Test - 2 614 7.61 1.8  AC4 6-Oct-11 Full Test - 2 827 13.36 2.5  AC4 6-Oct-11 Full Test - 2 1079 6.22 3.1  AC4 6-Oct-11 Full Test - 2 1079 6.22 3.1  AC4 6-Oct-11 Full Test - 2 1199 6.71 3.4  AC4 6-Oct-11 Full Test - 2 1199 6.71 3.4  AC4 6-Oct-11 Full Test - 2 489 7.43 1.5  AC4 6-Oct-11 Full Test - 2 489 7.43 1.5  AC4 6-Oct-11 Full Test - 3 489 8.72 1.5  AC4 6-Oct-11 Full Test - 3 489 8.72 1.5  AC4 6-Oct-11 Full Test - 3 614 9.25 1.9  AC4 6-Oct-11 Full Test - 3 827 8.97 2.4  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 7-Oct-11 One Flow Repeat 489 8.28 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.29 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.29 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.11 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.11 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.64 1.5  AC5 30-Sep-11 Initial Trial 1215 30.2 4.0  AC5 30-Sep-11 Initial Trial 1215 30.2 4.0  AC5 4-Oct-11 Full Test - 1 1200 36.6 4.3  AC5 4-Oct-11 Full Test - 1 1385 29.8 4.4	AC3	13-Oct-11	Full Test - 3	598	14.2	2.0
AC3         13-Oct-11         Full Test - 3         1218         12.1         3.5           AC3         13-Oct-11         Full Test - 3         512         14.9         1.8           AC4         6-Oct-11         Full Test - 1         489         1.27         1.4           AC4         6-Oct-11         Full Test - 1         614         1.89         1.7           AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 3         119         6.71         3.4           AC4         6-Oct-11         Full Test - 3         489 </td <td>AC3</td> <td>13-Oct-11</td> <td>Full Test - 3</td> <td>821</td> <td>14.8</td> <td>2.5</td>	AC3	13-Oct-11	Full Test - 3	821	14.8	2.5
AC3         13-Oct-11         Full Test - 3         512         14.9         1.8           AC4         6-Oct-11         Full Test - 1         489         1.27         1.4           AC4         6-Oct-11         Full Test - 1         614         1.89         1.7           AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         827 <td>AC3</td> <td>13-Oct-11</td> <td>Full Test - 3</td> <td>1084</td> <td>15.0</td> <td>3.2</td>	AC3	13-Oct-11	Full Test - 3	1084	15.0	3.2
AC4         6-Oct-11         Full Test - 1         489         1.27         1.4           AC4         6-Oct-11         Full Test - 1         614         1.89         1.7           AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 1         489         5.40         1.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         827	AC3	13-Oct-11	Full Test - 3	1218	12.1	3.5
AC4         6-Oct-11         Full Test - 1         614         1.89         1.7           AC4         6-Oct-11         Full Test - 1         827         3.24         2.4           AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         614         7.61         1.8           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079 <td>AC3</td> <td>13-Oct-11</td> <td>Full Test - 3</td> <td>512</td> <td>14.9</td> <td>1.8</td>	AC3	13-Oct-11	Full Test - 3	512	14.9	1.8
AC4 6-Oct-11 Full Test - 1 827 3.24 2.4  AC4 6-Oct-11 Full Test - 1 1079 4.00 3.1  AC4 6-Oct-11 Full Test - 1 1199 5.02 3.4  AC4 6-Oct-11 Full Test - 1 1199 5.02 3.4  AC4 6-Oct-11 Full Test - 1 489 5.40 1.4  AC4 6-Oct-11 Full Test - 2 489 6.53 1.5  AC4 6-Oct-11 Full Test - 2 614 7.61 1.8  AC4 6-Oct-11 Full Test - 2 827 13.36 2.5  AC4 6-Oct-11 Full Test - 2 1079 6.22 3.1  AC4 6-Oct-11 Full Test - 2 1079 6.22 3.1  AC4 6-Oct-11 Full Test - 2 1199 6.71 3.4  AC4 6-Oct-11 Full Test - 2 1489 7.43 1.5  AC4 6-Oct-11 Full Test - 2 489 7.43 1.5  AC4 6-Oct-11 Full Test - 3 489 8.72 1.5  AC4 6-Oct-11 Full Test - 3 614 9.25 1.9  AC4 6-Oct-11 Full Test - 3 827 8.97 2.4  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1079 9.78 3.1  AC4 6-Oct-11 Full Test - 3 1199 7.83 3.4  AC4 6-Oct-11 Full Test - 3 1199 7.83 3.4  AC4 6-Oct-11 Full Test - 3 489 8.28 1.5  AC4 7-Oct-11 One Flow Repeat 489 7.36 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.29 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.29 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.11 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.15 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.15 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.64 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.64 1.5  AC4 7-Oct-11 One Flow Repeat 489 9.33 1.5  AC4 7-Oct-11 One Flow Repeat 489 9.33 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.64 1.5  AC4 7-Oct-11 One Flow Repeat 489 9.33 1.5  AC4 7-Oct-11 One Flow Repeat 489 8.64 1.5  AC5 4-Oct-11 Full Test - 1 995 27.1 3.4  AC5 4-Oct-11 Full Test - 1 1200 36.6 4.3  AC5 4-Oct-11 Full Test - 1 1385 29.8 4.4	AC4	6-Oct-11	Full Test - 1	489	1.27	1.4
AC4         6-Oct-11         Full Test - 1         1079         4.00         3.1           AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 2         489         5.40         1.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         614         7.61         1.8           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199 </td <td>AC4</td> <td>6-Oct-11</td> <td>Full Test - 1</td> <td>614</td> <td>1.89</td> <td>1.7</td>	AC4	6-Oct-11	Full Test - 1	614	1.89	1.7
AC4         6-Oct-11         Full Test - 1         1199         5.02         3.4           AC4         6-Oct-11         Full Test - 1         489         5.40         1.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         614         7.61         1.8           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         1199 <td>AC4</td> <td>6-Oct-11</td> <td>Full Test - 1</td> <td>827</td> <td>3.24</td> <td>2.4</td>	AC4	6-Oct-11	Full Test - 1	827	3.24	2.4
AC4         6-Oct-11         Full Test - 1         489         5.40         1.4           AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         614         7.61         1.8           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489 <td>AC4</td> <td>6-Oct-11</td> <td>Full Test - 1</td> <td>1079</td> <td>4.00</td> <td>3.1</td>	AC4	6-Oct-11	Full Test - 1	1079	4.00	3.1
AC4         6-Oct-11         Full Test - 2         489         6.53         1.5           AC4         6-Oct-11         Full Test - 2         614         7.61         1.8           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         7-Oct-11         One Flow Repeat         489 </td <td>AC4</td> <td>6-Oct-11</td> <td>Full Test - 1</td> <td>1199</td> <td>5.02</td> <td>3.4</td>	AC4	6-Oct-11	Full Test - 1	1199	5.02	3.4
AC4         6-Oct-11         Full Test - 2         614         7.61         1.8           AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         7-Oct-11         One Flow Repeat         489 </td <td>AC4</td> <td>6-Oct-11</td> <td>Full Test - 1</td> <td>489</td> <td>5.40</td> <td>1.4</td>	AC4	6-Oct-11	Full Test - 1	489	5.40	1.4
AC4         6-Oct-11         Full Test - 2         827         13.36         2.5           AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         7-Oct-11         One Flow Repeat         489<	AC4	6-Oct-11	Full Test - 2	489	6.53	1.5
AC4         6-Oct-11         Full Test - 2         1079         6.22         3.1           AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.36         1.5           AC4         7-Oct-11         One Flow Repeat         489<	AC4	6-Oct-11	Full Test - 2	614	7.61	1.8
AC4         6-Oct-11         Full Test - 2         1199         6.71         3.4           AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.36         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.29         1.5           AC4         7-Oct-11         One Flow Repeat         489<	AC4	6-Oct-11	Full Test - 2	827	13.36	2.5
AC4         6-Oct-11         Full Test - 2         489         7.43         1.5           AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.56         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.29         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.84         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         4	AC4	6-Oct-11	Full Test - 2	1079	6.22	3.1
AC4         6-Oct-11         Full Test - 3         489         8.72         1.5           AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.56         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.36         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.29         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.11         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat <td< td=""><td>AC4</td><td>6-Oct-11</td><td>Full Test - 2</td><td>1199</td><td>6.71</td><td>3.4</td></td<>	AC4	6-Oct-11	Full Test - 2	1199	6.71	3.4
AC4         6-Oct-11         Full Test - 3         614         9.25         1.9           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.56         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.36         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.29         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.84         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat	AC4	6-Oct-11	Full Test - 2	489	7.43	1.5
AC4         6-Oct-11         Full Test - 3         827         8.97         2.4           AC4         6-Oct-11         Full Test - 3         1079         9.78         3.1           AC4         6-Oct-11         Full Test - 3         1199         7.83         3.4           AC4         6-Oct-11         Full Test - 3         489         8.28         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.56         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.29         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.84         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.11         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat	AC4	6-Oct-11	Full Test - 3	489	8.72	1.5
AC4       6-Oct-11       Full Test - 3       1079       9.78       3.1         AC4       6-Oct-11       Full Test - 3       1199       7.83       3.4         AC4       6-Oct-11       Full Test - 3       489       8.28       1.5         AC4       7-Oct-11       One Flow Repeat       489       7.56       1.5         AC4       7-Oct-11       One Flow Repeat       489       7.36       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.29       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.11       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.15       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.15       1.5         AC4       7-Oct-11       One Flow Repeat       489       9.33       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       1.0       1.6         AC5       30-Sep-11       Initial Trial	AC4	6-Oct-11	Full Test - 3	614	9.25	1.9
AC4       6-Oct-11       Full Test - 3       1199       7.83       3.4         AC4       6-Oct-11       Full Test - 3       489       8.28       1.5         AC4       7-Oct-11       One Flow Repeat       489       7.56       1.5         AC4       7-Oct-11       One Flow Repeat       489       7.36       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.29       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.11       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.15       1.5         AC4       7-Oct-11       One Flow Repeat       489       10.4       1.6         AC4       7-Oct-11       One Flow Repeat       489       9.33       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       10.0       1.6         AC5       30-Sep-11       Initial Tri	AC4	6-Oct-11	Full Test - 3	827	8.97	2.4
AC4       6-Oct-11       Full Test - 3       489       8.28       1.5         AC4       7-Oct-11       One Flow Repeat       489       7.56       1.5         AC4       7-Oct-11       One Flow Repeat       489       7.36       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.29       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.84       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.15       1.5         AC4       7-Oct-11       One Flow Repeat       489       10.4       1.6         AC4       7-Oct-11       One Flow Repeat       489       9.33       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       10.0       1.6         AC5       30-Sep-11       Initial Trial       1215       30.2       4.0         AC5       4-Oct-11       Full Test -	AC4	6-Oct-11	Full Test - 3	1079	9.78	3.1
AC4         7-Oct-11         One Flow Repeat         489         7.56         1.5           AC4         7-Oct-11         One Flow Repeat         489         7.36         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.29         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.84         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.11         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.4         1.6           AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.0         1.6           AC5         30-Sep-11         Initial Trial         1215         28.6         4.0           AC5         4-Oct-11         Full Test - 1         995         27.1         3.4           AC5         4-Oct-11         Full Test - 1	AC4	6-Oct-11	Full Test - 3	1199	7.83	3.4
AC4         7-Oct-11         One Flow Repeat         489         7.36         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.29         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.84         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.11         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.4         1.6           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.0         1.6           AC5         30-Sep-11         Initial Trial         1215         28.6         4.0           AC5         30-Sep-11         Initial Trial         1215         30.2         4.0           AC5         4-Oct-11         Full Test - 1         1200         36.6         4.3           AC5         4-Oct-11         Full Test - 1	AC4	6-Oct-11	Full Test - 3	489	8.28	1.5
AC4         7-Oct-11         One Flow Repeat         489         8.29         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.84         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.11         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.4         1.6           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.0         1.6           AC5         30-Sep-11         Initial Trial         1215         28.6         4.0           AC5         30-Sep-11         Initial Trial         1215         30.2         4.0           AC5         4-Oct-11         Full Test - 1         1200         36.6         4.3           AC5         4-Oct-11         Full Test - 1         1385         29.8         4.4	AC4	7-Oct-11	One Flow Repeat	489	7.56	1.5
AC4         7-Oct-11         One Flow Repeat         489         8.84         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.11         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.4         1.6           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.0         1.6           AC5         30-Sep-11         Initial Trial         1215         28.6         4.0           AC5         30-Sep-11         Initial Trial         1215         30.2         4.0           AC5         4-Oct-11         Full Test - 1         995         27.1         3.4           AC5         4-Oct-11         Full Test - 1         1200         36.6         4.3           AC5         4-Oct-11         Full Test - 1         1385         29.8         4.4	AC4	7-Oct-11	One Flow Repeat	489	7.36	1.5
AC4         7-Oct-11         One Flow Repeat         489         8.11         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.4         1.6           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.0         1.6           AC5         30-Sep-11         Initial Trial         1215         28.6         4.0           AC5         30-Sep-11         Initial Trial         1215         30.2         4.0           AC5         4-Oct-11         Full Test - 1         995         27.1         3.4           AC5         4-Oct-11         Full Test - 1         1200         36.6         4.3           AC5         4-Oct-11         Full Test - 1         1385         29.8         4.4	AC4	7-Oct-11	One Flow Repeat	489	8.29	1.5
AC4         7-Oct-11         One Flow Repeat         489         8.15         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.4         1.6           AC4         7-Oct-11         One Flow Repeat         489         9.33         1.5           AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.0         1.6           AC5         30-Sep-11         Initial Trial         1215         28.6         4.0           AC5         30-Sep-11         Initial Trial         1215         30.2         4.0           AC5         4-Oct-11         Full Test - 1         995         27.1         3.4           AC5         4-Oct-11         Full Test - 1         1200         36.6         4.3           AC5         4-Oct-11         Full Test - 1         1385         29.8         4.4	AC4	7-Oct-11	One Flow Repeat	489	8.84	1.5
AC4       7-Oct-11       One Flow Repeat       489       10.4       1.6         AC4       7-Oct-11       One Flow Repeat       489       9.33       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       10.0       1.6         AC5       30-Sep-11       Initial Trial       1215       28.6       4.0         AC5       30-Sep-11       Initial Trial       1215       30.2       4.0         AC5       4-Oct-11       Full Test - 1       995       27.1       3.4         AC5       4-Oct-11       Full Test - 1       1200       36.6       4.3         AC5       4-Oct-11       Full Test - 1       1385       29.8       4.4	AC4	7-Oct-11	One Flow Repeat	489	8.11	1.5
AC4       7-Oct-11       One Flow Repeat       489       9.33       1.5         AC4       7-Oct-11       One Flow Repeat       489       8.64       1.5         AC4       7-Oct-11       One Flow Repeat       489       10.0       1.6         AC5       30-Sep-11       Initial Trial       1215       28.6       4.0         AC5       30-Sep-11       Initial Trial       1215       30.2       4.0         AC5       4-Oct-11       Full Test - 1       995       27.1       3.4         AC5       4-Oct-11       Full Test - 1       1200       36.6       4.3         AC5       4-Oct-11       Full Test - 1       1385       29.8       4.4	AC4	7-Oct-11	One Flow Repeat	489	8.15	1.5
AC4         7-Oct-11         One Flow Repeat         489         8.64         1.5           AC4         7-Oct-11         One Flow Repeat         489         10.0         1.6           AC5         30-Sep-11         Initial Trial         1215         28.6         4.0           AC5         30-Sep-11         Initial Trial         1215         30.2         4.0           AC5         4-Oct-11         Full Test - 1         995         27.1         3.4           AC5         4-Oct-11         Full Test - 1         1200         36.6         4.3           AC5         4-Oct-11         Full Test - 1         1385         29.8         4.4	AC4	7-Oct-11	One Flow Repeat	489	10.4	1.6
AC4         7-Oct-11         One Flow Repeat         489         10.0         1.6           AC5         30-Sep-11         Initial Trial         1215         28.6         4.0           AC5         30-Sep-11         Initial Trial         1215         30.2         4.0           AC5         4-Oct-11         Full Test - 1         995         27.1         3.4           AC5         4-Oct-11         Full Test - 1         1200         36.6         4.3           AC5         4-Oct-11         Full Test - 1         1385         29.8         4.4	AC4	7-Oct-11	One Flow Repeat	489	9.33	1.5
AC5       30-Sep-11       Initial Trial       1215       28.6       4.0         AC5       30-Sep-11       Initial Trial       1215       30.2       4.0         AC5       4-Oct-11       Full Test - 1       995       27.1       3.4         AC5       4-Oct-11       Full Test - 1       1200       36.6       4.3         AC5       4-Oct-11       Full Test - 1       1385       29.8       4.4	AC4	7-Oct-11	One Flow Repeat	489	8.64	1.5
AC5       30-Sep-11       Initial Trial       1215       30.2       4.0         AC5       4-Oct-11       Full Test - 1       995       27.1       3.4         AC5       4-Oct-11       Full Test - 1       1200       36.6       4.3         AC5       4-Oct-11       Full Test - 1       1385       29.8       4.4	AC4	7-Oct-11	One Flow Repeat	489	10.0	1.6
AC5     4-Oct-11     Full Test - 1     995     27.1     3.4       AC5     4-Oct-11     Full Test - 1     1200     36.6     4.3       AC5     4-Oct-11     Full Test - 1     1385     29.8     4.4	AC5	30-Sep-11	Initial Trial	1215	28.6	4.0
AC5       4-Oct-11       Full Test - 1       1200       36.6       4.3         AC5       4-Oct-11       Full Test - 1       1385       29.8       4.4	AC5	30-Sep-11	Initial Trial	1215	30.2	4.0
AC5 4-Oct-11 Full Test - 1 1385 29.8 4.4	AC5	4-Oct-11	Full Test - 1	995	27.1	3.4
	AC5	4-Oct-11	Full Test - 1	1200	36.6	4.3
AC5 4-Oct-11 Full Test - 2 995 29.4 3.5	AC5	4-Oct-11	Full Test - 1	1385	29.8	4.4
	AC5	4-Oct-11	Full Test - 2	995	29.4	3.5

AC5	4-Oct-11	Full Test - 2	1200	29.3	4.0
AC5	4-Oct-11	Full Test - 2	1385	27.3	4.4
AC5	4-Oct-11	Full Test - 2	995	29.6	3.5
AC5	4-Oct-11	Full Test - 3	995	29.0	3.5
AC5	4-Oct-11	Full Test - 3	1200	31.1	4.0
AC5	4-Oct-11	Full Test - 3	1385	29.2	4.4
AC5	4-Oct-11	Full Test - 3	995	29.5	3.5
AC5	4-Oct-11	One Flow Repeat	1185	36.9	4.2
AC5	4-Oct-11	One Flow Repeat	1185	29.1	3.9
AC5	4-Oct-11	One Flow Repeat	1185	30.3	4.0
AC5	4-Oct-11	One Flow Repeat	1185	29.5	3.9
AC5	4-Oct-11	One Flow Repeat	1185	30.9	4.0
AC5	4-Oct-11	One Flow Repeat	1185	32.0	4.0
AC5	4-Oct-11	One Flow Repeat	1185	31.1	4.0
AC5	4-Oct-11	One Flow Repeat	1185	28.9	3.9
AC5	4-Oct-11	One Flow Repeat	1185	30.0	4.0
AC5	4-Oct-11	One Flow Repeat	1185	30.2	4.0
AC6	29-Sep-11	Initial Trial	490	0.543	1.4
AC6	29-Sep-11	Initial Trial	490	0.366	1.4
AC6	29-Sep-11	Initial Trial	490	0.010	1.4
AC6	29-Sep-11	Initial Trial	490	0.147	1.4
AC6	30-Sep-11	Full Test - 1	490	0.636	1.4
AC6	30-Sep-11	Full Test - 1	615	0.940	1.7
AC6	30-Sep-11	Full Test - 1	805	1.03	2.3
AC6	30-Sep-11	Full Test - 1	1095	0.000	3.1
AC6	30-Sep-11	Full Test - 1	1215	0.000	3.4
AC6	30-Sep-11	Full Test - 1	490	0.210	1.4
AC6	13-Sep-11	Full Test - 2	490	0.372	1.4
AC6	13-Sep-11	Full Test - 2	615	0.000	1.7
AC6	13-Sep-11	Full Test - 2	805	1.350	2.3
AC6	13-Sep-11	Full Test - 2	1095	0.000	3.1
AC6	13-Sep-11	Full Test - 2	1215	0.000	3.4
AC6	13-Sep-11	Full Test - 2	490	0.259	1.4
AC6	13-Sep-11	Full Test - 3	490	0.230	1.4
AC6	13-Sep-11	Full Test - 3	615	0.000	1.7
AC6	13-Sep-11	Full Test - 3	805	0.484	2.3
AC6	27-Sep-11	Full Test - 3	1095	0.000	3.1
AC6	27-Sep-11	Full Test - 3	1215	0.000	3.4
AC6	27-Sep-11	Full Test - 3	490	0.000	1.4
AC6	27-Sep-11	Full Test - 4	490	0.444	1.4
AC6	27-Sep-11	Full Test - 4	615	0.117	1.7

