QUALITY ASSURANCE FINAL REPORT

FOR THE

SOUTHERN OXIDANT STUDY

ATLANTA SUPERSITE FIELD EXPERIMENT

August 3 – September 1, 1999

Final

Revision 1.2
August 3, 2001

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Executive Summary

The "Atlanta Supersite Field Experiment[1]" was conducted between the dates of August 3 – September 1, 1999 in Atlanta, Georgia. This research project was conceived and implemented by a number of university, private contractor and U.S. Environmental Protection Agency (EPA) researchers. The Atlanta Supersite was the first of its kind; the first time that fine particle research instruments had been brought together into one location with well established fine particle Federal Reference Methods (FRMs), and instruments that analyze for photochemical precursors and oxidants. There were a several instruments that were operated for the first time in a field setting. This report will attempt to characterize the uncertainty of the data collected for future use.

The following statements can be made about the quality of the data set:

- The accuracy audit data shows that the audited instruments were accurate when compared to audit standards that were administered by the EPA - Region 4 laboratory.
- The data completeness (study average was 87%) goal of 75% was exceeded. However, the data completeness for the surface meteorological parameters was 72.6%, which was less than the data completeness goal.
- Only a small portion of the researchers submitted precision data for the study. The results are detailed in Table 6. Many of the instruments that were operated at the Supersite were being tested in a field situation for the first time; therefore precision for these was unknown. The author believes that the relative bias and comparability data are better estimates of the uncertainty of the data. The comparability data estimates whether the data are normally distributed about the mean with a confidence of 95%. In most cases, the data are normally distributed.
- A major portion of the researchers did submit minimum detection limits data.
- The relative bias data illustrates that the majority of the elemental parameters are within the target goal of +/- 25% with the exception of the Federal Reference Methods and the R& P Speciation Sampler.
- The relative bias results for the Organic Carbon (OC), Elemental Carbon (EC) and Nitrates illustrate that the majority of samplers are outside of the +/-25% target goal. The relative bias data shows that the ammonium and sulfates analyses are within the target goal.
- The comparability and relative bias data show a very strong negative relative bias for the filter based EC data. This is trend is the opposite with the OC data. The filter-based systems OC data show a strong positive relative bias.
- The relative bias results for the gaseous formaldehyde, Nitrous ion (HONO) and oxalate illustrate that these data are outside of the target goal of +/- 25%.
- Ozone, sulfur dioxide, nitric oxide, reactive NOy relative bias data shows that these parameters are within the relative bias target of +/- 25%.
- The monitoring location was in an acceptable location in term of representativeness and exposure. The monitoring site was located in an industrial sector of the city of Atlanta, Georgia. Representative scale was determined to be urban for ozone and neighborhood scale for fine particles.

2. Project Description and Data Analysis Overview

2.1 Overview

The "Supersite" program was first conceived as a set of special studies extending beyond National regulatory network for particulate matter (PM) to elucidate source-receptor relationships and atmospheric processes in support of State Implementation Plans[2]. The program would establish monitoring centers in 4-7 airsheds representing a spectrum of PM problems across the country. Spurred by the recommendations of the National Academy of Sciences committee on PM research, EPA staff further developed the mission of the Supersite program to address priority health and exposure related research needs identified by the committee through a coordinated monitoring/coordinated science planning effort. An important part of the effort was instituting a dialogue among health and atmospheric science disciplines and research and regulatory groups, such as took place at the July, 1998 workshop on PM Measurements held in Chapel Hill, NorthCarolina[3].

In recognition of the growing concern over the deleterious health effects of atmospheric particulate matter and the commonalties and synergism that exist between photochemical oxidants and Fine Particulate Matter, less than or equal to 2.5 micron ($PM_{2.5}$), the Southern Oxidant Study (SOS) began making a transition in late 1997 from a research and assessment program concerned primarily with ozone and other oxidants in rural and urban areas of the South, to a research and assessment program concerned with ozone, other oxidants and Fine Particle Matter. This transition was solidified in the spring of 1998 with EPA funding of SOS' Southern Center for the Integrated Study of Secondary Pollutants (SCISSAP); SCISSAP's initial 3-year focus is the integrated study of ground-level ozone and PM in the South. Shortly thereafter, SOS began planning for a major field experiment during the summer of 1999 to address key scientific issues related to the interactions and couplings between the formation of photochemical oxidants and $PM_{2.5}$. EPA decided that Atlanta would be the center for one of two initial Supersite Programs (the other one being located in Fresno, California). In December 1998, the SOS Science Team was contacted by officials from the EPA and requested that it develop a plan for the Atlanta Supersite that could be implemented during the Fiscal Year 99-00.