AC6	27-Sep-11	Full Test - 4	805	0.234	2.3
AC6	27-Sep-11	Full Test - 4	1095	0.000	3.1
AC6	27-Sep-11	Full Test - 4	1215	0.825	3.4
AC6	27-Sep-11	Full Test - 4	490	0.441	1.4
AC7	13-Oct-11	Full Test - 1	512	35.53	2.9
AC7	13-Oct-11	Full Test - 1	1051	29.17	3.6
AC7	13-Oct-11	Full Test - 1	1354	28.21	4.3
AC7	13-Oct-11	Full Test - 1	1947	27.06	5.8
AC7	13-Oct-11	Full Test - 1	2208	27.31	6.5
AC7	13-Oct-11	Full Test - 1	512	33.47	2.75
AC7	13-Oct-11	Full Test - 2	512	35.83	2.9
AC7	13-Oct-11	Full Test - 2	598	28.19	3.6
AC7	13-Oct-11	Full Test - 2	821	24.25	4.19
AC7	13-Oct-11	Full Test - 2	1084	25.87	5.8
AC7	13-Oct-11	Full Test - 2	1218	26.87	6.5
AC7	13-Oct-11	Full Test - 2	512	34.49	2.8
AC7	13-Oct-11	Full Test - 3	512	34.21	2.80
AC7	13-Oct-11	Full Test - 3	598	29.02	3.6
AC7	13-Oct-11	Full Test - 3	821	27.13	4.27
AC7	13-Oct-11	Full Test - 3	1084	25.50	5.8
AC7	13-Oct-11	Full Test - 3	1218	23.27	6.5
AC7	13-Oct-11	Full Test - 3	512	33.20	2.7

# **Appendix C: Detailed Data from Test Runs**

## AIR CLEANER 1

RUN 1									4-0ct-11
Sampling Period 1					Absolute Uncertainty in $\Delta C$	Relative Uncertainty of	Relative Relative	Relative Relative	Absolute Uncertainty of E
Average	0	<u> </u>	0 00110	ma/ma	(ppb)	ΔC			(mg/hr)
> ( C ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )		7		Q					
Downstream	4.49	ppb	0.00898	mg/m3	1.4	36%	7.0%	37%	1.4
DeltaC		ppb	0.00780 mg/m3	mg/m3					
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & Up)	ppb		
Q	288	CFM	489	m3/hr		1	4.8		
						2	3.0		
Е	1124	1124 CFMxppb	3.82	3.82 mg/hr					

RUN 2									4-Oct-11
Sampling Period 1					Absolute Uncertainty in AC	Relative Uncertainty of	Relative	Relative Reference of E	Absolute Uncertainty of E
Average					(pph)	ΔC	סווכפו גמווונץ טו ע	Officer raility of E	(mg/hr)
Upstream	1.24	ppb	0.00247	mg/m3	VI I I I I				9
Downstream	5.39	ppb	0.01077	mg/m3	1.4	34%	7.0%	35%	1.4
DeltaC	4.15	ppb	0.00830	mg/m3	ı				
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & Up)	ppb		
Q	288	CFM	489	m3/hr		1	4.7		
						2	3.6		
E	4.06	CFMxppb		mg/hr					
RUN 3					_				4-0ct-11
Sampling Period					Absolute	D)			Absolute
1					Uncertainty in DC	Uncertainty of	Relative	Relative Uncertainty of F	Uncertainty of E
Average					(daa)	DC			(mg/hr)
Opstream  Average	0.50	add	0.00099	mg/m3					
Downstream	4.95	ppb	0.00989	mg/m3	1.4	32%	7.0%	33%	1.4
DeltaC	4.45	ppb	0.00890	mg/m3	1				
					•	Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & Up)	ppb		
Q	288	CFM	489	m3/hr		1.0	4.8		
						2.0	4.1		
Ш	4.36	mg/hr							

RUN 4									4-0ct-11
Sampling Period					Absolute				Absolute
1					Uncertainty in DC	Relative	Relative Uncertainty of O	Relative Uncertainty of F	Uncertainty of E
Average					(anh)	סווככו ימווונץ טו סכ	Officer control of C	טונכנו נמווונץ טו ב	(ma/hr)
Upstream	0.52	ppb	0.00104	mg/m3	(ppp)				(111/8/111)
Average	л 1	n h	0 01021	mg/m3	1 4	31%	7 0%	37%	1 4
DeltaC	4 59	n :	0.00917	mg/m3					
		-		Ç		Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & Up)	ppb		
ρ	288	CFM	489	m3/hr		1.0	4.1		
						2.0	5.1		
Е	4.49	mg/hr							
RUN 5									4-0ct-11
Sampling Period					Absolute				Absolute
Ъ					Uncertainty in DC	Relative Uncertainty of DC	Relative Uncertainty of O	Relative Uncertainty of F	Uncertainty of E
Average					(hnh)				(mg/hr)
Upstream Average	0.41	ppb	0.00081	mg/m3	-				ç
Downstream	5.19	ppb	0.01038	mg/m3	1.4	30%	7.0%	30%	1.4
DeltaC	4.79	ppb	0.00957	mg/m3	-				
1						Sampling Set	Delta C		
Processo	ى ت	<b>7</b>				(7)	5 5		
	3 6	2	200	2		(DOW: 00 OP)	יו לק		
۵	004	<u> </u>	ģ	5/1		2.0	4.4		
m	4.68	mg/hr							

288 CFM 489 m3/hr 5.13 mg/hr  5.13 mg/hr  Absolute Uncertainty in ΔC (ppb)  am 4.93 ppb 0.00985 mg/m3 3.36 ppb 0.00672 mg/m3  e 3.5 Pa 288 CFM 489 m3/hr	Sampling Period 1 Average Upstream Average Downstream DeltaC FlowPlate Pressure	4-Oc 0.35 5.59 5.24		0.00070 0.01118 0.01048	mg/m3 mg/m3 mg/m3	Absolute Uncertainty in $\Delta C$ (ppb)	Relative Uncertainty of $\Delta C$ 27%  Sampling Set	e of AC	Uncer	
Absolute Uncertainty in AC  0.00313 mg/m3 0.00985 mg/m3 0.00672 mg/m3 489 m3/hr	3. j		P 7		g		Sampling Set (Down & Up)	o) et		
mg/hr  Absolute Uncertainty in ΔC Unppb 0.00313 mg/m3 ppb 0.00985 mg/m3 ppb 0.00672 mg/m3 Pa CFM 489 m3/hr		288			m3/hr		1 1 5		4.6	4.6
Absolute Uncertainty in ΔC  4.93 ppb 0.00313 mg/m3  4.93 ppb 0.00985 mg/m3 3.36 ppb 0.00672 mg/m3  3.5 Pa  288 CFM 489 m3/hr		5.13		,			7		3.9	J.
Absolute Uncertainty in ΔC  4.93 ppb 0.00313 mg/m3  4.93 ppb 0.00985 mg/m3  3.36 ppb 0.00672 mg/m3  3.5 Pa  288 CFM 489 m3/hr							4-0ct-11			
n 1.56 ppb 0.00313 mg/m3 (ppb) eam 4.93 ppb 0.00985 mg/m3 3.36 ppb 0.00672 mg/m3 e 3.5 Pa 288 CFM 489 m3/hr	g Period					Absolute Uncertainty in ΔC	Relative Incertainty of	S .	Relative	
e	e am	1.56			mg/m3	(ppb)		i		
3.36 ppb 0.00672 mg/m3  ite  9.5 Pa 288 CFM 489 m3/hr	ge stream	4.93			mg/m3	1.4	42%		7.0%	7.0% 43%
e 3.5 Pa 288 CFM 489 m3/hr	taC	3.36			mg/m3				_	
essure 3.5 Pa	owPlate						Sampling Set		Delta C	Delta C
288 CFM 489 m3/hr	ressure	3.5					(Down & Up)		ppb	ppb
2		288			m3/hr		1		2.7	2.7
							2		4.0	4.0

RUN 8						12-0ct-11			
Sampling Period 1					Absolute Uncertainty in AC	Relative	Relative Incertainty of O	Relative Uncertainty of F	Absolute Uncertainty of E
Average Upstream	0.87	ppb	0.00173	mg/m3	(ppb)			,	(mg/hr)
Average	) )	-		<b>`</b>	•		1	)	
DOMISTICATION	5.09	ppo		mg/m3	1.4	33%	7.0%	34%	1.4
DeltaC	4.23	ppb	0.00846	mg/m3					
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & Up)	ppb		
ρ	288	CFM	489	m3/hr		1	4.9		
						2	3.6		
Е	4.14	mg/hr							
RUN 9						12-Oct-11			
Sampling Period 1					Absolute Uncertainty in ΔC	Relative Uncertainty of AC	Relative Uncertainty of Q	Relative Uncertainty of E	Absolute Uncertainty of E
Average					(hnh)				/ma/h
Upstream	0.72	ppb	0.00143	mg/m3	(505)				(111/8/111)
Average Downstream	4.90	ppb	0.00980	mg/m3	1.4	34%	7.0%	35%	1.4
DeltaC	4.19	ppb	0.00837	mg/m3					
FlowPlate						Sampling Set	Delta C		
Pressure	ω 5	Pa				(Down & Up)	ppb		
Q	288	CFM	489	m3/hr		1	4.0		
						2	4.4		
ш	4.10	mg/hr							

FlowPlate 3.80	e tream	Average Upstream 0.23	Sampling Period	Initial Test Run	E 4.56	Q 288	essure	FlowPlate	DeltaC 4.66	Average Downstream 5.33	Average Upstream 0.67	Sampling Period	RUN 10
Pa CFM	ppb	ppb			mg/hr	Ç K	Pa		ppb	ppb	ppb		
489	0.008056 0.007601	0.000455				489			0.00931	0.01065	0.00134		
m3/hr	mg/m3 mg/m3	mg/m3				m3/hr	:		mg/m3	mg/m3	mg/m3		
	1,414	(ppb)	Absolute Uncertainty in ΔC							1.4	(ppb)	Absolute Uncertainty in ΔC	
	37%		Relative Uncertainty of AC	25-Aug-11		2	(Down & Up)	Janiping Jec	Campling Set	30%		Relative Uncertainty of AC	12-Oct-11
	7.0%		Relative Uncertainty of Q			4.4	ppb	מינים כ	764	7.0%		Relative Uncertainty of Q	
	38%		Relative Uncertainty of E							31%		Relative Uncertainty of E	
	1.4	(mg/hr)	Absolute Uncertainty of E							1.4	(mg/hr)	Absolute Uncertainty of E	

Flow Meter Pressure 7.6 Q 331	ter 7.6	Flow Meter				Average Downstream 4.17	Average Upstream 0.40	Sampling Period 2		E 4.5		301	6.3	Flow Meter	DeltaC 4.44		m 0.53	Sampling Period	Full Test Run 1
	CFM	Pa			ppb	ppb	ppb			mg/hr		CFM	Pa		ppb	ppb	ppb		
	563				0.00754	0.00834	0.00080					512			0.00888	0.00994	0.00106		
	m3/hr				mg/m3	mg/m3	mg/m3					m3/hr			mg/m3	mg/m3	mg/m3		
						1.4	(ppb)	Uncertainty in ΔC	Absolute							1.4	(ppb)	Absolute Uncertainty in ΔC	
	ב	(Down & Up)	-	Sampling Set		38%		Relative Uncertainty of ΔC			2	1	(Down & Up)	Samping Sec	0.555	32%		Relative Uncertainty of $\Delta C$	12-0ct-11
;	4.1	ppb		Delta C		7.0%		Relative Uncertainty of Q			5.0	3.9	ppb	מפונמ כ	5	7.0%		Relative Uncertainty of Q	
						38%		Relative Uncertainty of E								33%		Relative Uncertainty of E	
						1.6	(mg/hr)	Uncertainty of E	Absolute							1.5	(mg/hr)	Absolute Uncertainty of E	

			4.2 mg/hr	4.2	М
	m3/hr	612	360 CFM	360	Q
•			Pa	9	Flow Meter Pressure
	mg/m3	0.00689	ppb	3.45	DeltaC
	mg/m3	0.00755	ppb	3.78	Downstream
	mg/m3	0.00066	ppb	0.33	Upstream Average
					3 Average
					Sampling Period

				4.2 mg/hr	4.2	ш
	•	m3/hr	612	360 CFM	360	Q
				Pa	9	Flow Meter Pressure
	ω	mg/m3	0.00689	ppb	3.45	DeltaC
	ω	mg/m3	0.00755	ppb	3.78	Downstream
	ū	mg/m3	0.00066	ppb	0.33 ppb	Upstream Average
						Average
_						Sampling Period 3
						; ;

2	1	(Down & Up)	Sampling Set
0.0	0.0	ppb	Delta C

т Д	Pressure	Flow Meter	DeltaC	Downstream	Average	Upstream	Average	4	Sampling Period	
4.3	17		2.58 ppb	2.69		0.11 ppb				
mg/hr	Pa		ppb	ppb		ppb				
841	2		0.00516	0.00538		0.00022 mg/m3				
841 m3/hr	) =		mg/m3	mg/m3		mg/m3				

				1.4	(ppb)	Absolute Uncertainty in ΔC
2	1	(Down & Up)	Sampling Set	55%		Relative Uncertainty of AC
0.0	0.0	ppb	Delta C	7.0%	, , ,	Relative Uncertainty of O
				55%	, , , , ,	Relative Uncertainty of E
				2.4	(mg/hr)	Absolute Uncertainty of E

	1.4	(ppb)	Absolute Uncertainty in ΔC
Sampling Set (Down & Up)	41%		Relative Uncertainty of AC
Delta C ppb 0.0	7.0%		Relative Relative
	42%	,	Relative Uncertainty of E
	1.8	(mg/hr)	Absolute Uncertainty of E

Sampling Period 5 Average Upstream	0.44	ddd	0.00088 mg/m3	mg/m3	Absolute Uncertainty in ΔC (ppb)	Relative - Uncertainty of ΔC		Relative Uncertainty of Q	Relative Relative Uncertainty of Q Uncertainty of E
Average Downstream	4.68	ppb	0.00936	mg/m3	1.4	(1)	33%	33% 7.0%	
DeltaC	4.24		0.00848 mg/m3	mg/m3					
						Sam	Sampling Set	pling Set Delta C	
Flow Meter									
Pressure	6.3	6.3 Pa				(Dov	(Down & Up)	vn & Up) ppb	
Q	301	301 CFM	512	512 m3/hr			1	1 0.0	1 0.0
							2	2 0.0	2 0.0
Е	4.3	4.3 mg/hr							

Е	ρ	Pressure	Flow Meter	DeltaC	Downstream	Average	Upstream	Average	1	Sampling Period	Full Test Run 2
4.5	301	6.3		4.36	า 4.91		0.55			riod	1 2
4.5 mg/hr	301 CFM	Pa		ppb	ppb		ppb				
	512			0.00872	0.00981		0.00109				
	m3/hr			mg/m3	mg/m3		mg/m3				
											]

/m3	/m3		
1.4	(ppb)	Absolute Uncertainty in ΔC	
32%		Relative Uncertainty of AC	12-0ct-11
7.0%		Relative Uncertainty of Q	
33%		Relative Uncertainty of E	
1.5	(mg/hr)	Absolute Uncertainty of E	
	1.4 32% 7.0% 33%	(ppb) 1.4 32% 7.0% 33%	Absolute Uncertainty in ΔC Relative Relative Relative (ppb)  1.4 32% 7.0% Relative Relative Relative Relative Relative Relative The Action Relative Action Relative Relative Relative Relative Relative Action Section 1.4 32% The Action Relative Action Section 1.0% Action 1.0% Act

		•	
2	1	(Down & Up)	Sampling Set
4.5	4.2	ppb	Delta C
			_

Ш	Flow Meter Pressure Q	Sampling Period 2 Average Upstream Average Downstream DeltaC
4.0	7.6 331	0.68 4.23 3.56
4.0 mg/hr	Pa CFM	рр р фф ф
	563	0.00135 0.00846 0.00711
	m3/hr	mg/m3 mg/m3 mg/m3

_			4.0 mg/hr	4.0	m
	563 m3/hr	563	331 CFM	331	Q
			Pa	7.6	Flow Meter Pressure
	mg/m3	0.00711	ppb	3.56	DeltaC
1.4	mg/m3	0.00846	ppb	4.23	Downstream
					Average
(ppb)	mg/m3	0.00135 mg/m3	ppb	0.68	Average Upstream
Absolute Uncertainty in ΔC					Sampling Period 2

 $\begin{array}{ccc} & & & & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & & \\ & \\ & & \\ & \\ & & \\ &$ 

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

40%

7.0%

40%

1.6

2	1	(Down & Up)	Sampling Set	
3.0	4.1	ppb	Delta C	

			mg/hr	4.8	m
	612 m3/hr	612	CFM	360	Q
			Pa	9	Pressure
					Flow Meter
	mg/m3	0.00792	ppb	3.96	DeltaC
	mg/m3	0.00809	ppb	4.05	Downstream
					Average
I	mg/m3	0.00017	ppb	0.09	Upstream
					Average
ı					3
					Sampling Period
1					

			1.4	(ppb)		Uncertainty in $\Delta C$
1	(Down & Up)	Sampling Set	36%	,	Uncertainty of AC	Relative
0.0	ppb	Delta C	7.0%		Uncertainty of Q	Relative
			36%		Uncertainty of E	Relative
						_

1	(Down & Up)	Sampling Set	1.4 36%	(ppb)	Absolute ncertainty in $\Delta C$ Relative Uncertainty of $\Delta C$
	Up)	Set			
0.0	ррь	Delta C	7.0%		Relative Uncertainty of O
			36%	, , , ,	Relative Uncertainty of E
			1.8	(mg/hr)	Absolute Uncertainty of E

Sampling Period 4 Average Upstream O.67 ppb O.00133 mg/m3 Average Downstream 3.32 ppb O.00664 mg/m3 DeltaC 2.66 ppb O.00531 mg/m3 Flow Meter Pressure 17 Pa Q 4.5 mg/hr F
ppb 0.00133 ppb 0.00664 ppb 0.00531 Pa CFM 841
0.00133 0.00664 0.00531
mg/m3 mg/m3 mg/m3
·

841 m3/hr
0.00531 mg/m3
0.00664 mg/m3
0.00133 mg/m3

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

53%

7.0%

54%

2.4

2	1	(Down & Up)	Sampling Set
0.0	0.0	ppb	Delta C

			mg/hr	3.6	m
	512 m3/hr	512	CFM	301	Q
			Pa	6.3	Pressure
					Flow Meter
	mg/m3	0.00705	ppb	3.53	DeltaC
	mg/m3	0.00858	ppb	4.29	Downstream
					Average
	mg/m3	0.00153	ppb	0.77 ppb	Upstream
					Average
					5
					Sampling Period
7					

2	1	(Down & Up)	Sampling Set	
0.0	0.0	ppb	Delta C	

				1.4	(ppb)	Absolute Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set	40%		Relative Uncertainty of AC
0.0	0.0	ppb	Delta C	7.0%		Relative Relative Uncertainty of AC Uncertainty of Q
				41%		Relative Uncertainty of E
				1.5	(mg/hr)	Absolute Uncertainty of E

۵	Pressure	Flow Meter		DeltaC 4	Average Downstream 4	Average Upstream C	Sampling Period 2	E		۵	Pressure	Flow Meter	DeltaC 3	Average Downstream 4	Average Upstream 1	Sampling Period	Full Test Run 3
331	7.6			4.15	4.35	0.20		3.8		301	6.3		3.72		1.14		
CFM	Pa			ppb	ppb	ppb		mg/hr		CFM	Pa		ppb	ppb	ppb		
563				0.00830	0.00869	0.00039				512			0.00743	0.00972	0.00229		
m3/hr				mg/m3	mg/m3	mg/m3				m3/hr			mg/m3	mg/m3	mg/m3		
					1.4	(ppb)	Absolute Uncertainty in ΔC							1.4	(ppb)	Absolute Uncertainty in ΔC	
1	(Down & Up)		Sampling Set		34%		Relative		2	1	(Down & Up)	Sampling Sec	C 2000 1:50 C 2+	38%		Relative Uncertainty of AC	12-Oct-11
4.3	ppb		Delta C		7.0%		Relative Uncertainty of Q		3.8	3.6	ppb	Della	7	7.0%		Relative Uncertainty of Q	-
					35%		Relative Uncertainty of E							39%		Relative Uncertainty of E	
					1.6	(mg/hr)	Absolute Uncertainty of E							1.5	(mg/hr)	Absolute Uncertainty of E	

- Ω	Flow Meter Pressure	DeltaC	Average Downstream	Average Upstream	Sampli 3
	⁄leter re		ge tream	še am	Sampling Period 3
360 4.5	9	3.68	4.09	0.40	
360 CFM 4.5 mg/hr	Pa	ppb	ppb	ppb	
612		0.00736	0.00817	0.00081	
m3/hr		mg/m3	mg/m3	mg/m3	

Sampling Period						ַ
Average Upstream	0.40 ppb	ppb	0.00081	mg/m3		
Average					П	
Downstream	4.09	ppb	0.00817	mg/m3		
DeltaC	3.68	ppb	0.00736	mg/m3		
Flow Meter						
Pressure	9	Pa				
Q	360	360 CFM	612	612 m3/hr		
m	4.5	4.5 mg/hr				

2	1	(Down & Up)	Sampling Set
0.0	0.0	ppb	Delta C

			4.7 mg/hr	4.7	т
	841 m3/hr	841	495 CFM	495	Q
			Pa	17	Pressure
					Flow Meter
	mg/m3	0.00554	ppb	2.77 ppb	DeltaC
	mg/m3	0.00566	ppb	2.83	Downstream
					Average
	mg/m3	0.00012	ppb	0.06	Upstream
					Average
;					4
Unc					Sampling Period

				1.4	(ppb)	Absolute Incertainty in ΔC
J	1	(Down & Up)	Sampling Set	51%		Relative Uncertainty of AC
00	0.0	ppb	Delta C	7.0%		Relative Uncertainty of O
				52%	, , , , , ,	Relative Uncertainty of F
				2.4	(mg/hr)	Absolute Uncertainty of E