In August 1999 many emerging and/or state-of-the-science measurement methods for fine, airborne particles were deployed at a site in Atlanta, Ga., 829 Jefferson Street, from the period of August 3, through September 1, 1999. These measurements were made as part of the first of the regional Supersite projects being established. The Atlanta Supersite was coordinated by the SOS in collaboration with the numerous universities and agencies that comprise SOS as well as a number of other programs and agencies including the Southeastern Aerosol Research Characterization/ Aerosol Research Inhalation Epidemiology Study (SEARCH/ARIES) and SCISSAP.

2.2 Objectives

Goals of the Atlanta Supersite study were three: first, to provide a platform for testing and contrasting some of the newer particle measurement techniques, second, to provide data to advance our scientific understanding of atmospheric processes regarding atmospheric particles, and lastly to evaluate hypotheses concerning health and air pollution concentrations. The objective of this report is to characterize the uncertainty of the data collected and then submitted to the GIT Supersite database.

2.3 Project Organization

SOS did oversight of the Atlanta Supersite, under a Cooperative Agreement between the National Exposure Research Laboratory At Research Triangle Park (NERL) of the U.S. EPA and the Georgia Institute of Technology.

Administration of the project was directed by the SOS Atlanta Supersite Project Director (Bill Chameides), along with Project Officers in charge of the Jefferson Street Site (Eric Edgerton), the sampling protocol (Susanne Hering), quality assurance (Dennis Mikel), data management (Jim St. John), and off- site laboratory facilities (Karsten Baumann).

This report only describes the results of the Quality Assurance (QA) activities and the subsequent analysis of these data for assessment of quality that occurred during the Supersite Study.

2.4 Data Collection and Analysis

In January 2001, the data base manager notified all persons who had been involved with the Atlanta Supersite that the final data had been submitted to the database. The Quality Assurance Manager (QAM) downloaded the data from the Georgia Tech Atlanta Supersite database Internet site (http://www-wlc.eas.gatech.edu/supersite/) on January 24, 2001**. Only the data that was in the Georgia Tech database before or on January 24, 2001 was analyzed in this report. Therefore, the quality of any data submitted after that date is not known.** The Atlanta Supersite Internet site has a File Transfer Protocol (ftp) section that is password protected. The data base manager had to be contacted for the proper password to open the zipped files. After the files were downloaded and unzipped, the data were uploaded to Microsoft Excel™ spreadsheets.

One-minute increment data were downloaded from the ftp site. The QAM averaged the 1-minute data to hourly data. This hourly data was then averaged into 24-hour averages. The hourly data and integrated 24-hour (daily) data were used in different statistical tests that are described in Section 3 and 4.

3.0 Data Quality Objectives

3.1 Measurement Quality Objectives Indicators

The Measurement Quality Objective (MQO) indicators for the Atlanta Supersite Experiment were defined in the Quality Assurance Project Plan[4]. The MQO indicators used in this report are listed and defined below.

- **Accuracy;**
- **Precision;**
- **Minimum Detection Limits (MDLs);**
- **Relative Bias;**
- **Comparability;**
- **Completeness;**
- **Representativeness;**

Attempts were made to quantify the error of the data generated. This was accomplished by performing performance audits on gas phase instruments, accuracy flow checks on filter based and semi-continuous particle instruments, Technical System Audits (TSAs) and statistical tests. The data collected by the QA Team were used to document accuracy. Data generated by the researchers were used to determine the MDLs and precision (where available and submitted). The relative bias, comparability and completeness data are generated using standard statistical tests. Each of the MQOs is discussed below.

3*.2 Accuracy*

The accuracy of the continuous gas monitors was determined from performance audits of the individual gas phase instruments. The performance audit challenged the instrument with standards, from an independent, NIST traceable source from U.S. EPA Region 4 laboratory. A minimum of three data points, including zero was used to conduct the performance audit. The following equation was be used to estimate the percent error:

$$\% \text{ Error} = [(Qr-Qa)/Qa] \times 100 \qquad \textbf{Equation 1}$$

Qr is the response of the instrument to the audit gas and Qa is the NIST-certified concentration calculated by the auditor.