				1.4	(ppb)	Absolute Uncertainty in ΔC
J	1	(Down & Up)	Sampling Set	38%		Relative Uncertainty of AC
0	0.0	ppb	Delta C	7.0%	, , , , , , , , , , , , , , , , , , , ,	Relative Uncertainty of O
				39%	, , , , , , , , , , , , , , , , , , , ,	Relative Uncertainty of E
				1.8	(mg/hr)	Absolute Uncertainty of E

		4.5 mg/hr	4.5	Е
m3/hr	512	301 CFM	301	ρ
		Pa	6.3	Flow Meter Pressure
mg/m3	0.00885	ppb	4.43	DeltaC
mg/m3	0.00962	ppb	4.81	Average Downstream
mg/m3	0.00077	ppb	0.39	Average Upstream
				Sampling Period 5

mg/m3	mg/m3	
1.4	(ppb)	Absolute Uncertainty in $\Delta C$
32%	,	Relative Uncertainty of AC
7.0%		Relative Relative
33%		Relative Uncertainty of E
1.5	(mg/hr)	Absolute Uncertainty of E

		1	
2	1	(Down & Up)	Sampling Set
0.0	0.0	ppb	Delta C

## Air CLEANER 2 Initial Trial

25-Aug-11

Е	FlowPlate Pressure Q	Average Downstream DeltaC	Sampling Period 1 Average Upstream
8.95	3.5	9.31 9.08	0.230
8.95 mg/hr	Pa CFM	ppb	dqq
	489	0.0186 0.0182	0.00046
	m3/hr	mg/m3 mg/m3	mg/m3

	ı			
1.4	(ppb)	Absolute Uncertainty in ΔC		
15.6%	ΔC	Relative Uncertainty of		
7.0%	Olicei tallity of the	Relative		
17%	Relative Relative Uncertainty of Q Uncertainty of E			
1.5	(mg/hr)	Absolute Uncertainty of E		

Absolute Uncertainty in Relative AC Uncertainty of One trainty of Q One trainty of Q One trainty of Q	Absolute Uncertainty in Relative AC Uncertainty of AC AC AC
Relative Uncertainty of Q  AC  Relative  Relative  Oncertainty of Q	Relative Uncertainty of Q  AC  Relative  Relative  Oncertainty of Q
Relative Uncertainty of Q	Relative Uncertainty of Q
Relative Uncertainty of Q 7.0%	Relative Relative Uncertainty of Q Uncertainty of E 7.0% 14%
	Relative Uncertainty of E

m	Ω	DeltaC	Average Downstream	Average Upstream	Sampling Period 2
11.4	327	10.2	10.7	0.440	
11.4 mg/hr	CFM	ppb	ppb	ppb	
	556	0.0205	0.0214	0.00088 mg/m3	
	m3/hr	mg/m3	mg/m3	mg/m3	

				1.4	(ppb)	Absolute Uncertainty in $\Delta C$
1	(Down & Up)	Sampling Set		14%	ΔC	Relative Uncertainty of
10.5	ppb	Delta C		7.0%	once taility of A	Relative
			•	15%	Officer faility of E	Relative
				1.8	(mg/hr)	Absolute Uncertainty of E

10.0

50

E	Q	DeltaC	Average Downstream	Average Upstream	Sampling Period 3
11.4	360	9.30	9.93	0.630	
11.4 mg/hr	CFM	ppb	ppb	ppb	
	612	0.0186	0.0199	0.00126	
	m3/hr	mg/m3	mg/m3	mg/m3	

Relative Uncertainty of  $\Delta C$ 

Relative Relative
Uncertainty of Q Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

15%

7.0%

17%

			11.4 mg/hr	11.4	m
	m3/hr	612	CFM	360	Q
	mg/m3	0.0186	ppb	9.30	DeltaC
1.4	mg/m3	0.0199	ppb	9.93	Average Downstream
(ppb)	mg/m3	0.00126	ppb	0.630	Average Upstream
Absolute Uncertainty in $\Delta C$					Sampling Period 3

2	1	(Down & Up)	Sampling Set	
9.3	9.3	ppb	Delta C	

			13.2 mg/hr	13.2	m
<u> </u>	1096 m3/hr	1096	645 CFM	645	Д
	mg/m3	0.0120	ppb	6.02	DeltaC
າ <u>ສ</u>	mg/m3	0.0129	ppb	6.46	Average Downstream
ევ	mg/m3	0.00089	ppb	0.445 ppb	Average Upstream
					Sampling Period 4

1 5.4	(Down & Up) ppb	Sampling Set Delta C	1.4 24% 7.0% 25%	(ppb) AC Sincertainty of K. Sincertainty of K.	Absolute  Uncertainty in Relative Relative Relative Relative
			25%	טווכפו נמווונץ טו ב	Relative
			3.2	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set
6.6	5.4	ppb	Delta C

E			Q		DeltaC	Downstream	Average	Upstream	Average	Period 5	Sampling	
12.2			720		4.97	5.43		0.465				
12.2 mg/hr			CFM		ppb	ppb		ppb				
			1223		0.00993	0.0109		0.00093				
			1223 m3/hr		3 mg/m3	mg/m3		3 mg/m3				
											_	
						1.4			(had)	ΔC	Uncertainty in	Absolute
	2	(Down & Up) 1		Sampling Set		28%			ΔC	Uncertainty of	Relative	
	4.5	5.5	ppb	Delta C		7.0%			טווכבו נמווונץ טו ע	Illocertainty of O Illocertainty of E	Relative	
						29%			Officer contret of E	Uncertainty of F	Relative	
						-						

3.6

Absolute Uncertainty of E

(mg/hr)

Full Test	13-Sep-11				1
Sampling					
Period 1					
Average					
Upstream	0.55	ppb	0.00110	mg/m3	
Average					
Downstream	12.1	ppb	0.0243	mg/m3	
DeltaC	11.6	ppb	0.0232	mg/m3	
ρ	290	CFM	493	m3/hr	
Ш	11.4	11.4 mg/hr			

		1.4	(ppb)	Absolute Uncertainty in $\Delta C$
(all '8 amoa)	Sampling Set	12%	ΔC	Relative Uncertainty of
daa	Delta C	7.0%	once tallity of a	Relative
		14%	טוויבו נמווויץ טו ע	Relative
		1.6	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set
12.6	10.6	ppb	Delta C

т	ρ	DeltaC	Average Downstream	Average Upstream	Sampling Period 3	Е	Q	DeltaC	Average Downstream	Average Upstream	Sampling Period 2
12.6	360	10.3	10.4	0.165		12.8	290	13.0	13.3	0.32	
mg/hr	CFM	ppb	ppb	ppb		mg/hr	CFM	ppb	ppb	ppb	
	612	0.0205	0.0209	0.00033 mg/m3			492.71	0.0260	0.0267	0.00065	
	m3/hr	mg/m3	mg/m3	mg/m3			m3/hr	mg/m3	mg/m3	mg/m3	
			1						1		
			1.4	(ppb)	Absolute Uncertainty AC				1.4	(ppb)	Absolute Uncertainty AC

Sampling Set (Down & Up)

Delta C

9.61 10.9

0209	0033					92.71		0260	0267	0065	
mg/m3	mg/m3					m3/hr		mg/m3	mg/m3	mg/m3	
1.4	(ppb)	Absolute Uncertainty in $\Delta C$	_						1.4	(ppb)	Absolute Uncertainty in  AC
14%	ΔC	Relative Uncertainty of		2	1	(Down & Up)	Sampling Set		11%	ΔC	Relative Uncertainty of
7.0%	Office taility of Q	Relative		13.0	12.7	ppb	Delta C		7.0%	טווכפו נמווונץ טו ע	Relative
15%	Officer family of E	Relative							13%	Officer family of E	Relative
1.9	(mg/hr)	Absolute Uncertainty of E							1.7	(mg/hr)	Absolute Uncertainty of E

	m3/hr	1096	CFM	645	ρ
	mg/m3	0.0107	ppb	5.34	DeltaC
1.4	mg/m3	0.0126	ppb	6.32	Average Downstream
(ppb)	mg/m3	0.00196	ppb	0.980	Average Upstream
Absolute Uncertainty in AC					Sampling Period 5
			mg/hr	12.8	П
	m3/hr	1096	CFM	645	Q
	mg/m3	0.0117	ppb	5.83	DeltaC
1.4	mg/m3	0.0119	ppb	5.97	Average Downstream
(ppb)	mg/m3	0.000273	ppb	0.137	Average Upstream
Absolute Uncertainty in  AC					Sampling Period 4

5.34 645	5.34	5.34		e tream 6.32 ppb	e am 0.980 ppb	ng 5	12.8 mg/hr			645 CFM		5.83 ppb	e tream 5.97 ppb	e am 0.137 ppb (	ng 4
	1096		0.0107		0.00196					1096		0.0117	0.0119	0.000273	
	m3/hr		mg/m3	mg/m3	mg/m3					m3/hr		mg/m3	mg/m3	mg/m3	
				1.4	(ppb)	Absolute Uncertainty in AC							1.4	(ppb)	Uncertainty in $\Delta C$
	(Down & Up)	Sampling Set		26%	ΔC	Relative Uncertainty of		2	1	(Down & Up)	Sampling Set		24%	ΔC	Relative Uncertainty of
п //	ppb	Delta C		7.0%		Relative Uncertainty of O		6.01	5.51	ppb	Delta C		7.0%	טווכפו ומווונץ טו ע	Relative
				27%		Relative Uncertainty of E							25%	Olice Lallity of E	Relative
				3.2	(mg/hr)	Absolute Uncertainty of E							3.2	(mg/hr)	Absolute Uncertainty of E

Absolute Uncertainty of E

ш

11.7 mg/hr

			13.2 mg/hr	13.2	Е	
	m3/hr	1198	705 CFM	705	Q	
w	mg/m3	0.0110	ppb	5.52	DeltaC	
$\sim$	mg/m3	0.0127	ppb	6.35	Average Downstream	
~	mg/m3	0.00165	ppb	0.825	Average Upstream	
					Sampling Period 6	

Relative Uncertainty of  $\Delta C$ 

Relative Relative
Uncertainty of Q Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

3.5

			13.2 mg/hr	13.2	m
	1198 m3/hr	1198	705 CFM	705	ρ
	mg/m3	0.0110	ppb	5.52	DeltaC
1.4	mg/m3	0.0127	ppb	6.35	Average Downstream
(ppb)	mg/m3	0.00165	ppb	0.825	Average Upstream
Absolute Uncertainty in $\Delta C$					Sampling Period 6

		ppb 4.44	(Down & Up) 1	
		Delta C	Sampling Set	
3.6	29%	7.0%	28%	1.4
(mg/hr)	Officer country of E		ΔC	(ppb)
Absolute Uncertainty of E	Relative	Relative	Relative Uncertainty of	ncertainty in $\Delta C$

2

(ppb)	Absolute ncertainty in AC						1.4	(ppb)
$\Delta C$	Relative Uncertainty of	2	1	(Down & Up)	Sampling Set		26%	Δί
Officer family of C	Relative	5.68	5.36	ppb	Delta C		7.0%	
Officer	Relative		<u> </u>	•		•	27%	

ш	Q	DeltaC	Average Downstream	Average Upstream	Period 9	Sampling	Е	ρ	DeltaC	Downstream	Upstream Average	Average	Period 8	Sampling
12.5	290	12.7	12.8	0.135			16.0	720	6.55	6.58	0.0267			
mg/hr	CFM	ppb	ppb	ppb			mg/hr	CFM	ppb	ppb	ppb			
	493	0.0254		0.00027				1223.28 m3/hr	0.0131	0.0132	0.0000533			
	m3/hr	mg/m3	mg/m3	mg/m3				m3/hr	mg/m3	mg/m3	mg/m3			
			1.4	(ppb)	ΔC	Absolute Uncertainty in				1.4	(770)	(499)	ΔC	Absolute Uncertainty in
		7	<b>-</b>		-		Г		_					

рb рb	0.0000533 0.0132 0.0131	mg/m3 mg/m3 mg/m3	(ppb)	Uncertainty of $\Delta C$ 22%	of Q	Uncertainty of E	(mg/hr) 3.6
				Sampling Set	Delta C		
FΜ	1223.28	m3/hr		(Down & Up)	ppb		
				1	6.67		
				2	6.40		
າg/hr							
			Absolute Uncertainty in	Relative Uncertainty of	Relative	Relative	Absolute Uncertainty of E
рb	0.00027	mg/m3	(ppb)	ΔC	טווככו ומווונץ טו ע	Olice Lallity of F	(mg/hr)
рb	0.0257	0.0257 mg/m3	1.4	11%	7.0%	13%	1.6
рb	0.0254	mg/m3					
				Sampling Set	Delta C		
ξ	493	m3/hr		(Down & Up)	ppb		
				1	12.8		
				2	12.6		

Absolute Uncertainty of E

								1 1												1
Е		ρ		DeltaC	Average Downstream	Average Upstream	Sampling Period 2		Ш		ρ		DeltaC	Downstream	Average	Upstream	Average	Period 1	Sampling	Full Test
20.2		290		20.5	21.2	0.72			18.3		290		18.6	19.6		1.04				27-Sep-11
mg/hr		CFM		ppb	ppb	ppb			mg/hr		CFM		ppb	ppb		ppb				11
		493		0.0409	0.0424	0.00144					492.71		0.0372	0.0393		0.00208				
		m3/hr		mg/m3	mg/m3	mg/m3					m3/hr		mg/m3	mg/m3		mg/m3				
					1.4	(ppb)	Absolute Uncertainty in  AC							1.4		(טלט)	(55)	ΔC	Absolute Uncertainty in	
2	בו	(Down & Up)	Sampling Set		6.9%	ΔC	Relative Uncertainty of		2	ъ	(Down & Up)	Sampling Set		7.6%			ΔC	Uncertainty of	Relative	
20.8	20.2	ppb	Delta C		7.0%		Relative Uncertainty of O		19.4	17.8	ppb	Delta C		7.0%			סווככו ימווינץ טו ע	Relative		
0.2	120	13			9.8%		Relative Uncertainty of F		0.2	120	13			10%			Olice raility of F	Relative		
Amp	Volts	Watt			2.0	(mg/hr)	Absolute Uncertainty of E		Amp	120 Volt	Watt			1.9		(111/8/111)	(ma /hr)	Uncertainty of E	Absolute	

М		Q		DeltaC	Downstream	Average	Average Upstream	Period 4	Sampling		ш		Q		DeltaC	Downstream	Average	Upstream		Period 3	5
12.7		645		5.79	6.47		0.680				20.6		360		16.8	17.0		0.175			
12.7 mg/hr		CFM		ppb	ppb		ppb				mg/hr		CFM		ppb	ppb		ppb			
		1096		0.0116	0.0129		0.00136						612		0.0336	0.0340		0.00035			
		m3/hr		mg/m3	mg/m3		mg/m3						m3/hr		mg/m3	mg/m3		mg/m3			
					1.4		(ppb)	ΔC	Uncertainty in	Absolute						1.4		(ppb)		VC Officer (quility iii	Absolute
2	ъ	(Down & Up)	Sampling Set		24%		ΔC	Uncertainty of	Relative		2	ב	(Down & Up)	Sampling Set		8.4%		ΔC	Olice reliated	Uncertainty of	D
8.71	10.3	ppb	Delta C		7.0%			Uncertainty of O	Relative		16.5	17.1	ppb	Delta C		7.0%			Uncertainty of Q	Relative	
0.21	120	13		-	25%			Uncertainty of F	Relative		0.21	120	13			11%			Uncertainty of E	Relative	
0.21 Amp	120 Volts	Watt			3.2		(mg/hr)		Uncertainty of F	Absolute	0.21 Amp	120 Volts	Watt			2.2		(mg/hr)		Uncertainty of E	Absolute

ш		Q		DeltaC	Downstream	Average Upstream	Sampling Period 6	ш		ρ		DeltaC	Average Downstream	Average Upstream	Sampling Period 5
19.7		705		8.21	9.21	1.00		13.8		645		6.30	6.42	0.114	
mg/hr		CFM		dqq	ppb	ppb		mg/hr		CFM		ppb	ppb	ppb	
		1198		0.0164	0.0184	0.00200				1095.855 m3/hr		0.0126	0.0128	0.000228	
		m3/hr		mg/m3	mg/m3	mg/m3				m3/hr		mg/m3	mg/m3	mg/m3	
					1.4	(ppb)	Absolute Uncertainty in  AC						1.4	(ppb)	Absolute Uncertainty in AC
2	ъ	(Down & Up)	Sampling Set		17%	ΔC	Relative Uncertainty of	2	ב	(Down & Up)	Sampling Set		22%	ΔC	Relative Uncertainty of
8.45	7.97	ppb	Delta C	-	7.0%		Relative Uncertainty of Q	9.11	8.93	ppb	Delta C		7.0%	Once which of x	Relative
0.21	119.8 Volts	13			19%		Relative Uncertainty of E	0.21 Amp	120	13			24%		Relative
Amp	Volts	13 Watt			3.7	(mg/hr)	Absolute Uncertainty of E	Amp	120 Volts	13 Watt			3.2	(mg/hr)	Absolute Uncertainty of E

								_												
Е		Q		DeltaC	Average Downstream	Average Upstream	Sampling Period 8		ш		Q		DeltaC	Downstream	Upstream	Average	Period 7	Sampling		
19.4		720		7.92	8.88	0.960			17.2		720		7.04	8.74	1.70					
mg/hr		CFM		ppb	ppb	ppb			mg/hr		CFM		ppb	ppb	ppb					
		1223		0.0158	0.0178	0.00192 mg/m3					1223		0.0141	0.0175	0.0034					
		m3/hr		mg/m3	mg/m3	mg/m3					1223 m3/hr		mg/m3	mg/m3	mg/m3					
					1.4	(ppb)	Uncertainty in $\Delta C$							1.4	(ppb)		ΔC	Uncertainty in	Absolute	
2	1	(Down & Up)	Sampling Set		18%	ΔC	Relative Uncertainty of		2	1	(Down & Up)	Sampling Set		20%		Relative Uncertainty of $\Delta C$				
7.57	8.27	ppb	Delta C		7.0%	Girce willy of x	Relative		6.72	7.35	ppb	Delta C		7.0%		Relative Uncertainty of Q				
0.21	121	13			19%		Relative		0.21	121	13			21%		Officer (dility of E	Theoretainty of E	D		
Amp	121 Volts	Watt			3.7	(mg/hr)	Absolute Uncertainty of E		0.21 Amp	121 Volts	Watt			3.7	(mg/hr)		Olicer (allity of E	Absolute	-	

ш		Q	Pressure	FlowPlate		DeltaC	Downstream	Average	Average	Period 1	Sampling	Run 1		Е		ρ		DeltaC	Downstream	Upstream	Average	Period 9	Sampling
18.4		288	3.5			18.7	20.2	1.4/	1			27-Sep-11		17.6		290		17.9	18.9	1.03			
mg/hr		CFM	Pa			ppb	ppb	טטט	5 5			11		mg/hr		CFM		ppb	ppb	ppb			
		489				0.0375	0.0404	0.00294 III8/III3								493		0.0357	0.0378	0.00206			
		m3/hr				mg/m3	mg/m3	CIII/BIII	ma /m2							493 m3/hr		mg/m3	mg/m3	mg/m3			
							1.4		(ppb)	ΔC	Absolute Uncertainty in								1.4	(700)	(nnh)	ΔC	Absolute Uncertainty in
	2	ב	(Down & Up)		Sampling Set		7.5%		ΔC	Uncertainty of	Relative			2	ב	(Down & Up)	Sampling Set		7.9%		ΔC	Uncertainty of	Relative
	19.6	17.9	ppb		Delta C		7.0%			Uncertainty of O	Relative			17.7	18.0	ppb	Delta C	-	7.0%		טווכנו נמווינץ טו ע	Uncertainty of O	Relative
	0.19	120.9	13				10%		Relative Uncertainty of E				•	0.21 Amp	120.6 Volts	13			11%		Relative Uncertainty of E		Rolativo
	Amp	Volt	Watt				1.9		(mg/hr)		Absolute Uncertainty of E			Amp	Volts	Watt			1.9	(6/)	(mg/hr)	Officer taility of E	Absolute

ш		ρ	Pressure	FlowPlate		DeltaC	Downstream	Average	Upstream	Average	Period 3	Sampling	Е		Ω	Pressure	FlowPlate		DeltaC	Downstream	Average	Upstream	Average	Period 2	Sampling	
18.4		714	21.5			7.59	8.64		1.06				18.1		475	9.5			11.2	12.3		1.04				
mg/hr		CFM	Pa			ppb	ppb		ppb				mg/hr		CFM	Pa			ppb	ppb		ppb				
		1213				0.0152	0.0173		0.00211						806				0.0225	0.0246		0.00208				
		m3/hr				mg/m3	mg/m3		mg/m3						m3/hr				mg/m3	mg/m3		mg/m3				
							1.4		(ppb)	/	ΔC	Absolute Uncertainty in								1.4		(סקס)	(55)	ΔC	Uncertainty in	\hcol::+a
	2	1	(Down & Up)		Sampling Set		19%		Relative Relative Uncertainty of Uncertainty of Q			Relative		2	1	(Down & Up)		Sampling Set		13%			ΔC	Uncertainty of	Relative	
	0.0	0.0	ppb		Delta C		7.0%						12.0	10.5	ppb		Delta C		7.0%			טווכבו שווורץ טו ע	Lincartainty of O	Ro stivo		
	0.21	121.2	13				20%		Relative Uncertainty of E				0.19	121.1	13				14%			טווכפו נמווונץ טו ב	I incertainty of E	Rolativo		
	Amp	Volt	Watt				3.7		(mg/hr)		טווכפו נמווינץ טו ב	Absolute		Amp	Volt	Watt				2.6		(1118/111)	(ma/hr)	סווככו ימווירץ טו ב	Absolute	

Q	riessuie	75000	FlowPlate	DeltaC	Downstream	Upstream	Average	Period 2	Sampling	г	ı	Q	Pressure	FlowPlate		DeltaC	Average Downstream	3	A COLOUR	Period 1	Sampling	Run 2 27	
	475	9.5		11.8	13.0	1.26				18.1		288	3.5			18.5	19.6	1.12				27-Sep-11	
	CFM	Pa		ppb	ppb	ppb				mg/hr	:	CFM	Pa			ppb	ppb	ppb				1	
	806			0.0235	0.0261	0.00251						489				0.0370	0.0393	0.00224					
	m3/hr			mg/m3	mg/m3	mg/m3						m3/hr				mg/m3	mg/m3	mg/m3					
					1.4	(ppb)		ΔC	Absolute Uncertainty in								1.4	(ppb)	40	<u> </u>	Absolute Uncertainty in		
)	1	(Down & Up)	Sampling Set		12%	ļ	<u>`</u>	Uncertainty of	Relative		2	1	(Down & Up)	-	Sampling Set		7.6%	ΔC	לווכבו נמווינץ טו	Uncertainty of	Relative	-	
	11.7	ppb	Delta C		7.0%		Uncertainty of Q	Relative			19.2	17.8	ppb		Delta C		7.0%		Uncertainty of Q	Relative			
0 21	120.9 Volt	13			14%		Uncertainty of E	Relative			0.19	120.7 Volt	13				10%		Uncertainty of E	Relative	! -		
0.21 Amp	Volt	Watt			2.6	(mg/hr)		Uncertainty of E	Absolute		Amp	Volt	Watt				1.9	(mg/hr)		Uncertainty of E	Absolute		

									a a												
ш		Q	Pressure	FlowPlate	DeltaC	Average Downstream	Average Upstream	Sampling Period 1	Run 3	E		Q	Pressure	FlowPlate		DeltaC	Average Downstream	Upstream	Average	Period 3	Sampling
19.9		288	3.5		20.4	21.7	1.37		27-Sep-11	19.7		714	21.5		()  -	x 17	8.77	0.66			
mg/hr		CFM	Pa		ppb	ppb	ppb		11	mg/hr		CFM	Pa		7	5	ppb	ppb			
		489			0.0408	0.0435	0.00274					1213			0.01	0 0162	0.0175	0.00131			
		m3/hr			mg/m3	mg/m3	mg/m3					1213 m3/hr			6/	mg/m3	mg/m3	mg/m3	•		
						1.4	(ppb)	Absolute Uncertainty in AC									1.4	NIT IT IT	(daa)	ΔC	Absolute Uncertainty in
	2	1	(Down & Up)	Sampling Set		6.9%	ΔC	Relative Uncertainty of			2	1	(Down & Up)	-	Sampling Set		17%		ΔC	Uncertainty of	Relative
	20.2	20.5	ppb	Delta C		7.0%		Relative	-		0.0	0.0	ppb		Delta C		7.0%		Officer raility of C	Uncertainty of O	Relative
	0.21	121	13			9.9%		Relative Uncertainty of F			0.21 Amp	120.9 Volt	13				19%		Officer callity of E	Uncertainty of F	Relative
	0.21 Amp	Volt	Watt			2.0	(mg/hr)	Absolute Uncertainty of E			Amp	Volt	Watt				3.7	ç	(mg/hr)	011001001111111111111111111111111111111	Absolute

							mg/hr	19.1	ш	
Amp		0.0	2							
Volt		0.0	1		m3/hr	1213	CFM	714	ρ	
Watt	13	ppb	(Down & Up)				Pa	21.5	Pressure	
									FlowPlate	
		Delta C	Sampling Set							
					mg/m3	0.0157	ppb	7.87	DeltaC	
3	19%	7.0%	18%	1.4	mg/m3	0.0180	ppb	9.00	Downstream	
									Average	
(118				(מקים)	mg/m3	0.00226	ppb	1.13	Upstream	
(3)	Officer family of E	טווכבו נמווונץ טו ע	ΔC	(55)					Average	
01100100	I Incertainty of F	I Incertainty of O	Uncertainty of	ΔC					Period 3	
Abso	Relative	Relative	Relative	Absolute Uncertainty in					Sampling	
							ģ		1	
							mg/hr	19.2	m	
Amp	0.21 Amp	11.8	2							
Volt	121	12.0	1		m3/hr	806	CFM	475	Q	
Watt	13	ppb	(Down & Up)				Pa	9.5	Pressure	
									FlowPlate	
		Delta C	Sampling Set							
					mg/m3	0.0238	ppb	11.9	DeltaC	
2	14%	7.0%	12%	1.4	mg/m3	0.0269	ppb	13.4	Downstream	
									Average	
3111				(500)	mg/m3	0.00309	ppb	1.55	Upstream	
(ma	Olicer raility of E	טווכפו שווונץ טו ע	ΔC	(444)					Average	
Olicelia	Telative	Telative of O	Uncertainty of	ΔC					Period 2	
Abso	D )	D	Relative	Uncertainty in					Sampling	
				Absolute						

Absolute Uncertainty of E

(mg/hr)

3.7

Absolute Uncertainty of E

(mg/hr)

DeltaC 10.7 ppb 0.0214 mg/m3	Average         Downstream         13.3 ppb         0.0267 mg/m3         1.4         13%         7.0%		$\begin{array}{cccccccccccccccccccccccccccccccccccc$	10.7	F 19.7 mg/hr 2 21.3	Q 288 CFM 489 m3/hr 1 19.0	Pressure 3.5 Pa (Down & Up) ppb	FlowPlate	Sampling Set Delta C	DeltaC 20.1 ppb 0.0402 mg/m3	Average  Downstream 21.9 ppb 0.0438 mg/m3 1.4 7.0% 7.0%	n 1.80 ppb 0.00360 mg/m3 (ppb)		Uncertainty in Relative	1830.660
	7.0%	Since with Si	Relative Uncertainty of O		21.3	19.0	ppb		Delta C		7.0%		Uncertainty of Q	Relative	
	15%	Olice railry of r	Relative		0.19	120.2	13			J	9.9%		Uncertainty of E	Relative	
	2.6	(mg/hr)	Absolute Uncertainty of E		0.19 Amp	120.2 Volt	Watt				2.0	(mg/hr)		Absolute Uncertainty of E	

FlowPlate Pressure

Q

9.5 Pa 475 CFM

806 m3/hr

Sampling Set

Delta C

(Down & Up)

9.0 12.3 ppb

13 Watt 120.3 Volt 0.19 Amp

m	Q	Pressure	FlowPlate	DeltaC	Downstream	Average	Upstream	Average	Period 3	Sampling	
19.6	714	21.5		8.09	8.84		0.76				
19.6 mg/hr	714 CFM	Pa		ppb	ppb		ppb				
	1213			0.0162	0.0177		0.00151				
	m3/hr			mg/m3	mg/m3		mg/m3				

Sampling Set Delta C (Down & Up) ppb 1 7.6 2 8.6				
Delta C ppb 7.6 8.6	2	1	(Down & Up)	Sampling Set
	8.6	7.6	ppb	Delta C

8.6	7.6	ppb
0.21	120.3	13
Amp	Volt	Watt

## AIR CLEANER 3

Initial Trial	1-Sep-11			
Sampling				
Period 1				
Average				
Upstream	0.111	ppb	0.000223	mg/m3
Average				
Downstream	9.42	ppb	0.0188	mg/m3
DeltaC	9.31	ppb	0.0186	mg/m3
FlowPlate				
Pressure		Pa		
ρ	290	290 CFM	493	m3/hr
m	9.17	9.17 mg/hr		
г	J.1/	0/		

1.4	(ppb)	Absolute Uncertainty in
15%	ΔC	Relative Uncertainty of
7.0%	Q	Relative Uncertainty of
17%	Officer failing of E	Relative
1.5	(mg/hr)	Absolute Uncertainty of E

			_			_	_	_		_				l_
П		Q	Pressure	FlowPlate		DeltaC	Downstream	Average	Upstream	Average	Period 1	Sampling		Run 1
10.4		288	3.5			10.6	11.3		0.75					29-Sep-11
mg/hr		CFM	Pa			ppb	ppb		ppb					1
		489				0.0212	0.0227		0.00150 mg/m3					
		489 m3/hr				mg/m3	mg/m3		mg/m3					
							1.4		(קלט)	(nnh)	ΔC	Uncertainty in	Absolute	
	2	1	(Down & Up)		Sampling Set		13%			ΔC	Uncertainty of	Relative		
	10.7	10.5	ppb		Delta C		7.0%			Q	Uncertainty of	Relative		
						•	15%			Officer (a) Interpretation	lincertainty of F	Relative		
							1.6		(1118/111)	(mg/hr)	סווכבו נמווונץ טו ב	I incertainty of F	۸ hso اسام	
									•					

Run 2	29-Sep-11	1				1
Sampling						_
Period 1					1	
Average						
Upstream	0.11	ppb	0.00021 mg/m3	mg/m3		
Average						
Downstream	13.3	ppb	0.0265	mg/m3		
DeltaC	13.1	ppb	0.0263	mg/m3		
FlowPlate						
Pressure	3.5	Pa				
Q	288	288 CFM	489	489 m3/hr		
т	12.9	12.9 mg/hr				

υ —	ω	ω	
	1.4	(ppb)	Absolute Uncertainty in AC
	11%	ΔC	Relative Uncertainty of
	7.0%	Q	Relative Uncertainty of
	13%	Officer faility of E	Relative
	1.7	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
12.9	13.4	ppb	Delta C	

Ш	Pressure Q	FlowPlate	DeltaC	Downstream	Upstream Average	Average	Period 2	Sampling	
13.0	3.5 288	) 	13.3	14.3	1.00				
13.0 mg/hr	Pa CFM	1	ppb	ppb	ppb				
	489		0.0266	0.0286	0.00200				
	m3/hr		mg/m3	mg/m3	mg/m3				

	489			0.0266 mg/m3	0.0286	0.00200 mg/m3		
	m3/hr			mg/m3	mg/m3	mg/m3		
					1.4	(ppb)	Absolute Uncertainty in $\Delta C$	
2	1	(Down & Up)	Sampling Set		11%	ΔC	Relative Uncertainty of	
13.6	12.9	ppb	Delta C		7.0%	Relative Uncertainty of Q		
					13%	Officer carries of E	Relative	
					1.7	(mg/hr)	Absolute Uncertainty of E	

2	1	(Down & Up)	Sampling Set
13.6	12.9	ррь	Delta C

Full Test 1	13-Oct-11	i			7
Sampling					
Period 1					
Average					
Upstream	1.23	ppb	0.00245	mg/m3	
Average					
Downstream	13.6	ppb	0.0271	mg/m3	
DeltaC	12.3	ppb	0.0247	mg/m3	
Flow Meter					
Pressure	6.3	Pa			
ρ	301	CFM	512	m3/hr	
ш	12.6	12.6 mg/hr			

	ı		1.4	(ppb)	Absolute Uncertainty in  AC
Ь	(Down & Up)	Sampling Set	11.5%	ΔC	Relative Uncertainty of
11.4	ppb	Delta C	7.0%	Q	Relative Uncertainty of
			13%	Officer faility of E	Relative
			1.7	(mg/hr)	Absolute Uncertainty of E

598 m3/nr	g/hr	mg/	352 CFM 12.6 mg/hr	т Д
	, w	Pa	3. 8. 6. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	Flow Meter Pressure
0.0211		ppb	10.5	DeltaC
0.0228		ppb	11.4	Average Downstream
0.00173 mg/m3		ppb	0.87	Average Upstream
				Sampling Period 2

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

15%

			12.6 mg/hr	12.6	m
	598 m3/hr	598	CFM	352	ρ
			Pa	8.6	Flow Meter Pressure
	mg/m3	0.0211	ppb	10.5	DeltaC
1.4	mg/m3		ppb	11.4	Downstream
					Average
(ppb)	mg/m3	0.00173 mg/m3	ppb	0.87	Average Upstream
ΔC					Period 2
Uncertainty in					Sampling
Absolute					

				1.4
2	1	(Down & Up)	Sampling Set	13.4%
11.5	9.6	ppb	Delta C	7.0%

m	Ω	Pressure	Flow Meter	DeltaC	<del>-</del>	Downstream	Average	Upstream	Average	Period 3	Sampling	
11.4	483	16.2		6.94		8.11		1.17				
11.4 mg/hr	CFM	Pa		ppb	-	ppb		ppb				
	821			0.0139		0.0162		0.00234				
	821 m3/hr			mg/m3	,	mg/m3		mg/m3				
											_	
								l			Ţ	

•	(Down & Up)	Sampling Set	1.4 20.4%	(ppb) ΔC	Absolute Uncertainty in Relative  AC Uncertainty of
7 1	ppb	Delta C	7.0%	Q	Relative Uncertainty of
			22%	Officer faility of E	Relative
			2.5	(mg/hr)	Absolute Uncertainty of

2	1	(Down & Up)	Sampling Set	
6.8	7.1	ppb	Delta C	

			12.5 mg/hr	12.5	Е
	1084 m3/hr	1084	638 CFM	638	ρ
			Pa	28.2	Flow Meter Pressure
	mg/m3	0.0115	ppb	5.76	DeltaC
_	mg/m3	0.0128	ppb	6.42	Downstream
					Average
	mg/m3	0.00132	ppb	0.66	Upstream
					Average
					Period 4
					Sampling

	2					
	1		1084 m3/hr	1084	38 CFM	88
	(Down & Up)				.2 Pa	.2
	Sampling Set					
1			0.0115 mg/m3	0.0115	76 ppb	76
	24.6%	1.4	0.0128 mg/m3	0.0128	ppb	12
	ΔC	(ppb)	mg/m3	0.00132 mg/m3	56 ppb	66
	Uncertainty of	ΔC				
	Relative	Uncertainty in				
		Absolute				

7.0%

26%

3.2

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

2	1	(Down & Up)	Sampling Set	
5.9	5.6	ppb	Delta C	

			12.8 mg/hr	12.8	ш
	1218 m3/hr	1218	CFM	717	ρ
			Pa	35.6	Pressure
					Flow Meter
	mg/m3	0.0105	ppb	5.27	DeltaC
	mg/m3	0.0123	ppb	6.14	Downstream
					Average
	mg/m3	0.00174 mg/m3	ppb	0.87	Upstream
					Average
					Period 5
Un					Sampling
_					

(Dc	Sar	1.4	(ppb)	Absolute  Jncertainty in  AC  Unc
own & Up)	npling Set	26.9%	ΔC	Relative Uncertainty of
ррь	Delta C	7.0%	Q	Relative Uncertainty of
		28%	Officer (affile) of E	Relative
		3.6	(mg/hr)	Absolute Uncertainty of E
	(Down & Up) ppb		26.9% 7.0% 28%  Sampling Set Delta C  (Down & Up) ppb	ΔC Q ORGINITY OF L  26.9% 7.0% 28%  Sampling Set Delta C  (Down & Up) ppb

		13.7 mg/hr	13.7	ш
512 m3/hr	512	301 CFM	301	Q
		Pa	6.3	Flow Meter Pressure
mg/m3	0.0268	ppb	13.4	DeltaC
mg/m3	0.0287	ppb	14.3	Average Downstream
mg/m3	0.00182	ppb	0.91	Average Upstream
				Sampling Period 6

	512			0.0268 mg/m3	0.0287 mg/m3	).00182 mg/m3	
	512 m3/hr			mg/m3	mg/m3	mg/m3	
					1.4	(ppb)	Absolute Uncertainty in  AC
2	1	(Down & Up)	Sampling Set		10.5%	ΔC	Relative Uncertainty of
13.9	13.0	ppb	Delta C		7.0%	Q	Relative Uncertainty of
					13%	Officer family of E	Relative
					1.7	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
13.9	13.0	ррь	Delta C	

Full Test 2 Sampling Period 1 Average Upstream Average	13-Oct-11	. pp	0.00218	mg/m3
Downstream	13.9	ppb	0.0278	mg/m3
DeltaC	12.8	ppb	0.0256	mg/m3
Flow Meter	) )	,		
Pressure	301	CEN.	п 1 3	m2/hr
m ,с	301 13.1	301 CFM 13.1 mg/hr	21.5	512 m3/nr

			1.4	(ppb)	Absolute Uncertainty in
Ь	(Down & Up)	Sampling Set	11%	ΔC	Relative Uncertainty of
12.5	ppb	Delta C	7.0%	Q	Relative Uncertainty of
			13%	Officer faility of E	Relative
			1.7	(mg/hr)	Absolute Uncertainty of E

13.2

72

		12.9 mg/hr	12.9	Ш
598 m3/hr	598	352 CFM	352	Q
		Pa	8.6	Pressure
				Flow Meter
mg/m3	0.0216	ppb	10.8	DeltaC
mg/m3	0.0239	ppb	12.0	Downstream
				Average
mg/m3	0.00231 mg/m3	ppb	1.16 ppb	Upstream
				Average
				Period 2
				Sampling

8.6 Pa 352 CFM 598 m3/hr	12.0 ppb 0.0239 mg/m3 10.8 ppb 0.0216 mg/m3	1.16 ppb 0.00231 mg/m3 (F	Uncer
	1.4	(ppb)	Absolute Uncertainty ii  AC

13%

7.0%

15%

1.9

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

2	1	(Down & Up)	Sampling Set	
10.8	10.8	ppb	Delta C	

			13.1 mg/hr	13.1	Е
	821 m3/hr	821	483 CFM	483	Q
			Pa	16.2	Pressure
					Flow Meter
	mg/m3	0.0160	ppb	7.99	DeltaC
	mg/m3	0.0180	ppb	9.02	Downstream
					Average
	mg/m3	0.00206 mg/m3	ppb	1.03	Upstream
					Average
					Period 3
Unce					Sampling
Ab					

				1.4	(ppb)	Absolute Uncertainty in AC
2	1	(Down & Up)	Sampling Set	18%	ΔC	Relative Uncertainty of
8.8	7.2	ppb	Delta C	7.0%	Q	Relative Uncertainty of
				19%	Officer faility of E	Relative
				2.5	(mg/hr)	Absolute Uncertainty of E

		12.6 mg/hr	12.6	т
m3/hr	1084	CFM	638	ρ
		Pa	28.2	Flow Meter Pressure
Ç		-		
mg/m3	0.0117	daa	5.84	DeltaC
 mg/m3	0.0148	ppb	7.40	Downstream
				Average
mg/m3	0.00312	ppb	1.56	Upstream
				Average
				Period 4
				Sampling

				1.4	
2	1	(Down & Up)	Sampling Set	24%	
5.7	6.0	ppb	Delta C	7.0%	

Absolute Uncertainty in  $\Delta C$ 

Relative Uncertainty of AC

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

25%

3.2

(ppb)

Sampling					_	$\subseteq$
Period 5						
Average						
Upstream	1.11	ppb	0.00221	mg/m3		l
Average						
Downstream	6.50	ppb	0.0130	mg/m3		1
DeltaC	5.39	ppb	0.0108	mg/m3		
Flow Meter						
Pressure	35.6	Pa				
Q	717	CFM	1218	m3/hr		
m	13.1	13.1 mg/hr				
		Ç				

			1.4	(ppb)	Absolute Uncertainty in $\Delta C$
1	(Down & Up)	Sampling Set	26%	ΔC	Relative Uncertainty of
4.9	ppb	Delta C	7.0%	Q	Relative Uncertainty of
			27%	Officer faility of E	Relative
			3.6	(mg/hr)	Absolute Uncertainty of E

		14.4 mg/hr	14.4	ш
m3/hr	512	CFM	301	Q
		Pa	6.3	Flow Meter Pressure
 mg/m3	0.0281	ppb	14.0	DeltaC
 mg/m3	0.0313	ppb	15.7	Average Downstream
 mg/m3	0.00323	ppb	1.62	Average Upstream
				Sampling Period 6

	512			0.0281 mg/m3	0.0313 mg/m3	.00323 mg/m3	
	512 m3/hr			mg/m3	mg/m3	mg/m3	
					1.4	(ppb)	Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set		10%	ΔC	Relative Uncertainty of
14.0	14.1	ppb	Delta C		7.0%	Q	Relative Uncertainty of
					12%	Olice Lallity of E	Relative
					1.8	(mg/hr)	Absolute Uncertainty of E
					-		•

		15.2 mg/hr	15.2	ш
512 m3/hr	512	301 CFM	301	Q
		Pa	6.3	Flow Meter Pressure
mg/m3	0.0296	ppb	14.8	DeltaC
mg/m3	0.0319	ppb	15.9	Downstream
mg/m3	0.00230	ppb	1.15	Average Upstream
				Sampling Period 1
				Full Test 3

1.4	(ppb)	Absolute Uncertainty in AC
9.6%	ΔC	Relative Uncertainty of
7.0%	Q	Relative Uncertainty of
12%	Olicel callity of E	Relative
1.8	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
15.3	14.3	ррь	Delta C	

		14.2 mg/hr	14.2	m
m3/hr	598	CFM	352	ρ
		Pa	8.6	Flow Meter Pressure
mg/m3	0.0237	ppb	11.8	DeltaC
mg/m3	0.0256	ppb	12.8	Downstream
mg/m3	0.00191	ppb	0.96	Upstream Average
				Average
				Sampling Period 2