For gravimetric and speciated fine particle samplers, the performance audit was an accuracy flow check. The estimation of accuracy for this method is:

$$\% \text{ Difference} = [(Qm-Qa)/Qa] \times 100 \qquad \textbf{Equation 2}$$

where: Qa is the flow rate measured using a NIST traceable flow device, Qm is the flow rate measured by investigator.

3.3 Precision

Precision of the continuous gas monitors was determined from replicate analyses of calibration standards; instrument span check standard and/or precision check standard records. Precision was determined for data time periods between calibrations or other major maintenance periods that may affect the operation performance of the instrument. Comparing the percent difference between similar methods using the following equation performed precision for filter-based instruments.

$$Precision = \{x\}_{avg.} +/- 1.96*s/ \mathbf{p}2 \qquad \textbf{Equation 3}$$

Where: $\{x\}_{avg}$ is the average of the span or precision measurements, s is the standard deviation of the replicate span check standard or precision check standard data. The upper and lower 95% probability limits are set using this statistical test.

3.4 Method Detection Limits

The Method Detection Limit (MDL) is defined as a statistically determined value above which the reported concentration can be differentiated, at a specific probability, from a zero concentration. Analytical procedures and sampling equipment impose specific constraints on the determination of detection limits.

For the gaseous parameters, MDLs were determined by challenging the instruments with purified zero air, however, for filter based instruments, the MDLs were determined by blanks. Field blanks are defined as a filter that travels with the filters that will be utilized in sample collection. The filter were treated in the same manner as any other filter with the exception of begin loaded into the filter mechanism. It is a good field practice to take the field blank up to the sampler and leave it inside the instrument housing with the filter cover on. When the sample filters were removed after the sample run, the field blank was also removed and processed in the same manner as all filters. The filter traveled in the same carry case as all filters. Storage and handling were identical to all processed filters. Laboratory (lab) blanks are filters that are pre-weighed and processed in the same manner as all filters.

The following section illustrates how MDLs were quantified for filter and non-filter methods.

3.4.1 Continuous Measurements

The configuration of the continuous gas monitors (in particular the ability to introduce standards at the sample inlet) allows for the determination of the MDL for each continuous analyte. The MDL includes all sampling and analytical procedures and therefore represents a detection limit that can be applied to ambient concentrations. The MDL concentration is determined in zero air and therefore will not address matrix interferences. The MDL for each continuous gas monitor was determined through statistical evaluation of the zero check standards. The following equation;

$$MDL = t_{(n-1,1-a = 0.99)} * s \qquad \textbf{Equation 4}$$

where s is the standard deviation of the replicate zero analyses, t is the students t value appropriate to a 99% confidence level and a standard deviation estimate with n-1 degrees of freedom, will be used to determine the method detection limit [4].

3.4.2 Discrete Measurements

The laboratory analytical protocol requires that samples be collected at a location away from analysis. Standards for the determination of detection limits for these laboratory instruments are prepared in the laboratory and therefore are not subjected to the same procedures and equipment as the ambient samples. This detection limit is referred to as the instrument detection limit (IDL). The IDL is indicative of the ability of the instrument to differentiate, at a specific probability, between zero and at a specific concentration. The IDL standard does not experience the same handling procedures since collection on filter medium and denuders is not involved. Therefore the IDL does not provide information relating to the detection limit in ambient conditions.

3.5 Relative Bias

Due to the unique research nature of many of the measurements conducted by the Supersite, the situation may arise where primary standards were unavailable to determine relative bias. In addition, relative bias of the discrete methodologies can only be determined for the analytical instruments, and does include effects introduced by sample collection and transport. In these instances the determination of relative bias is the correct action. Relative bias was calculated using the following equation:

$$\% \text{ Relative Bias} = (M1_i - M2i)/M1i \times 100 \qquad \textbf{Equation 5}$$

Where: the M1i is the average of all of the methodologies measuring a given species in a similar or dissimilar manner and M2i is the ith value of the individual measurement system.

3.6 Comparability

A major goal of the quality assurance related data analysis was to assess measurement equivalency. For each of these data, a "standard" or control value does not exist. Therefore, each of the parameters were intercompared against other methods in the following manner:

1. The data for each parameter was averaged across the study period, this is known as the relative reference or the mean.
2. The study mean and the standard deviations were calculated for the study period (i.e., a portion of the study period, the 25-day period from August 3-28, 1999).
3. The 95% Confidence Limits (upper and lower confidence limits, UCL and LCL) were derived by multiplying 1.96 to the standard deviation.
4. The individual study parameter means were plotted and compared against the UCL and LCL.