			14.2 mg/hr	14.2	ш
	598 m3/hr	598	352 CFM	352	Q
			Pa	8.6	Flow Meter Pressure
	mg/m3	0.0237	ppb	11.8 ppb	DeltaC
_	mg/m3	0.0256	ppb	12.8	Downstream
					Average
	mg/m3	0.00191	ppb	0.96	Upstream
					Average
					Period 2
					Sampling

			14.2 mg/hr	14.2	
	598 m3/hr	598	352 CFM	352	
			Pa	8.6 Pa	essure
					ow Meter
	mg/m3	0.0237 mg/m3	ppb	11.8 ppb	eltaC
1.4	mg/m3	0.0256	ppb	12.8	)wnstream
(ppb)	mg/m3	0.00191 mg/m3	ppb	0.96	erage ostream
ΔC					riod 2
Absolute					

2	1	(Down & Up)	Sampling Set	
12.9	10.8	ррь	Delta C	

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

12%

7.0%

14%

Sampling					
Period 3					
Average					
Upstream	1.11 ppb	ppb	0.00221 mg/m3	mg/m3	1
Average					
Downstream	10.1	ppb	0.0202	mg/m3	
DeltaC	9.00	ppb	0.0180	mg/m3	
Flow Meter					
Pressure	16.2	Pa			
ρ	483	483 CFM	821	m3/hr	
m	14.8	14.8 mg/hr			
	14.0	1118/111			

				1.4	(qdd)	Absolute Uncertainty in AC
J	1	(Down & Up)	Sampling Set	16%	ΔC	Relative Uncertainty of
2	8.0	ppb	Delta C	7.0%	Q	Relative Uncertainty of
				17%	Officer faility of E	Relative
				2.5	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
10.0	8.0	ppb	Delta C	

ш	Q	Flow Meter Pressure	DeltaC	Downstream	Average	Upstream	Average	Period 4	Sampling
15.0	638	28.2	6.90	n 7.91		1.01			
15.0 mg/hr	CFM	Pa	ppb	ppb		ppb			
	1084		0.0138	0.0158		0.00202			
	m3/hr		mg/m3	mg/m3		mg/m3			

			15.0 mg/hr	15.0	Е
	m3/hr	1084	CFM	638	ρ
			Pa	28.2	Flow Meter Pressure
	mg/m3	0.0138	ppb	6.90	DeltaC
_	mg/m3	0.0158	ppb	7.91	Downstream
					Average
1	mg/m3	0.00202	ppb	1.01	Upstream
					Average
					Period 4
					Sampling

Absolute Uncertainty in  $\Delta C$ 

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

22%

3.2

(ppb)

				1.4
2	1	(Down & Up)	Sampling Set	20%
7.3	6.5	ppb	Delta C	7.0%

Sampling					_	_
Period 5						
Average						
Upstream	1.56	ppb	0.00312	mg/m3		l
Average						
Downstream	6.53	ppb	0.0131	mg/m3		1
DeltaC	4.97	ppb	0.00994	mg/m3		
Flow Meter						
Pressure	35.6	Pa				
Ω	717	CFM	1218	m3/hr		
m	12.1	12.1 mg/hr				
Г	T.7.T	1116/111				

				1.4	(ppb)	Absolute Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set	28%	ΔC	Relative Uncertainty of
4.5	5.5	ppb	Delta C	7.0%	Q	Relative Uncertainty of
				29%	Once tallity of E	Relative
				3.5	(mg/hr)	Absolute Uncertainty of E

		14.9 mg/hr	14.9	ш
512 m3/hr	512	301 CFM	301	Q
		Pa	6.3	Flow Meter Pressure
mg/m3	0.0290	ppb	14.5	DeltaC
mg/m3	0.0308	ppb	15.4	Downstream
				Average
mg/m3	0.00180 mg/m3	ppb	0.90	Upstream
				Average
				Period 6
				Sampling

		ng/m3	ng/m3	ng/m3	
			1.4	(ppb)	Absolute Uncertainty in
(Down & Up)	Sampling Set		9.8%	ΔC	Relative Uncertainty of
ppb	Delta C		7.0%	Q	Relative Uncertainty of
			12%	Officer callity of E	Relative
			1.8	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set
15.7	13.3	ppb	Delta C

## AIR CLEANER 4

Full Test 1 6-0ct-11

		1.3 mg/hr	1.3	Ш
m3/hr	489	288 CFM	288	Q
		Pa	3.5	Pressure
				FlowPlate
mg/m3	0.00260	ppb	1.30	DeltaC
mg/m3	0.00389	ppb	1.95	Downstream
				Average
mg/m3	0.00129	ppb	0.65	Upstream
				Average
				1
				Sampling Period

_	1.4	(ppb)	Absolute Uncertainty in $\Delta C$
	109%	ΔC	Relative Uncertainty of
	7.0%	Uncertainty of Q	Relative
_	109%	Uncertainty of Q Uncertainty of E	Relative
	1.4	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
1.4	1.2	ррь	Delta C	

FlowPlate Pressure Q	Average Downstream DeltaC	Sampling Period 2 Average Upstream
5.5 361	2.56 1.54	1.02
Pa CFM	ppb	ppb
614	0.00511 0.00308	0.00203
m3/hr	mg/m3 mg/m3	mg/m3
	e 5.5 Pa 361 CFM	eam 2.56 ppb 0.00511 1.54 ppb 0.00308 :e 5.5 Pa 361 CFM 614

			1.9 mg/hr	1.9	ш
	614 m3/hr	614	361 CFM	361	ρ
			Pa	5.5	Pressure
					!
	mg/m3	0.00308	ppb	1.54 ppb	DeltaC
1.4	mg/m3	0.00511	ppb	2.56	Downstream
					Average
(דעט)	mg/m3	0.00203 mg/m3	ppb	1.02	Upstream
(555)					Average
Uncertainty in $\Delta C$					2
Absolute					Sampling Period

Relative Uncertainty of  $\Delta C$ 

Uncertainty of Q Relative

Uncertainty of E

Relative

Uncertainty of E

Absolute

(mg/hr)

1.7

92%

7.0%

	827 m3/hr	827	10 Pa 487 CFM	10 487	Pressure Q
					FlowPlate
-	mg/m3	0.00392	ppb	1.96	DeltaC
1.4	mg/m3	0.00631	ppb	3.16	Downstream
					Average
(טקט)	mg/m3	0.00239 mg/m3	ppb	1.20	Upstream
(556)					Average
Uncertainty in $\Delta C$					ω
Absolute					Sampling Period

Relative Uncertainty of  $\Delta C$ 

Uncertainty of Q

Uncertainty of E

Relative

Uncertainty of E

(mg/hr)

Absolute

Relative

72%

7.0%

72%

3.2 mg/hr

•				
	2	1	(Down & Up)	Sampling Set
	1.3	1.7	ppb	Delta C

2	1	(Down & Up)	Sampling Set	
1.9	2.0	ррь	Delta C	

Ш	0.7.7			<u> </u>	. <u>.</u> 2
m	FlowPlate Pressure Q	DeltaC	Average Downstream	Average Upstream	Sampling Period 4
4.0	17 635	1.86	2.41	0.550	
4.0 mg/hr	17 Pa 635 CFM	ppb	ppb	ppb	
	1079	0.00371	0.00481	0.00110	
	1079 m3/hr	mg/m3	mg/m3	mg/m3	

4.0 mg/hr
635 CFM 1079 m3/hr
Pa
ppb 0.00371
ppb 0.00481
0.00110 mg/m3

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Uncertainty of E Relative

Uncertainty of E

(mg/hr)

Absolute

76%

7.0%

77%

3.1

2	1	(Down & Up)	Sampling Set
2.5	1.3	ррь	Delta C

Sampling Period 5					Absolute Uncertainty in AC	
Average	0 075	5	0 00175 mg/m3	ma/ma	(ppb)	
Average		7		Q		
Downstream	2.97	ppb	0.00594	mg/m3	1.4	1
DeltaC	2.10	ppb	0.00419 mg/m3	mg/m3	1	1
7						- 1
FlowPlate	<u>.</u> د	5				
Pressure	21	Pa				1
Q	706	706 CFM	1199	1199 m3/hr		1
п	л Э	3 /hr				
	5.0	5.0 mg/hr				

				1.4	(ppb)
2	1	(Down & Up)	Sampling Set	68%	ΔC
1.8	2.4	ppb	Delta C	7.0%	
				68%	

Relative Uncertainty of  $\Delta C$ 

Relative Relative
Uncertainty of Q Uncertainty of E

Uncertainty of E

(mg/hr)

3.4

Absolute

$\alpha$
$\ddot{\sim}$
$\overline{}$

		5.4 mg/hr	5.4	ш
489 m3/hr	489	CFM	288	Q
		Pa	3.5	Pressure
				FlowPlate
mg/m3	0.0110	ppb	5.52	DeltaC
mg/m3	0.0128	ppb	6.38	Downstream
				Average
mg/m3	0.00172	ppb	0.860	Upstream
				Average
				6
				Sampling Period

				5.4 mg/hr	5.4	ш
		n3/hr	489 m3/hr	CFM	288 CFM	ρ
1				Pa	3.5 Pa	Pressure
1						FlowPlate
	_	ng/m3	0.0110 mg/m3	ppb	5.52	DeltaC
1	1.4	mg/m3	0.0128	ppb	6.38	Downstream
						Average
	(000)	ng/m3	0.00172 mg/m3	ppb	0.860	Upstream
	(hph)					Average
	Uncertainty in $\Delta C$					6
	Absolute					Sampling Period

26%

7.0%

27%

1.4

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

2	1	(Down & Up)	Sampling Set
6.2	4.8	ppb	Delta C

Full Test 2	6-0ct-11				1
Sampling Period 1					
Average				•	
Upstream	0.855	ppb	0.00171	mg/m3	
Average					
Downstream	7.53	ppb	0.0151	mg/m3	
DeltaC	6.68	ppb	0.0134	mg/m3	
FlowPlate					
Pressure	3.5	Pa			
ρ	288	288 CFM	489	m3/hr	
1	) 1	4			
П	0.0	0.5 1118/111			

		1.4	(ppb)	Absolute Uncertainty in $\Delta C$
(Down & In)	Sampling Set	21%	ΔC	Relative Uncertainty of
5	Delta C	7.0%	Uncertainty of Q	Relative
		22%	Uncertainty of Q Uncertainty of E	Relative
		1.5	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
6.9	6.5	ppb	Delta C	

т	FlowPlate Pressure Q	DeltaC	Average Downstream	Average Upstream	Sampling Period 2
7.6	5.5 361	6.20	7.38	1.18 ppb	
7.6 mg/hr	5.5 Pa 361 CFM	ppb	ppb	ppb	
	614	0.0124	0.0148	0.00235	
	614 m3/hr	mg/m3	mg/m3	mg/m3	

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

23%

7.0%

24%

0.0148 mg/m3	0.0148 mg/m3
0.0124 mg/m3	0.0124 mg/m3
614 m3/hr	614 m3/hr
148 mg/m3	148 mg/m3
124 mg/m3	124 mg/m3
124 m3/hr	124 m3/hr

2	1	(Down & Up)	Sampling Set	
6.5	5.9	ppb	Delta C	

Sampling Period					
ω					
Average					
Upstream	1.20	ppb	0.00240	mg/m3	
Average					
Downstream	9.28	ppb	0.0186	mg/m3	
DeltaC	8.08	ppb	0.0162	mg/m3	
	2	7			
Pressure	10	Pa			
Q	487	487 CFM	827	827 m3/hr	
1	7	) 			
E	13.4	13.4 mg/hr			

Uncertainty in $\Delta C$ (ppb)  1.4  Uncertainty of $\Delta C$ 18%  Sampling Set	
Rela Uncerta At  18  Samplii	Absolute
tive sinty of C % ng Set ng Set	
Relative Uncertainty of Q  7.0%  Delta C  Relative Relative Relative 19%	
Relative Uncertainty of E 19%	
Uncertainty of E (mg/hr) 2.5	Absolute

2	1	(Down & Up)	Sampling Set	
5.3	10.9	ррь	Delta C	

п	Q	Pre	Flo	Del	Dov	Ave	Up	Αve	4	San
		Pressure	FlowPlate	DeltaC	Downstream	Average	Upstream	Average		Sampling Period
6.2	635	17		2.89	4.17		1.29			
6.2 mg/hr	635 CFM	Pa		ppb	ppb		ppb			
	1079			0.00577	0.00834		0.00257			
	1079 m3/hr			mg/m3	mg/m3		mg/m3			

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

49%

7.0%

50%

3.1

1079 m3/hr
0.00577 mg/m3
0.00834 mg/m3 1.4
0.00257 mg/m3
Uncertainty in $\Delta C$
Absolute

2	1	(Down & Up)	Sampling Set	
2.9	2.9	ppb	Delta C	

Sampling Period					
5					
Average					
Upstream	1.51	ppb	0.00302	mg/m3	1
Average					
Downstream	4.31	ppb	0.00862	mg/m3	
DeltaC	2.80	ppb	0.00560	mg/m3	
FlowPlate					
Pressure	21	Pa			
Ω	706	706 CFM	1199	1199 m3/hr	
П	6.7	6.7 mg/hr			

			1.4	(ppb)	Absolute Uncertainty in $\Delta C$
	(Down & Up)	Sampling Set	51%	ΔC	Relative Uncertainty of
)	ppb	Delta C	7.0%	Uncertainty of Q	Relative
			51%	Uncertainty of E	Relative
			3.4	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
2.2	3.5	ррь	Delta C	

m		ρ	Pressure	FlowPlate	DeltaC	Downstream	Upstream	Avorago O	Sampling Period	Full Test 3		Е		Ω	Pressure	FlowPlate	מבונמכ	DeltaC	Average Downstream	Upstream	Average	6	Sampling Period
8.7		288	3.5		8.91	9.32	0.410			11	6-0ct-	7.4		288	3.5		7.59	7 50	8.73	1.14			
mg/hr		CFM	Pa		ppb	ppb	ppb					mg/hr		CFM	Pa		כככ	5	ppb	dqq			
		489			0.0178	0.0186	0.00082							489			0.0102	0 0153	0.0175	0.00228			
		m3/hr			mg/m3	mg/m3	mg/m3							m3/hr			1118/1113	ma/ma	mg/m3	mg/m3			
						1.4	(ppb)		Absolute Uncertainty in ΔC										1.4		(dad)	Uncertainty in ΔC	Absolute
	2	1	(Down & Up)	Sampling Set		16%	Δζ	Uncertainty of	Relative				2	1	(Down & Up)	Sampling Sec	Campling Co+		19%		ΔC	Uncertainty of	Relative
	8.5	9.3	ppb	Delta C	:	7.0%		Uncertainty of Q	Relative				8.5	6.6	ppb	Delta	7		7.0%		Uncertainty of Q	Relative	
					_	17%		Uncertainty of E	Relative										20%		Uncertainty of E	Relative	
							1			1										+		1	

Absolute Uncertainty of E

(mg/hr)

1.5

Absolute Uncertainty of E

(mg/hr)

ш		_			_	_	_	_		10
	Q	Pressure	FlowPlate	DeltaC	Downstream	Average	Upstream	Average	2	Sampling Period
9.3	361	5.5		7.54	8.00		0.460			
9.3 mg/hr	361 CFM	Pa		ppb	ppb		ppb			
	614			0.0151	0.0160		0.00092			
	614 m3/hr			mg/m3	mg/m3		mg/m3			

Uncertainty in  $\Delta C$ 

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

(ppb)

1.4

19%

7.0%

20%

1.9

Absolute

		9.3 mg/hr	9.3	Е	
 614 m3/hr	614	CFM	361	Q	
		Pa	5.5	Pressure	
				FlowPlate	
mg/m3	0.0151	ppb	7.54	DeltaC	
mg/m3	0.0160	ppb	8.00	Downstream	
				Average	
mg/m3	0.00092	ppb	0.460	Upstream	
				Average	
				2	
				Sampling Period	

2	1	(Down & Up)	Sampling Set
7.4	7.7	ррь	Delta C

Sampling Period 3					
Average					
Upstream	0.990	ppb	0.00198	mg/m3	
Average					
Downstream	6.41	ppb	0.0128	mg/m3	
DeltaC	5.42	ppb	0.0108	mg/m3	
7					
FlowPlate	2	י ו			
Pressure	10	Pa			
ρ	487	487 CFM	827	827 m3/hr	
ш	9.0	mg/hr			
		Q			

			1.4	(ppb)	Absolute Uncertainty in $\Delta C$
1	(Down & Up)	Sampling Set	26%	ΔC	Relative Uncertainty of
5.8	ppb	Delta C	7.0%	Uncertainty of Q Uncertainty of E	Relative
			27%	Uncertainty of E	Relative
			2.4	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
5.1	5.8	ppb	Delta C	

т	FlowPlate Pressure Q	Sampling Period 4 Average Upstream Average Downstream DeltaC
9.8	17 635	0.915 5.45 4.54
9.8 mg/hr	17 Pa 635 CFM	ppb bpb
	1079	0.00183 0.0109 0.00907
	1079 m3/hr	mg/m3 mg/m3 mg/m3

Uncertainty in  $\Delta C$ Absolute

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

(ppb)

1.4

31%

7.0%

32%

3.1

		9.8 mg/hr	9.8	ш
1079 m3/hr	1079	CFM	635	Q
		Pa	17	Pressure
				FlowPlate
Q		7		
mg/m3	0.00907	daa	4.54	DeltaC
mg/m3	0.0109	ppb	5.45	Downstream
				Average
mg/m3	0.00183	ppb	0.915	Upstream
				Average
				4
				Sampling Period

2	1	(Down & Up)	Sampling Set	
4.1	5.0	ppb	Delta C	

Sampling Period 5					
Average					
Upstream	1.02 ppb	ppb	0.00203 mg/m3	mg/m3	ı
Average					
Downstream	4.28	ppb	0.00856	mg/m3	
DeltaC	3.27	ppb	0.00653	mg/m3	
FlowPlate					
Pressure	21	Pa			
Q	706	706 CFM	1199	1199 m3/hr	
1	0	) 			
	7.8	7.8 mg/hr			

	:				<u>:</u>
	Absolute Uncertainty in ΔC	Relative Uncertainty of		Relative	
n <sub>3</sub>	(ppb)	ΔC	Uncertainty of Q	Uncertainty of E	
n3	1.4	43%	7.0%	44%	
n3					
		Sampling Set	Delta C		
		(Down & Up)	ppb		
<u> </u>		1	3.7		
		2	2.8		

2	ב	(Down & Up)	Sampling Set	
4.1	5.0	ppb	Delta C	

Sampling Period 6					Absolute Uncertainty in ΔC
Average					(anh)
Upstream	1.39	ppb	0.00278 mg/m3	mg/m3	(500)
Average					
Downstream	9.85	ppb	0.0197	mg/m3	1.4
DeltaC	8.46	ppb	0.0169	mg/m3	7
FlowPlate					
Pressure	3.5	Pa			<b>T</b>
ρ	288	CFM	489	489 m3/hr	
ш	8.3	8.3 mg/hr			

2	1	(Down & Up)	Sampling Set	
7.3	9.6	ppb	Delta C	

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

17%

7.0%

18%

RUN 1	7-0ct-11				
Sampling Period 1					U <sub>n</sub>
Average					
Upstream	0.76	ppb	0.00151	mg/m3	
Average		•			
Downstream	8.49	ppb	0.0170	mg/m3	
DeltaC	7.73	ppb	0.0155	mg/m3	
FlowPlate					
Pressure	3.5	Pa			
Q	288	CFM	489	489 m3/hr	
m	7.57	7.57 mg/hr			

Delta C	Jncertainty in $\Delta C$ (ppb)  1.4  Sampling Set (Down & Up)
<u> </u>	Relative Uncertainty of Q 7.0% Delta C ppb 7.5 8.0

RUN 2	7-0ct-11								
Sampling Period 1					Absolute Uncertainty in ΔC	Relative Uncertainty of	Relative	Relative	Absolute Uncertainty of E
Average					(556)	ΔC	Uncertainty of Q	Uncertainty of E	(mg/hr)
Upstream	1.26	ppb	0.00252	mg/m3	(ppb)				(111/8/111)
Average									
Downstream	8.78	ppb	0.0176	mg/m3	1.4	19%	7.0%	20%	1.5
DeltaC	7.52	ppb	0.0150	mg/m3					
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & Up)	ppb		
Q	288	CFM	489	489 m3/hr		1	7.2		
						2	7.9		
Е	7.36	7.36 mg/hr							

ш		ρ	Pressure	FlowPlate		DeltaC	Downstream	Average	Upstream	Average	ב	Sampling Period	RUN 3
				æ			eam		<b>T</b>			Period	
8.29		288	3.5			8.47	9.16		0.69				7-0ct-11
8.29 mg/hr		CFM	Pa			ppb	ppb		ppb				
		489				0.0169	0.0183		0.00138				
		m3/hr				mg/m3	mg/m3		mg/m3				
											Unc	-	
							1.4		(770)	(554)	Uncertainty in $\Delta C$	Absolute	
	2	1	(Down		Samplir		179			Δ	Uncerta	Relat	

1.4	(ppb)	Absolute Uncertainty in ΔC
17%	ΔC	Relative Uncertainty of
7.0%	Uncertainty of Q	Relative
18%	Uncertainty of E	Relative
1.5	(mg/hr)	Absolute Uncertainty of E

1	(Down & Up)	Sampling Set
8.3	ppb	Delta C
	1 8.3	

RUN 4	7-0ct-11								
Sampling Period 1					Absolute Uncertainty in ΔC	Relative Uncertainty of	Relative	Relative	Absolute Uncertainty of E
Average					(556)	ΔC	Uncertainty of Q Uncertainty of E	Uncertainty of E	(50)
Upstream	1.00	ppb	0.00200 mg/m3	mg/m3	(ppb)				(111/8/111)
Average									
Downstream	10.0	ppb	0.0201	mg/m3	1.4	16%	7.0%	17%	1.5
DeltaC	9.03	ppb	0.0181 mg/m3	mg/m3					
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5 Pa	Pa				(Down & Up)	ppb		
Q	288	288 CFM	489	489 m3/hr		1	8.9		
						2	9.2		
П	8.84	8.84 mg/hr							

RUN 5	7-0ct-11				
Sampling Period 1					
Average					
Upstream	1.29	ppb	0.00258	mg/m3	
Average					
Downstream	9.58	ppb	0.0192	mg/m3	
DeltaC	8.29	ppb	0.0166	mg/m3	
FlowPlate					
Pressure	3.5	Pa			
Q	288	CFM	489	m3/hr	
ш	8.11	8.11 mg/hr			

1.4	(ppb)	Absolute Uncertainty in $\Delta C$
17%	ΔC	Relative Uncertainty of
7.0%	Uncertainty of Q	Relative
18%	Uncertainty of E	Relative
1.5	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
9.0	7.6	ppb	Delta C	
).0	7.6	рb	lta C	

RUN 6	7-0ct-11								
Sampling Period 1					Absolute Uncertainty in ΔC	Relative Uncertainty of	Relative	Relative	Absolute Uncertainty of E
Average					(554)	ΔC	Uncertainty of Q Uncertainty of E	Uncertainty of E	(ma/hr)
Upstream	1.24	ppb	0.00247 mg/m3	mg/m3	(ppp)				(111/8/111)
Average									
Downstream	9.56	ppb	0.0191	mg/m3	1.4	17%	7.0%	18%	1.5
DeltaC	8.33	ppb	0.0167 mg/m3	mg/m3					
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & ∪p)	ppb		
Q	288 CFM	CFM	489	489 m3/hr		1	7.7		
						2	8.9		
М	8.15	8.15 mg/hr							

RUN 7	7-0ct-11				
Sampling Period					
Þ					T
Average					
Upstream	0.485	ppb	0.00097	mg/m3	
Average					
Downstream	11.1	ppb	0.0222	mg/m3	
DeltaC	10.6	ppb	0.0213	mg/m3	
FlowPlate					
Pressure	3.5	Pa			
ρ	288	CFM	489	m3/hr	
т	10.4	10.4 mg/hr			

1.4	(ppb)	Absolute Uncertainty in ΔC
13%	ΔC	Relative Uncertainty of
7.0%	Uncertainty of Q	Relative
15%	Uncertainty of E	Relative
1.6	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
11.2	10.1	ppb	Delta C	

RUN 8	7-0ct-11	•							
Sampling Period 1					Absolute Uncertainty in ΔC	Relative Uncertainty of	Relative	Relative	Absolute Uncertainty of E
Average		•		•	(dad)	ΔC	Uncertainty of Q Uncertainty of E	Uncertainty of E	(mg/hr)
Upstream	0.725	ppb	0.00145 mg/m3	mg/m3	(775)				(1118/111)
Average									
Downstream	10.3	ppb	0.0205 mg/m3	mg/m3	1.4	15%	7.0%	16%	1.5
DeltaC	9.54	ppb	0.0191 mg/m3	mg/m3					
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & ∪p)	ppb		
Q	288 CFM	CFM	489	489 m3/hr		1	9.4		
						2	9.7		
Ш	9.33	9.33 mg/hr							

		Q 288	Pressure 3.5	FlowPlate		DeltaC 8.83	eam 9.80	Average	n 0.973	Average	Ъ	Sampling Period	RUN 9 7-Oct-11
		CFM 489	Pa			ppb 0.0177	ppb 0.0196		ppb 0.00195				
		489 m3/hr				0.0177 mg/m3	mg/m3		mg/m3				
F						Ī	1.4		(1000)	(5)	Uncertainty in $\Delta C$	Absolute	
	2	1	(Down & Up)		Sampling Set		16%			ΔC	Uncertainty of	Relative	
-	9	8	р		Del		7.			Uncerta	: Rela	1	

		•
1.4	(ppb)	Absolute Uncertainty in ΔC
16%	ΔC	Relative Uncertainty of
7.0%	Uncertainty of Q	Relative
17%	Uncertainty of E	Relative
1.5	(mg/hr)	Absolute Uncertainty of E

		1		
2	1	(Down & Up)	Sampling Set	
9.1	8.5	ppb	Delta C	

RUN 10	7-0ct-11								
Sampling Period 1					Absolute Uncertainty in ΔC	Relative Uncertainty of	Relative	Relative	Absolute Uncertainty of E
Average					(554)	ΔC	Uncertainty of Q Uncertainty of E	Uncertainty of E	(ma/hr)
Upstream	0.62	ppb	0.00123 mg/m3	mg/m3	(000)				(111/8/111)
Average									
Downstream	10.9	ddd	0.0217	mg/m3	1.4	14%	7.0%	15%	1.6
DeltaC	10.2	ppb	0.0205 mg/m3	mg/m3	į				
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5 Pa	Pa				(Down & Up)	ppb		
Q	288 CFM	CFM	489	489 m3/hr		1	9.9		
						2	10.6		
Е	10.0 mg/hr	mg/hr							

## AIR CLEANER 5

			28.6 mg/hr	28.6	ш
	1213 m3/hr	1213	CFM	714	Q
			Pa	21.5	Pressure
					FlowPlate
	mg/m3	0.0235	ppb	11.8	DeltaC
	mg/m3	0.0262	ppb	13.1	Downstream
					Average
1	mg/m3	0.00266 mg/m3	ppb	1.33	Upstream
,					Average
7					Period 1
Uncer					Sampling
Abs					
			-11	30-Sep-11	Initial Trial

ω	ω	
1.4	(ppb)	Absolute Uncertainty in $\Delta C$
12%	ΔC	Relative Uncertainty of
7.0%	Q	Relative Uncertainty of
14%	Officer faility of E	Relative
4.0	(mg/hr)	Absolute Uncertainty of E
	1.4 12% 7.0% 14%	(ppb) ΔC Q OICEIGIII, y OI L 1.4 12% 7.0% 14%

2	1	(Down & Up)	Sampling Set
12.6	11.0	ppb	Delta C
0.31	120.5 Volts	24	
0.31 Amp	Volts	24 Watt	

ш		ρ	Pressure	FlowPlate		DeltaC	Downstream	Average	Upstream	Average	Period 2	Sampling	
30.2		714	21.5				n 13.3		0.863				
30.2 mg/hr		CFM	Pa			ppb	ppb		ppb				
		1213				0.0249	0.0267		0.001726667				
		1213 m3/hr				mg/m3	mg/m3		mg/m3				
							1.4		(ndd)	(555)	ΔC	Uncertainty in	Absolute
	2	1	(Down & Up)		Sampling Set		11%			ΔC	Uncertainty of	Relative	
						l	-		-				

				ū	ω	ω	
					1.4	(ppb)	$\Delta C$
2	1	(Down & Up)	Sampling Set		11%	ΔC	Uncertainty of
11.6	13.3	ppb	Delta C		7.0%	Q	Uncertainty of
0.31	120.5 Volts	24		•	13%	Officer faility of E	Relative
0.31 Amp	Volts	Watt			4.0	(mg/hr)	Uncertainty o

Relative

Uncertainty of E Absolute

	996			0.0272	0.0299	0.00276	
	996 m3/hr			0.0272 mg/m3	mg/m3	mg/m3	
					1.4	(ppb)	Absolute Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set		10%	ΔC	Relative Uncertainty of
14.0	13.2	ppb	Delta C		7.0%	Q	Relative Uncertainty of
				•	13%	Officer faility of E	Relative
					3.4	(mg/hr)	Absolute Uncertainty of E

Average Downstream

Average Upstream

1.38

ppb

Sampling Period 1

Full Test 1

4-0ct-11

DeltaC

13.6 15.0

ppb

FlowPlate Pressure

14.5

Pa

586

CFM

27.1 mg/hr

Q

Е	ρ	FlowPlate Pressure	DeltaC	Downstream	Average	Upstream	Average	Period 2	Sampling
		ate re	.,	stream	ge G	am	ge Ge	2	ing
36.6	706	21	15.3	16.5		1.22			
36.6 mg/hr	CFM	Pa	ppb	ppb		ppb			
	1199		0.0306	0.0330		0.00244			
	m3/hr		mg/m3	mg/m3		mg/m3			

			36.6 mg/hr	36.6	Ш
	1199 m3/hr	1199	706 CFM	706	Q
			Pa	21	Pressure
					FlowPlate
	mg/m3	0.0306	ppb	15.3	DeltaC
1.4	mg/m3	0.0330	ppb	16.5	Downstream
					Average
(ppb)	mg/m3	0.00244 mg/m3	ppb	1.22	Upstream
					A 10000
ΔC					Period 2
Uncertainty in					Sampling
Absolute					

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

9.3%

7.0%

12%

2	1	(Down & Up)	Sampling Set	
12.6	17.9	ppb	Delta C	

ampling eriod 3  verage lpstream 1.30 ppb 0.00260 mg/m3 verage lownstream 12.1 ppb 0.0242 mg/m3 leltaC 10.8 ppb 0.0216 mg/m3 lowPlate ressure 28 Pa 29.8 mg/hr 29.8 mg/hr							
/erage       1.30 ppb       0.00260         /erage       12.1 ppb       0.0242         ownstream       12.1 ppb       0.0242         eltaC       10.8 ppb       0.0216         owPlate       28 Pa         essure       28 Pa         815 CFM       1385         29.8 mg/hr	Sampling Period 3						S
pstream 1.30 ppb 0.00260 /erage  ownstream 12.1 ppb 0.0242 eltaC 10.8 ppb 0.0216  owPlate essure 28 Pa essure 28 Pa 29.8 mg/hr	Average						
/erage       /erage       0.0242         ownstream       12.1 ppb       0.0242         eltaC       10.8 ppb       0.0216         owPlate       28 Pa         essure       28 Pa         815 CFM       1385         29.8 mg/hr	Upstream	1.30	ppb		mg/m3	1	
ownstream       12.1 ppb       0.0242         eltaC       10.8 ppb       0.0216         owPlate       28 Pa         essure       28 Pa         815 CFM       1385         29.8 mg/hr	Average						
eltaC 10.8 ppb 0.0216  owPlate essure 28 Pa 815 CFM 1385	Downstream		ppb	0.0242	mg/m3		
owPlate essure 28 Pa 815 CFM	DeltaC	10.8	ppb		mg/m3		
essure 28 Pa 815 CFM							
815 CFM 29.8 mg/hr	FlowPlate Pressure		Pa				
29.8	ρ	815	CFM	1385	m3/hr		
	m	29.8	mg/hr				

Т			1.4	(ppb)	Absolute Uncertainty in $\Delta C$
1	(Down & Up)	Sampling Set	13%	ΔC	Relative Uncertainty of
10.6	ppb	Delta C	7.0%	Q	Relative Uncertainty of
			15%	Officer callity of E	Relative
			4.4	(mg/hr)	Absolute Uncertainty of E

Full Test 2	4-0ct-11	1			
Sampling					Un ,
Period 1					
Average					
Upstream	0.73	ppb	0.00146	mg/m3	
Average					
Downstream	15.5	ppb	0.0310	mg/m3	
DeltaC	14.8	ppb	0.0295	mg/m3	
FlowPlate					
Pressure	14.5	Pa			
Q	586	CFM	996	m3/hr	
т	29.4	29.4 mg/hr			

	/hr			/m3	/m3	/m3	U <sub>r</sub>
					1.4	(ppb)	Absolute Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set		9.6%	ΔC	Relative Uncertainty of
14.6	14.9	ppb	Delta C		7.0%	Q	Relative Uncertainty of
					12%	Officer family of E	Relative
					3.5	(mg/hr)	Absolute Uncertainty of

Sampling					
Period 2					
Average					
Upstream	1.07 ppb	ppb	0.00213 mg/m3	mg/m3	1
Average					
Downstream	13.3	ppb	0.0266	mg/m3	1
DeltaC	12.2	ppb	0.0245	mg/m3	
FlowPlate					
Pressure	21	Pa			
Q	706	706 CFM	1199	1199 m3/hr	
П	30	ma/b;			
г	29.3	29.3 mg/nr			

		1.4	(ppb)	Absolute Uncertainty in  AC
(Down 8 115)	Sampling Set	12%	ΔC	Relative Uncertainty of
5 5	Delta C	7.0%	Q	Relative Uncertainty of
		14%	Officer faility of E	Relative
		4.0	(mg/hr)	Absolute Uncertainty of E

Sampling Set	Delta C
(Down & Up)	ppb
1	13.3
2	11.2

			27.3 mg/hr	27.3	т
	1385 m3/hr	1385	815 CFM	815	Q
			Pa	28	Pressure
					Elox Diato
	0.0197 mg/m3	0.0197	ppb	9.85	DeltaC
1.4	mg/m3	0.0222	ppb	11.1	Downstream
					Average
(ppp)	mg/m3	0.00253 mg/m3	ppb	1.27 ppb	Upstream
(5.5.b.)					Average
ΔC					Period 3
Uncertainty in					Sampling
Absolute					

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

14%

7.0%

16%

2	1	(Down & Up)	Sampling Set	
9.4	10.3	ppb	Delta C	

Sampling Period 4       0.73       ppb       0.00145       mg/m3       ng/m3         Average Downstream       15.6       ppb       0.0311       mg/m3       ng/m3         DeltaC       14.8       ppb       0.0297       mg/m3         FlowPlate Pressure Q       14.5       Pa         Q       586       CFM       996       m3/hr         E       29.6       mg/hr						
m 0.73 ppb 0.00145 eam 15.6 ppb 0.0311 14.8 ppb 0.0297 te 14.5 Pa 586 CFM 996	Sampling					
m 0.73 ppb 0.00145 eam 15.6 ppb 0.0311 14.8 ppb 0.0297 te 14.5 Pa 586 CFM 996	Period 4					
m 0.73 ppb 0.00145 eam 15.6 ppb 0.0311 14.8 ppb 0.0297 te 14.5 Pa 586 CFM 996	Average					
eam 15.6 ppb 0.0311 14.8 ppb 0.0297 te 14.5 Pa 586 CFM 996	Upstream	0.73	ppb		mg/m3	ı
am 15.6 ppb 0.0311 14.8 ppb 0.0297 14.5 Pa 586 CFM 996	Average					
14.8 ppb 0.0297 14.5 Pa 586 CFM 996 29.6 mg/hr	Downstream	15.6	ppb	0.0311	mg/m3	
14.5 Pa 586 CFM 996 29.6 mg/hr	DeltaC	14.8	ppb	0.0297	mg/m3	
14.5 Pa 586 CFM 996 29.6 mg/hr	FlowPlate					
586 CFM 996 29.6 mg/hr	Pressure		Pa			
	Q	586	CFM		m3/hr	
	m	29.6	mg/hr			

	1.4	(ppb)	Absolute Uncertainty in AC
Sampling Set (Down & Up)	9.5%	ΔC	Relative Uncertainty of
Delta C ppb	7.0%	ρ	Relative Uncertainty of
	12%	Once control	Relative
	3.5	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
		(Up)	g Set	
15.0	14.7	ppb	Delta C	

ш	ρ	Pressure	FlowPlate	DeltaC	Downstream	Average	Upstream	Average	Period 1	Sampling	 Full Test 3
29.0	586	14.5		14.6	am 15.9		1.31				4-0ct-11
29.0 mg/hr	6 CFM	5 Pa		5 ppb	9 ppb		1 ppb				t-11
	996			0.0291	0.0318		0.00261				
	m3/hr			mg/m3	mg/m3		mg/m3				
										Un .	

				1.4	(ppb)	Absolute Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set	9.7%	ΔC	Relative Uncertainty of
14.1	15.1	ppb	Delta C	7.0%	Q	Relative Uncertainty of
				12%	Officer family Of E	Relative

Absolute Uncertainty of E

(mg/hr)

Sampling Period 2					
Average					
Upstream	1.10	ppb	0.00220	mg/m3	l
Average					
Downstream	14.1	ppb	0.0281	mg/m3	
DeltaC	13.0	ppb	0.0259	mg/m3	
ElowDlate					
Pressure	21	Pa			
Ω	706	706 CFM	1199	m3/hr	
1	7 7	) 			
г	31.1	31.1 mg/hr			

			Ur
	1.4	(ppb)	Absolute Uncertainty in $\Delta C$
	11%	ΔC	Relative Uncertainty of
	7.0%	Q	Relative Uncertainty of
-	13%	Officer faility of E	Relative
	4.0	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
13.3	12.6	ppb	Delta C	

1385
0.0211
0.0245
0.00342

			29.2 mg/hr	29.2	ш
	1385 m3/hr	1385	815 CFM	815	Q
			Pa	28	Pressure
					FlowPlate
	mg/m3	0.0211	ppb	10.6	DeltaC
1.4	mg/m3	0.0245	ppb	12.3	Downstream
					Average
(ppb)	mg/m3	0.00342 mg/m3	ppb	1.71	Upstream
					>
ΔC					Period 3
Uncertainty in					Sampling
Absolute					

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

13%

7.0%

15%

2	1	(Down & Up)	Sampling Set
10.7	10.5	ppb	Delta C

						_
Sampling						٦
Period 4						
Average						
Upstream	1.07 ppb	ppb	0.00213 mg/m3	mg/m3	l	
Average						
Downstream	15.9	ppb	0.0317	mg/m3		
DeltaC	14.8	ppb	0.0296	mg/m3		
<u> </u>						
FlowPlate Pressure	14.5	Pa				
Q	586	CFM	996	996 m3/hr		
m	29.5	29.5 mg/hr				
Г	23.3	1118/111				

		14.2	2	
		15.5	1	
		ppb	(Down & Up)	
		Delta C	Sampling Set	
3.5	12%	7.0%	9.6%	1.4
(mg/hr)	Officer callity of E	Q	ΔC	(ppb)
Absolute Uncertainty of E	Relative	Relative Uncertainty of	Relative Uncertainty of	Absolute Uncertainty in $\Delta C$

					Absolute			
Sampling					Uncertainty in	Relative	Relative	D
Period 1					ΔC	Uncertainty of		Relative
Average					(444)	ΔC	ρ	Officer (diffice) of E
Upstream	1.14	ppb	0.00227 mg/m3	mg/m3	(000)			
Average								
Downstream	16.7	ppb	0.0334	mg/m3	1.4	9.1%	7.0%	11%
DeltaC		ppb	0.0312	mg/m3				
						Sampling Set	Delta C	
FlowPlate								
Pressure	20.5	Pa				(Down & Up)	ppb	
Q	697 CFM	CFM	1185	1185 m3/hr		1	15.0	
						2	16.2	
Е	36.9	mg/hr						

Absolute Uncertainty of E

(mg/hr)

4.2

	697	20.5		12.3	13.6	1.35		
	7 CFM	Pa		ppb	ppb	ppb		
	1185			0.0246	0.0273	0.00269		
	1185 m3/hr			mg/m3	mg/m3	mg/m3		
					1.4	(ppb)	Uncertainty in $\Delta C$	Ahsolute
2	1	(Down & Up)	Sampling Set		12%	ΔC	Relative Uncertainty of	
11.8	12.8	ppb	Delta C		7.0%	ρ	Relative Uncertainty of	
				•	13%	Olice callity of F	Relative	
					3.9	(mg/hr)	Absolute Uncertainty of E	

Sampling
Period 1
Average
Upstream
Average
Downstream
DeltaC

FlowPlate Pressure

							mg/hr	30.3	ш	
		13.1	2							
		12.5	1		1185 m3/hr	1185	CFM	697	Q	
		ppb	(Down & Up)				Pa	20.5	Pressure	
									FlowPlate	
		Delta C	Sampling Set							
					mg/m3	0.0256	ppb	12.8	DeltaC	
4.0	13%	7.0%	11%	1.4	mg/m3	0.0276	ppb	13.8	Downstream	
									Average	
(1118/111)				(555)	mg/m3	0.00197 mg/m3	ppb	0.985	Upstream	
(mg/hr)	Officer faility of E	ρ	ΔC	(pph)					Average	
סווככו נמווונץ טו ד		Uncertainty of	Uncertainty of	ΔC					Period 1	
Incertainty of F		Relative	Relative	Uncertainty in					Sampling	
A bool 1+0				Absolute						

4-0ct-11

Sampling					Absolute	Relative	Relative
Sampling Period 1					Uncertainty in $\Delta C$	Relative Uncertainty of	
Average	υ 1	5	0 00313 mg/m3	ma/m2	(ppb)	ΔC	
Average		-		Ć			
Downstream	14.0	ppb	0.0280	mg/m3	1.4	11%	ı
DeltaC		ppb	0.0249 mg/m3	mg/m3			
						Sampling Set	
FlowPlate							
Pressure	20.5	Pa				(Down & Up)	
Q	697	CFM	1185	1185 m3/hr		1	
						2	
П	29.5	29.5 mg/hr					

ng/m3	ng/m3				n3/hr		
1.4	(ppb)	Absolute Uncertainty in  AC					
11%	ΔC	Relative Uncertainty of		2	1	(Down & Up)	sampling set
7.0%	Q	Relative Uncertainty of		13.1	12.5	ppb	Delta C
13%	Outer family of F	Relative					
3.9	(mg/hr)	Absolute Uncertainty of E					

RUN 5	4-0ct-11	11							
					Absolute				Ahsolute
Sampling					Uncertainty in	Relative	Relative	Polativo	Absolute
Period 1					ΔC	Uncertainty of	Uncertainty of	Neidtive	Officer faility of E
Average					(22)	ΔC	Q	OliceIrallity of E	(mg/hr)
Upstream	1.09	ppb	0.00218 mg/m3	mg/m3	(000)				(111/8/111)
Average									
Downstream	14.1	ppb	0.0283	mg/m3	1.4	11%	7.0%	13%	4.0
DeltaC		ppb	0.0261 mg/m3	mg/m3					
						Sampling Set	Delta C		
FlowPlate									
Pressure	20.5	Pa				(Down & Up)	ppb		
Q	697	CFM	1185	1185 m3/hr		1	12.7		
						2	13.4		
ш	30.9	30.9 mg/hr							

ω	ω	
1.4	(ppb)	Absolute Uncertainty in  AC
10%	ΔC	Relative Uncertainty of
7.0%	Q	Relative Uncertainty of
13%	Once canney of E	Relative
4.0	(mg/hr)	Absolute Uncertainty of E

		ρ	Pressure	FlowPlate		DeltaC	Dow	Average	Upstream	Average	Period 1	Sampling		RUN 7
			sure	Plate		Č	Downstream	age	ream	age	od 1	oling		7
7		697	20.5				14.4		1.29					4-0ct-11
		CFM	Pa			ppb	ppb		ppb					L1
		1185 m3/hr				0.0262	0.0288		0.00258					
		m3/hr				mg/m3	mg/m3		mg/m3					
							1.4		(000)	(nnh)	ΔC	Uncertainty in	Absolute	
	2	1	(Down & Up)		Sampling Set		11%			ΔC	Uncertainty of	Relative		
	13.6	12.7	ppb		Delta C		7.0%			ρ	Uncertainty of	Relative		
							13%			סווכפו נמווונץ טו ב	I Incertainty of F	Relative		
							4.0		(1118/111)	(mg/hr)	Officer raility of E	Uncertainty of F	^ h;ol;+o	
									•		•			

				28.9 mg/hr	28.9	ш
		m3/hr	1185 m3/hr	CFM		ρ
(Down				Pa	20.5	Pressure
						FlowPlate
Sampl						
		mg/m3	0.0244	ppb	12.2	DeltaC
12	1.4	mg/m3	0.0269	ppb	13.4	Downstream
						Average
	(770)	mg/m3	0.00249 mg/m3	ppb	1.25	Upstream
Δ	(pph)					Average
Uncert	ΔC					Period 1
Rela	Uncertainty in					Sampling
	Absolute					
				11	4-0ct-11	RUN 8

1.4	(ppb)	Absolute Uncertainty in $\Delta C$
12%	ΔC	Relative Uncertainty of
7.0%	Q	Relative Uncertainty of
14%	Officer faility of E	Relative
3.9	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
13.2	11.2	ppb	Delta C	

Absolute Uncertainty in AC Uncertainty of AC Uncertainty of AC  Onnh)  AC  AC  Onnh)  AC  Q  Relative Relative Uncertainty of E
Relative Relative Uncertainty of Uncertainty of Uncertainty of E  11% 7.0% 13%  Sampling Set Delta C  (Down & Up) ppb  1 12.6  2 12.7
Relative Uncertainty of Uncertainty of Uncertainty of Uncertainty of E  11%  7.0%  Sampling Set  Delta C  (Down & Up)  ppb  1 12.6  2 12.7
Relative Uncertainty of E - Q Uncertainty of E - 13%  Delta C ppb 12.6 12.7
Relative Uncertainty of E
Absolute Uncertainty of E (mg/hr)

_		Q 697 CFM 1185 m3/hr	Pressure 20.5 Pa (	FlowPlate		DeltaC 12.8 ppb 0.0255 mg/m3	eam 13.8 ppb 0.027	Average	Upstream 1.10 ppb 0.00219 mg/m3 (PPD)		Period 1 ΔC U		Absolute	RUN 10 4-Oct-11
	2	1	(Down & Up)	2011-2111-2	Sampling Set		1.4 11%		(575)		ΔC Uncertainty of	ertainty in Relative	bsolute	
	13.0	12.5	ppb	0	Delta C		7.0%				Uncertainty of	Relative		
							139			011001	Ilpoprisi	Pols+		

## AIR CLEANER 6

ш		Q	Pressure	FlowPlate		DeltaC	Downstream	Average	Upstream	Average	Period 1	Sampling		Initial Trial 1
0.543		288	3.5				0.835		0.280					29-Sep-11
0.543 mg/hr		CFM	Pa			ppb	ppb		ppb					
		489				0.00111	0.00167		0.00056					
		m3/hr				mg/m3	mg/m3		mg/m3					
							1.4		(סקט)	(nnh)	ΔC	Uncertainty in	Absolute	
	2	1	(Down & Up)		Sampling Set		255%			ΔC	Uncertainty of	Relative		
	0.62	0.49	ppb		Delta C		7.0%			ρ	Uncertainty of	Relative		

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

255%

1.4

			0.366 mg/hr	0.366	Ш
	489 m3/hr	489	288 CFM	288	Q
			Pa	3.5	FlowPlate Pressure
	mg/m3	0.00075	ppb	0.374	DeltaC
1.4	mg/m3	0.00283	ppb	1.41	Downstream
					Average
(20)	mg/m3	0.00208	ppb	1.04	Upstream
(np					Average
ΔC					Period 2
Uncertai					Sampling
Absol					

	1.4	(ppb)	Absolute Uncertainty in $\Delta C$
Sampling Set	378%	ΔC	Relative Uncertainty of
Delta C	7.0%	Q	Relative Uncertainty of
	378%	Officer family of E	Relative
	1.4	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
0.11	0.64	ррь	Delta C	

Initial Irial 2	TT-dac-67								
					Absolute				Absolute
Sampling					Uncertainty in	Relative	Relative	Dola+ico	Absolute
Period 1					ΔC	Uncertainty of	Uncertainty of	neiduve	Officer rallity of E
Average					(pph)	ΔC	Q	Officer rallity of E	(ma/hr)
Upstream	0.985	ppb	0.00197 mg/m3	mg/m3	(טטט)				(111/8/111)
Average									
Downstream	1.00	ppb	0.00199	mg/m3	1.4	13813%	7.0%	13813%	1.4
DeltaC	0.0102	ppb	0.0000205 mg/m3	mg/m3					
						Sampling Set	Delta C		
FlowPlate									
Pressure	3.5	Pa				(Down & Up)	ppb		
ρ	288	CFM	489	m3/hr		1	-0.263		
						2	0.283		
П	0.0100 mg/hr	mø/hr							

ш	FlowPlate Pressure Q	Sampling Period 2 Average Upstream Average Downstream DeltaC
0.147	3.5 288	0.585 0.735 0.150
0.147 mg/hr	Pa CFM	р р р р в в в в в в в в в в в в в в в в
	489	0.00117 0.00147 0.000300
	m3/hr	mg/m3 mg/m3 mg/m3

	1.4	(ppb)	ΔC	Uncertainty in	Absolute
Sampling Set Delta C	943%	ΔC	Uncertainty of	Relative	
Delta C	7.0%	Q	Uncertainty of	Relative	
	943%	Officer faility of E	Relative Relative	J	
	1.4	(mg/hr)	Officer Latinty Of E	Absolute	A 5001+0

2	1	(Down & Up)	Sampling Set	
0.360	-0.060	ррь	Delta C	

			0.636 mg/hr	0.636	m
	489 m3/hr	489	CFM	288	ρ
			Pa	3.5	FlowPlate Pressure
	mg/m3	0.00130	ppb	0.650	DeltaC
	mg/m3	0.00322	ppb	1.61	Downstream
	mg/m3	0.00192 mg/m3	ppb	0.960	Upstream Average
					Average
					Period 1
					Sampling
1				30-Sep-11	Full Test 1

/hr				/m3	/m3 1.4	/m3 (ppb)	Absolute Uncertainty in
2	1	(Down & Up)	Sampling Set		218%	ΔC	Relative Uncertainty of
1.7	-0.4	ppb	Delta C		7.0%	Q	Relative Uncertainty of
				-	218%	Officer faility of E	Relative
					1.4	(mg/hr)	Absolute Uncertainty of

					1
Sampling					
Period 2					
Average					
Upstream	0.469	ppb	0.000938	mg/m3	
Average					
Downstream	1.24	ppb	0.00247	mg/m3	
DeltaC	0.766	ppb	0.00153	mg/m3	
FlowPlate					
Pressure	5.5	Pa			
ρ	361	CFM	614	614 m3/hr	
		:			
	0.940	0.940 mg/hr			

		1.4	(ppb)	Uncertainty in $\Delta C$	A h-col-1+6
0	Sampling Set	185%	ΔC	Relative Uncertainty of	
	Delta C	7.0%	Q	Relative Uncertainty of	
1		185%	Officer family of E	Relative	
		1.7	(mg/hr)	Absolute Uncertainty of E	

2	1	(Down & Up)	Sampling Set	
0.5	1.0	ррь	Delta C	

ш	Q	Flow	DeltaC	Dov	Ave Ove	Sam
		FlowPlate Pressure	taC	Downstream	Average Upstream Average	Sampling Period 3
1.03	475	9.5	0.640	0.695	0.0550	
1.03 mg/hr	475 CFM	Pa	ppb	ppb	ppb	
	806		0.00128	0.00139	0.00011	
	m3/hr		mg/m3	mg/m3	mg/m3	

			1.03 mg/hr	1.03	Е
	806 m3/hr	806	475 CFM	475	ρ
			Pa	9.5	FlowPlate Pressure
	mg/m3	0.00128 mg/m3	ppb	0.640	DeltaC
1.4	mg/m3	0.00139	ppb	0.695	Downstream
					Average
(ppb)	mg/m3	0.00011 mg/m3	ppb	0.0550 ppb	Average Upstream
ΔC					Period 3
Uncertainty in					Sampling
Absolute					

m3/nr	3.7/F:			mg/m3	mg/m3 1.4	mg/m3 (ppb)	ΔC	Uncertainty in
2	1	(Down & Up)	Sampling Set		221%	ΔC	Uncertainty of	Relative
0.0	0.0	ppb	Delta C		7.0%	ρ	Uncertainty of	Relative

0.0

221%

2.3

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

			-0.140 mg/hr	-0.140	E
	1095 m3/hr	1095	CFM	644	ρ
			Pa	17.5	Pressure
					FlowPlate
	mg/m3	-0.000128	ppb	-0.0639	DeltaC
	mg/m3	0.00180	ppb	0.901	Downstream
					Average
	mg/m3	0.00193	ppb	0.965	Upstream
					Average
					Period 4
Unc					Sampling
<b>&gt;</b>					

		1.4	(ppb)	Absolute Uncertainty in AC
Sampling Set		-2214%	ΔC	Relative Uncertainty of
Delta C		7.0%	Q	Relative Uncertainty of
	•	2214%	Officer family of E	Relative
		-3.1	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
0.0	0.0	ррь	Delta C	

Q	FlowPlate Pressure	DeltaC	Downstream	Upstream Average	Average	Period 5	Sampling
714	21.5	-0.365	0.640	1.01			
714 CFM	Pa	ppb	ppb	ppb			
1213		-0.000730	0.00128	0.00201 mg/m3			
m3/hr		mg/m3	mg/m3	mg/m3			

Ш	ρ	FlowPlate Pressure	DeltaC	Downstream	Average	Average Upstream	Period 5	Sampling	
-0.886 mg/hr	714	21.5	-0.365	0.640		1.01			
mg/hr	714 CFM	Pa	ppb	ppb		ppb			
	1213		-0.000730	0.00128		0.00201			
	1213 m3/hr		mg/m3	mg/m3		mg/m3			
				1.4		(ppb)	ΔC	Uncertainty in	Absolute

2	1	(Down & Up)	Sampling Set	
0.0	0.0	ppb	Delta C	

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

-387%

7.0%

388%

-3.4

				1.4	(ppb)	Absolute Uncertainty in AC	
ı	1	(Down & Up)	Sampling Set	658%	ΔC	Relative Uncertainty of	
)	0.0	ppb	Delta C	7.0%	Q	Relative Uncertainty of	
				658%	Relative Uncertainty of E		
				1.4	(mg/hr)	Absolute Uncertainty of E	

2	1	(Down & Up)	Sampling Set	
0.0	0.0	ррь	Delta C	

			0.372 mg/hr	0.372	E
	m3/hr	489	CFM	288	ρ
			Pa	3. <sub>5</sub>	FlowPlate Pressure
	mg/m3	0.000760	ppb	0.380	DeltaC
	mg/m3	0.00235	ppb	1.18	Downstream
					Average
	mg/m3	0.00159	ppb	0.795	Upstream
					Average
					Period 1
					Sampling
]				30-Sep-11	Full Test 2

	ੜੇ			m3	m3	m3	
					1.4	(ppb)	Absolute Uncertainty in AC
2	1	(Down & Up)	Sampling Set		372%	ΔC	Relative Uncertainty of
0.800	-0.040	ppb	Delta C		7.0%	Q	Relative Uncertainty of
			•	372%	Officer family of F	Relative	
					1.4	(mg/hr)	Absolute Uncertainty of E

		-0.12 III/8/III	-0.123	П
		30 /hr	0 1 2 2	П
m3/hr	614	CFM	361	ρ
		Pa	5.5	Pressure
				FlowPlate
mg/m3	-0.000200	ppb	-0.100	DeltaC
mg/m3	0.00102	ppb	0.510	Downstream
				Average
mg/m3	0.00122	ppb	0.610	Upstream
				Average
				Period 2
				Sampling

1.4	(ppb)	Absolute Uncertainty in $\Delta C$
-1414%	ΔC	Relative Uncertainty of
7.0%	Q	Relative Uncertainty of
1414%	Officer faility of E	Relative
-1.7	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
-0.490	0.290	ppb	Delta C	

Е	Q	FlowPlate Pressure	DeltaC	Downstream	Average	Upstream	Average	Period 3	Sampling
		e te		ream		Ħ	10	ω	ē
1.35	475	9.5	0.840	1.44		0.595			
1.35 mg/hr	475 CFM	Pa	ppb	ppb		ppb			
	806		0.00168	0.00287		0.00119			
	m3/hr		mg/m3	mg/m3		mg/m3			

		1.35 mg/hr	1.35	Е
806 m3/hr	806	475 CFM	475	ρ
		Pa	9.5	Pressure
				FlowPlate
mg/m3	0.00168	ppb	0.840	DeltaC
mg/m3	0.00287	ppb	1.44	Downstream
				Average
mg/m3	0.00119	ppb	0.595	Upstream
				Average
				Period 3
				Sampling

	m3/hr			mg/m3	mg/m3	mg/m3			
					1.4	(ppb)	ΔC	Uncertainty in	Absolute
2	1	(Down & Up)	Sampling Set		168%	ΔC	Uncertainty of	Relative	
0.000	0.000	ppb	Delta C		7.0%	Q	Uncertainty of	Relative	

169%

2.3

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

			mg/hr	-0.0438	ш
	1095 m3/hr	1095	644 CFM	644	ρ
			Pa	17.5	Pressure
					FlowPlate
	mg/m3	0.0000400	ppb	-0.0200	DeltaC
	mg/m3	0.00132	ppb	0.660	Downstream
	mg/m3	0.00136	ppb	0.680	Upstream
					Average
					Period 4
C <sub>n</sub>					Sampling

	1.4	(ppb)	Absolute Uncertainty in $\Delta C$
Sampling Set	-7071%	ΔC	Relative Uncertainty of
Delta C	7.0%	Q	Relative Uncertainty of
	7071%	Officer family of E	Relative
	-3.1	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ррь	Delta C	

Е	Q	FlowPlate Pressure	DeltaC	Downstream	Upstream Average	Average	Period 5	Sampling
-0.510	714	21.5	-0.210	0.820	1.03			
-0.510 mg/hr	714 CFM	Pa	ppb	ppb	dqq			
	1213		-0.000420	0.00164	0.00206			
	m3/hr		mg/m3	mg/m3	mg/m3			

			mg/hr	-0.510 mg/hr	т
	1213 m3/hr	1213	21.5 Pa 714 CFM	21.5 714	FlowPlate Pressure Q
	mg/m3	-0.000420	ppb	-0.210	DeltaC
	mg/m3	0.00164	ppb	0.820	Average Downstream
1	mg/m3	0.00206	ppb	1.03	Average Upstream
					Sampling Period 5
_					

	CFM	Pa		ppb	ppb	ppb			
	1213			-0.000420	0.00164	0.00206			
	1213 m3/hr			mg/m3	mg/m3	mg/m3			
					1.4	(ppb)	ΔC	Uncertainty in	Absolute
2	1	(Down & Up)	Sampling Set		-673%	ΔC	Uncertainty of	Relative	

7.0%

673%

-3.4

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ррь	Delta C	

			0.259 mg/hr	0.259	Е
	m3/hr	489	CFM	288	Q
			Pa	3.5	Pressure
					FlowPlate
	mg/m3	0.00053	ppb	0.265	DeltaC
	mg/m3	0.00264	ppb	1.32	Downstream
					Average
	mg/m3	0.00211	ppb	1.06	Upstream
					Average
					Period 6
					Sampling

	į	1 //	(ppb)	Absolute Uncertainty in $\Delta C$
(Down & Up)	53476	%VE3	ΔC	Relative Uncertainty of
ppb 0.000		7 0%	ρ	Relative Uncertainty of
	J3470	53/1%	Officer (a) III ty	Relative
	ļ.	1 1	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ppb	Delta C	

Sampling Period 1       0.870 ppb       0.00174 mg/m3       U         Average Upstream Average Downstream Downstream 1.11 ppb 0.00221 mg/m3       0.00221 mg/m3       FlowPlate Pressure 3.5 Pa         Q       288 CFM       489 m3/hr				0.230 mg/hr	0.230	m
ng 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		m3/hr	489	CFM	288	ρ
ng 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0.870 ppb 0.00174 mg/m3 e tream 1.11 ppb 0.00221 mg/m3 0.235 ppb 0.000470 mg/m3				Pa	3. <sub>5</sub>	FlowPlate Pressure
3 30-Sep-11  g  m 0.870 ppb 0.00174 mg/m3 eam 1.11 ppb 0.00221 mg/m3		mg/m3		ppb		DeltaC
3 30-Sep-11 g m 0.870 ppb 0.00174 mg/m3		mg/m3	0.00221	ppb	1.11	Downstream
3 30-Sep-11 g m 0.870 ppb 0.00174 mg/m3						Average
3 30-Sep-11		mg/m3	0.00174	ppb	0.870	<b>Upstream</b>
3 30-Sep-11						Average
3 30-Sep-11						Period 1
	<u>_</u>					Sampling
					30-Sep-11	Full Test 3

	n3/hr			ng/m3	ng/m3	ng/m3 (	Unce
	ī		T	1	1.4	(ppb)	Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set		602%	ΔC	Relative Uncertainty of
0.060	0.410	ppb	Delta C		7.0%	Q	Relative Uncertainty of
				-	602%	Officer faility of E	Relative
					1.4	(mg/hr)	Absolute Uncertainty of E

			mg/hr	-0.669	П
	m3/hr	614	CFM	361	Q
			Pa	5.5	Pressure
					FlowPlate
	mg/m3	-0.00109	ppb	-0.545	DeltaC
	mg/m3	0.000710	ppb	0.355	Downstream
					Average
I	mg/m3	0.00180	ppb	0.900	Upstream
					Average
					Period 2
					Sampling
Ì					

	1.4	(ppb)	Absolute Uncertainty in $\Delta C$
Sampling Set	-259%	ΔC	Relative Uncertainty of
Delta C	7.0%	Q	Relative Uncertainty of
	260%	Olice tallity of E	Relative
	-1.7	(mg/hr)	Absolute Uncertainty of E
		-259% 7.0% 260% Sampling Set Delta C	ΔC Q OICE Gallity Of L -259% 7.0% 260%

2	1	(Down & Up)	Sampling Set	
-0.020	-1.070	ррь	Delta C	

		0.484 mg/hr	0.484	Е
806 m3/hr	806	475 CFM	475	ρ
		Pa	9.5	FlowPlate Pressure
mg/m3	0.000600	ppb	0.300	DeltaC
mg/m3	0.00177	ppb	0.885	Downstream
				Average
mg/m3	0.00117	ppb	0.585	Upstream
				Average
				Period 3
				Sampling

gnilar						Absolute Uncertainty in	
iod 3					<b>I</b>	ΔC	
rage						(pph)	
tream	0.585	ppb	0.00117	mg/m3	l	(500)	
rage							
vnstream	0.885	ppb	0.00177	mg/m3		1.4	1
taC	0.300	ppb	0.000600	mg/m3		1	1
νPlate						- 1	
ssure	9.5	Pa					1
	475	475 CFM	806	m3/hr			1
							1
	0.484	0.484 mg/hr					

Uncertainty of  $\Delta C$ Relative

Uncertainty of Q Relative

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

471%

7.0%

471%

2.3

-0.295 ppb -0.000590 mg/m3	0.705 ppb 0.00141 mg/m3	1.00 ppb 0.00200 mg/m3			
n3	n3	n3			
	1.4	(ppb)	ΔC	Uncertainty i	Absolute

Average Downstream

Average Upstream

Sampling Period 4

DeltaC

FlowPlate Pressure

17.5

644 CFM Pa

1095 m3/hr

Q

-0.646 mg/hr

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ppb	Delta C	

1.4	(ppb)	ncertainty in $\Delta C$
-479%	ΔC	Relative Uncertainty of
7.0%	Q	Relative Uncertainty of
479%	Officer railing of E	Relative
-3.1	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ррь	Delta C	

Е	_	Ъ	_			>	_	>	70	S
	~	Pressure	FlowPlate	DeltaC	Downstream	Average	<b>Upstream</b>	Average	Period 5	Sampling
		ure	Plate	С	ıstre	lge	eam	lge	d 5	ling
					am					
-0				-	0		0			
-0.388 mg/hr	714	21.5		-0.160	0.655		0.815			
3	714 CFM	Pa		ppb	ppb		ppb			
g/hr	Ë	ъ		Ъ	Ъ		Ъ			
				⊥						
				0.00	0.0		0.0			
	1213			-0.000320	0.00131		0.00163			
	~ 						ъ п			
	1213 m3/hr			mg/m3	mg/m3		mg/m3			
				ಒ	ಹ		ಹ			

			-0.388 mg/hr	-0.388	m
	1213 m3/hr	1213	714 CFM	714	Д
			Pa	21.5	Pressure
					FlowPlate
	mg/m3	-0.000320	ppb	-0.160	DeltaC
	mg/m3	0.00131	ppb	0.655	Downstream
					Average
	mg/m3	0.00163 mg/m3	ppb	0.815	Upstream
					Average
l					Period 5
					Sampling

21.5 Pa 714 CFM	0.655 -0.160	0.815	
Pa CFM	ppb	ppb	
1213 m3/hr	0.00131 -0.000320	0.00163	
m3/hr	mg/m3 mg/m3	mg/m3	
	1.4	(ppb)	Uncertainty in

-884%

7.0%

884%

-3.4

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ррь	Delta C	

			mg/hr	- 0.00489 mg/hr	ш
	m3/hr	489	CFM	288	Q
			Pa	3.5	Pressure
					FlowPlate
	 mg/m3	-0.00001	ppb	-0.005	DeltaC
	 mg/m3	0.00164	ppb	0.820	Downstream
					Average
	 mg/m3	0.00165	ppb	0.825	Upstream
					Average
					Period 6
_					Sampling

		0.0	<b>L</b>	
		ppb	(Down & Up)	
		Delta C	Sampling Set	
-1.4	28284%	7.0%	-28284%	1.4
(mg/hr)	טווכפו נמווונץ טו ר	Ω	ΔC	(ppb)
Absolute Uncertainty of E	Relative	Relative Uncertainty of	Relative Uncertainty of	Absolute Uncertainty in $\Delta C$

2	1	(Down & Up)	Sampling Set	
0.0	0.0	ppb	Delta C	

Full Test 4 - No 30-Sep-11 insert

		0.444 mg/hr	0.444	m
m3/hr	489	CFM	288	ρ
		Pa	3.5	FlowPlate Pressure
mg/m3	0.000908	ppb	0.454	DeltaC
mg/m3	0.00291	ppb	1.46	Downstream
mg/m3	0.00200	ppb	1.00	Average Upstream
				Sampling Period 1

				1.4	(ppb)	Absolute Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set	312%	ΔC	Relative Uncertainty of
1 200	-0.293	ppb	Delta C	7.0%	Q	Relative Uncertainty of
				312%	Officer family of E	Relative
				1.4	(mg/hr)	Absolute Uncertainty of E

		0.117 mg/hr	0.117	ш
614 m3/hr	614	361 CFM	361	Q
		Pa	5.5	Pressure
				FlowPlate
mg/m3	0.000190	ppb	0.0950	DeltaC
mg/m3	0.00179	ppb	0.895	Downstream
				Average
mg/m3	0.00160	ppb	0.800	Upstream
				Average
				Period 2
				Sampling

1.4	(ppb)	Absolute Uncertainty in
1489%	ΔC	Relative Uncertainty of
7.0%	Q	Relative Uncertainty of
1489%	Olicel fallity of F	Relative
1.7	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
-0.050	0.240	ррь	Delta C	

Sampling Period 3  Average Upstream 1.08 ppb Average Downstream 1.23 ppb DeltaC 0.145 ppb FlowPlate Pressure 9.5 Pa
1.08 eam 1.23
1.08 am 1.23
1.08
Sampling Period 3
Sampling

			0.234 mg/hr	0.234	т
	806 m3/hr	806	9.5 Pa 475 CFM	9.5 475	Pressure Q
			1	·	FlowPlate
	mg/m3	0.000290	ppb	0.145	DeltaC
1.4	mg/m3	0.00245	ppb	1.23	Downstream
					Average
(ppb)	mg/m3	0.00216 mg/m3	ppb	1.08	Average Upstream
ΔC					Period 3
Uncertainty in					Sampling
Absolute					

	,			ω	ω	ω
					1.4	(ppb)
2	1	(Down & Up)	Sampling Set		975%	ΔC
0.000	0.000	ppb	Delta C		7.0%	Ų

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

975%

2.3

	m3/hr	1095	Pa CFM	17.5 644	FlowPlate Pressure Q
	mg/m3 mg/m3	0.00191 -0.000870	ppb	0.955	Average Downstream DeltaC
	mg/m3	0.00278	ppb	1.39	Average Upstream
Al Unce					Sampling Period 4

-0.952 mg/hr

1.4	(ppb)	Absolute Uncertainty in $\Delta C$		
-325%	ΔC	Relative Uncertainty of		
7.0%	Q	Relative Uncertainty of		
325%	Relative Uncertainty of E			
-3.1	(mg/hr)	Absolute Uncertainty of E		

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ррь	Delta C	

ш	Q	FlowPlate Pressure	DeltaC	Average Downstream	Average Upstream	Sampling Period 5
0.825	714	21.5	0.340	1.13	0.785	
0.825 mg/hr	CFM	Pa	ppb	ppb	ppb	
	1213		0.000680	0.00225	0.00157	
	m3/hr		mg/m3	mg/m3	mg/m3	

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

416%

7.0%

416%

			0.825 mg/hr	0.825	ш
	1213 m3/hr	1213	714 CFM	714	Q
			Pa	21.5	FlowPlate Pressure
	mg/m3	0.000680	ppb	0.340 ppb	DeltaC
1.4	mg/m3	0.00225	ppb	1.13	Downstream
					Average
(ppb)	mg/m3	0.00157 mg/m3	ppb	0.785 ppb	Average Upstream
ΔC					Period 5
Uncertainty in					Sampling
Absolute					

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ppb	Delta C	

Sampling					_
Period 6					
Average					
Upstream	0.795	ppb	0.00159 mg/m3	mg/m3	
Average					
Downstream	1.25	ppb	0.00249	mg/m3	
DeltaC	0.450	ppb	0.000900	mg/m3	
FlowPlate	ы Л	D			
	200	200 0514	200	100 man/h:	
,		:	į		
E	0.441	0.441 mg/hr			

			1.4	(ppb)	Absolute Uncertainty in AC
۷.	(Down & Up)	Sampling Set	314%	ΔC	Relative Uncertainty of
0	ppb	Delta C	7.0%	۵	Relative Uncertainty of
			314%	Olice raility of F	Relative
			1.4	(mg/hr)	Absolute Uncertainty of E

2	1	(Down & Up)	Sampling Set	
0.000	0.000	ppb	Delta C	

## AIR CLEANER 7

Full Test 1 17-Oct-11

		35.5 mg/hr	35.5	ш
m3/hr	512	301 CFM	301	Q
		Pa	6.3	Flow Meter Pressure
mg/m3	0.0694	ppb	34.7	DeltaC
mg/m3	0.0718	ppb	35.9	Downstream
mg/m3	0.00246	ddd	1.23	Upstream Average
·		-		Average
				1
				Sampling Period

-		_						
		512			0.0694	0.0718 mg/m3	0.00246	
		512 m3/hr			0.0694 mg/m3	mg/m3	mg/m3	
						1.4	(ppb)	Absolute Uncertainty in ΔC
	2	1	(Down & Up)	Sampling Set		4.1%	ΔC	Relative Uncertainty of
	36.2	33.1	ppb	Delta C		7.0%	Uncertainty of Q	
						8.1%	Uncertainty of E	Relative
						2.9	(mg/hr)	Absolute Uncertainty of E

Sampling Period 2					
Average					
Upstream	1.82	ppb	0.00364	mg/m3	
Average					
Downstream	15.7	ppb	0.0314	mg/m3	
DeltaC	13.9	ppb	0.0278	mg/m3	
Flow Meter					
Pressure	26.5	Pa			
ρ	618	618 CFM	1051	m3/hr	
Е	29.2	29.2 mg/hr			

				1.4	(ppb)	Absolute Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set	10%	ΔC	Relative Uncertainty of
14.0	13.8	ppb	Delta C	7.0%	Uncertainty of Q	
				12%	Uncertainty of E	Relative
				3.6	(mg/hr)	Absolute Uncertainty of E

Ш		Ω	Pressure	Flow Meter		DeltaC	Downstream	Average	Upstream	Average	Sampling Period 3	; ;
28.2		797	44			10.4	11.6		1.22			
28.2 mg/hr		797 CFM	Pa			ppb	ppb		ppb			
		1354				0.0208 mg/m3	0.0233 mg/m3		0.00243 mg/m3			
		1354 m3/hr				mg/m3	mg/m3		mg/m3			
									-	_	Uncert	<b>&gt;</b>
							1.4		(ppb)	5	Uncertainty in $\Delta C$	Absolute
	2	1	(Down & Up)		Sampling Set		1.4 14%				$\Delta C$ Relative Uncertainty of	hsolute
	2 10.7	1 10.2	(Down & Up) ppb		Sampling Set Delta C						Relative Uncertainty of	hsolute

2	1	(Down & Up)	Sampling Set	
10.7	10.2	ppb	Delta C	

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

15%

					ĺ
Sampling Period 4					Ç
Average					
Upstream	0.915	ppb	0.00183	mg/m3	
Average					
Downstream	7.87	ppb	0.0157	mg/m3	
DeltaC	6.95	ppb	0.0139	mg/m3	
Flow Meter					
Pressure	91	Pa			
ρ	1,146 CFM	CFM	1947	1947 m3/hr	
E	27.1	27.1 mg/hr			

				1.4	(ppb)	Absolute Uncertainty in ΔC
7	1	(Down & Up)	Sampling Set	20%	ΔC	Relative Uncertainty of
7 3	6.6	ppb	Delta C	7.0%	Uncertainty of Q	Relative
				22%	Uncertainty of E	Relative
				5.8	(mg/hr)	Absolute Uncertainty of E

E		Q	Pressure	Flow Meter		DeltaC	Downstream	Average	Upstream	Average	5	Sampling Period
27.3		1,299 CFM	117 Pa			6.19	7.26		1.08			
27.3 mg/hr		CFM	Pa			ppb	ppb		ppb			
		2208				0.0124	0.0145		0.00215 mg/m3			
		2208 m3/hr				mg/m3	mg/m3		mg/m3			
											G	:
					<u>,                                      </u>	ī	1.4		(500)	(pph)	Uncertainty in $\Delta C$	Absolute
	2	1	(Down		Samplir		239			Δ	Uncerta	Relat

2				
1		m3/hr	2208	Ξ
(Down 8				מ
Samplin				
	1	mg/m3	0.0124	рb
23%	1.4	mg/m3	0.0145	рb
ΔC	(ppb)	mg/m3	0.00215	рb
Uncertaii	Uncertainty in $\Delta C$			

2	1	(Down & Up)	Sampling Set
6.2	6.2	ррь	Delta C

			33.5 mg/hr	33.5	ш
	512 m3/hr	512	301 CFM	301	Q
			Pa	6.3	Flow Meter Pressure
	mg/m3	0.0653 mg/m3	ppb	32.7 ppb	DeltaC
1.4	mg/m3	0.0685	ppb	34.3	Downstream
(70	mg/m3	0.00316	ppb	1.58	Upstream Average
444)					Average
Absolu Uncertaint					Sampling Period 6

	(Da	Sa	1.4	(ppb)	bsolute $\Delta C$
1	(Down & Up)	Sampling Set	4.3%	ΔC	Relative Uncertainty of
31.9	ррь	Delta C	7.0%	Uncertainty of Q	Relative
			8.2%	Uncertainty of E	Relative
			2.8	(mg/hr)	Absolute Uncertainty of E

				l			
					1.4	(ppb)	Absolute Uncertainty in $\Delta C$
J	1	(Down & Up)	Sampling Set		23%	ΔC	Relative Uncertainty of
נ	6.2	ppb	Delta C		7.0%	Uncertainty of Q	Relative
					24%	Uncertainty of E	Relative
					6.5	(mg/hr)	Absolute Uncertainty of E

Full Test 2	17-0ct-11	11							
Sampling Period					Absolute Uncertainty in ΔC	Relative Uncertainty of		Relative	Absolute Uncertainty of E
Average	i				(dad)	ΔC	Uncertainty of Q	Uncertainty of E	(mg/hr)
Upstream	1.47 ppb		0.00294 mg/m3	mg/m3	(000)				(1118/111)
Average									
Downstream	36.4	ppb	0.0729 mg/m3	mg/m3	1.4	4.0%	7.0%	8.1%	2.9
DeltaC	35.0	ppb	0.0700 mg/m3	mg/m3					
						Sampling Set	Delta C		
Flow Meter									
Pressure	6.3	Pa				(Down & Up)	ppb		
Q	301 CFM	CFM	512	512 m3/hr		1	33.7		
						2	36.3		
m	35.8 mg/hr	mg/hr							

ш		ρ	Pressure	Flow Meter	DeltaC	Downstream	Average	Average Upstream	Sampli 2
			re	/leter		tream	je Se	am am	Sampling Period 2
28.2		618	26.5		13.4	14.6		1.17	
28.2 mg/hr		CFM	Pa		ppb	ppb		ppb	
		1051			0.0268	0.0292		0.00233 mg/m3	
		1051 m3/hr			mg/m3	mg/m3		mg/m3	
									⊆
					_	1.4		(ppb)	Absolute Uncertainty in ΔC
	2	1	(Down & L	Sampling	: :	11%		ΔC	Relative Uncertaint

, , , , , , , , , , , , , , , , , , ,
Absolute Uncertainty in AC (ppb)
Relative Uncertainty of AC
Relative Uncertainty of Q
Relative Uncertainty of E
Absolute Uncertainty of E (mg/hr)

т	Flow Meter Pressure Q	DeltaC	Average Downstream	Average Upstream	Sampling Period 3
24.2	44 797	8.96	10.7	1.73	
24.2 mg/hr	44 Pa 797 CFM	ppb	ppb	ppb	
	1354	0.0179	0.0214	0.00345 mg/m3	
	1354 m3/hr	mg/m3	mg/m3	mg/m3	
				l	
			1.4	(ppb)	Absolute Uncertainty in ΔC

2	1	(Down & Up)	Sampling Set
8.6	9.3	ррь	Delta C

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

16%

7.0%

17%

Sampling Period 4					
Average					
Upstream	1.11	ppb	0.00221	mg/m3	
Average					
Downstream	7.75	ppb	0.0155	mg/m3	
DeltaC	6.65	ppb	0.0133	mg/m3	
Flow Meter	91	D			
Pressure	91 Pa	Pa			
Q 1	1,146 CFM	CFM	1947	1947 m3/hr	
m	25.9	25.9 mg/hr			

1.4	(ppb)	Absolute Uncertainty in $\Delta C$
21%	ΔC	Relative Uncertainty of
7.0%	Uncertainty of Q	Relative
22%	Uncertainty of E	Relative
5.8	(mg/hr)	Absolute Uncertainty of E
	21% 7.0% 22%	ΔC Uncertainty of Q Uncertainty of E  21% 7.0% 22%

۰	۷	
'n	د	
'n	Ũ	

E	Q	Flow Meter Pressure	DeltaC	Average Downstream	Average Upstream	Sampling Period 5
26.9	1,299 CFM	117	6.09	7.45	1.37	
26.9 mg/hr	CFM	Pa	ppb	ppb	ppb	
	2208		0.0122	0.0149	0.00273	
	2208 m3/hr		mg/m3	mg/m3	mg/m3	
						ı
				1.,	(pp	Abso Uncertair

ب		_			
,299	117	6.09	7.45	1.37	
1,299 CFM	Pa	ppb	ppb	ppb	
2208		0.0122	0.0149	0.00273 mg/m3	
2208 m3/hr		mg/m3	mg/m3	mg/m3	
			Г	1	1
			1.4	(ppb)	Absolute Uncertainty i
		_	4	b)	Absolute Uncertainty in $\Delta C$

7.0%

24%

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

2	1	(Down & Up)	Sampling Set	
5.7	6.5	ppb	Delta C	

					_
Sampling Period 6					
Average					
Upstream	0.930	ppb	0.00186	mg/m3	
Average					
Downstream	34.6	ppb	0.0692	mg/m3	
DeltaC	33.7 ppb	ppb	0.0673	mg/m3	
Flow Meter					
Pressure	6.3	Pa			
ρ	301	CFM	512	m3/hr	
m	34.5	34.5 mg/hr			
		=			

				1.4	(ppb)	Absolute Uncertainty in $\Delta C$
2	1	(Down & Up)	Sampling Set	4.2%	ΔC	Relative Uncertainty of
33.6	33.7	ppb	Delta C	7.0%	Uncertainty of Q	Relative
				8.2%	Uncertainty of E	Relative
				2.8	(mg/hr)	Absolute Uncertainty of E

Full Test 3	17-0ct-11	11							
Sampling Period 1					Absolute Uncertainty in ΔC	Relative Uncertainty of	Relative	Relative	Absolute Uncertainty of E
Average					(554)	ΔC	Uncertainty of Q	Uncertainty of E	(ma/hr)
Upstream	1.34	ppb	0.00267 mg/m3	mg/m3	(000)				(1118/111)
Average									
Downstream	34.7	ppb	0.0695	mg/m3	1.4	4.2%	7.0%	8.2%	2.8
DeltaC	33.4	ppb	0.0668	mg/m3					
						Sampling Set	Delta C		
Flow Meter									
Pressure	6.3	Pa				(Down & Up)	ppb		
Q	301 CFM	CFM	512	512 m3/hr		1	32.6		
						2	34.2		
E	34.2	34.2 mg/hr							

Е		. P					<b>&gt;</b>	_	<b>&gt;</b>	S
	~	Pressure	Flow Meter		DeltaC	Downstream	Average	Upstream	Average	Sampling Period 2
29.0	618	26.5			13.8	14.9		1.08		
29.0 mg/hr	618 CFM	Pa			ppb	ppb		ppb		
	1051	) !			0.0276	0.0298		0.00215		
	1051 m3/hr	)			mg/m3	mg/m3		mg/m3		
										ı
					1	1.4		(575)	(pph)	Absolute Uncertainty in ΔC
		(Dov		Sam						Re Unce

	1.4	(ppb)	Absolute Uncertainty in ΔC		
Sampling Set	10%	ΔC	Relative Uncertainty of		
Delta C	7.0%	Relative Uncertainty of Q			
	12%	Uncertainty of E	Relative		
	3.6	(mg/hr)	Absolute Uncertainty of E		

2	1	(Down & Up)	Sampling Set
13.7	13.9	ррь	Delta C

П		Q	Pressure	Flow Meter		DeltaC	Downstream	Average	Upstream	Average	ω	Sampling Period	
27.1		797	44			10.0	11.2		1.15				
27.1 mg/hr		797 CFM	Pa			ppb	ppb		ppb				
		1354				0.0200	0.0223		0.00229 mg/m3				
		1354 m3/hr				0.0200 mg/m3	mg/m3		mg/m3				
1													
							1.4		(666)	(nnh)	Uncertainty in $\Delta C$	Absolute	
	2	1	(Down & Up)		Sampling Set		14%			ΔC	Uncertainty of	Relative	

2	1	(Down & Up)	Sampling Set
10.4	9.6	ppb	Delta C

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

7.0%

16%

4.3

m	ρ	Flow Meter Pressure	DeltaC	Average Downstream	Average Upstream	Sampling Period 4
25.5	1,146 CFM	91	6.55	7.50	0.95	
mg/hr	CFM	Pa	ppb	ppb	ppb	
	1947		0.0131	0.0150	0.00190	
	1947 m3/hr		mg/m3	mg/m3	mg/m3	
		•				

				1.4	(ppb)	Absolute Uncertainty in ΔC
)	1	(Down & Up)	Sampling Set	22%	ΔC	Relative Uncertainty of
1	7.2	ppb	Delta C	7.0%	Uncertainty of Q	Relative
				23%	Uncertainty of E	Relative

Absolute Uncertainty of E

(mg/hr)

m	Q	Flow Meter Pressure	DeltaC	Average Downstream	Average Upstream	Sampling Period 5
23.3	1,299	117	5.27	6.47	1.20	
23.3 mg/hr	CFM	Pa	ppb	ppb	ppb	
	2208		0.0105	0.0129	0.00239	
	m3/hr		mg/m3	mg/m3	mg/m3	
					1	
				1.4	(ppb)	Absolute Uncertainty in ΔC

2	1	(Down & Up)	Sampling Set
4.6	5.9	ppb	Delta C

Relative Uncertainty of  $\Delta C$ 

Relative Uncertainty of Q

Relative Uncertainty of E

Absolute Uncertainty of E

(mg/hr)

27%

7.0%

28%

Sampling Period			>
6			Uncer
Average			
Upstream 1.33 ppb	0.00265	mg/m3	
Average			
Downstream 33.7 ppb	b 0.0675	mg/m3	
DeltaC 32.4 ppb	0.0648	mg/m3	
Flow Meter			
Pressure 6.3 Pa			
Q 301 CFM	512	m3/hr	
E 33.2 mg/hr	;/hr		

1 31.4	(Down & Up) ppb	Sampling Set Delta C	1.4 4.4% 7.0% 8.2%	Uncertainty of Q Uncertainty of E	Relative
			2.7	(mg/hr)	Absolute Uncertainty of

$\vdash$	4
1	J
C	J

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This thesis was typed by the author.

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