Within each of the measurement categories, comparing individual data averages with the UCL and LCL assessed consistency between various instruments. If the data does fall within the Confidence Limits, then it can be assumed that the data is normally distributed about the mean.

3.7 Completeness

Completeness was determined from the data generated using the following equation:

$$\% \text{ Completeness} = (D_x - D_c)/D_c \times 100 \quad \textbf{Equation 6}$$

where D_x is the number of samples for which valid results are reported and D_c is the number of samples that are scheduled to be collected and analyzed during the study period. This is based on hourly data submitted to the database.

3.8 Representativeness

Generally, representativeness expresses how closely a sample reflects the characteristics of the surrounding environment. The Quality Assurance Project Plan discussed this in great detail. Please see discussion in Section 4.7.

4.0 Data Analysis Results

The results for this QAFR will be detailed as structured in Section 3 of this report.

4.1 Accuracy

During the weeks of August 3, and August 10, 1999, the EPA Audit Team performed TSAs and Performance Audits (PA) on many of the instruments at the Atlanta Supersite. However, due to time constraints, not all instruments received a PA. All monitoring systems received a TSA. Below are the results of the PAs that were performed. Please note that the gaseous parameters (Ozone and NOy) instruments were challenged with NIST traceable gases. The integrated filter and continuous particle instruments were challenged using a flow audit at the inlet. All instruments that were audited passed the audit criteria of +/- 15%.

Table 1. NOy Performance Audit

Researcher	Instrument Model	Serial No.	Indicated Conc. (ppb)	Measured Conc. (ppb)	Percent Error
ARA	Teco 42 CY	NOy Hi	174	167	4.2%
ARA	Teco 42 CY	NOy Hi	52	51	2.0%
ARA	Teco 42 CY	NOy Hi	32	31	3.2%

Table 2. Converter Check

Researcher	Instrument Model	Serial No.	Ozone Setting	NOy Original Conc. (ppb)	NOy Remaining
ARA	Teco 42 CY	NOy Hi	Off	190.1	-
ARA	Teco 42 CY	NOy Hi	300	190.1	188.3
ARA	Teco 42 CY	NOy Hi	250	190.1	188.3
ARA	Teco 42 CY	NOy Hi	200	190.1	187.7

Table 3. Ozone Performance Audit

Researcher	Instrument Model	Serial No.	Indicated Conc. (ppb)	Measured Conc. (ppb)	Percent Error
ARA	Teco 49	00017	351	352	-0.9%
ARA	Teco 49	00017	145	147	-2.7%
ARA	Teco 49	00017	76	77	-3.0%

Table 4. Integrated Filter Instruments Audits

Researcher	Instrument Model	Serial No.	Indicated Flow (l/m)	Measured Flow (l/m)	Percent Difference
EPA, NERL	R+P 2000	999675, Teflon filter	16.6	16.46	0.85%
EPA, NERL	R+P 2000	999674, Quartz filter	16.6	16.36	2.1%
EPA, NERL	Andersen FRM	999788	16.67	16.43	1.46%
EPA, NERL	BGI	A02392	16.7	16.96	-1.21%
EPA, NERL	R+P 2025	Channel 1	10.0	9.94	-0.60%
EPA, NERL	R+P 2025	Channel 2	10.0	9.94	-0.60%
EPA, NERL	R+P 2025	Channel 31	10.0	9.94	-0.60%

EPA, NERL	R+P Dichot	Fine	15.02	15.07	-0.33%
EPA, NERL	R+P Dichot	Coarse	1.68	1.75	-4.00%
EPA, NERL	VAPS	Channel 1	16.31.	15.55	-4.88%
EPA, NERL	VAPS	Channel 2	2.97	3.06	-2.94%
EPA, NERL	VAPS	Channel 3	15.83	15.37	-2.91%
EPA, NERL	URG 400	Channel 1	16.66	16.49	1.03%
EPA, NERL	URG 400	Channel 2	16.66	16.31	2.15%
EPA, NERL	Andersen	Channel 1	7.29	7.27	0.28%
EPA, NERL	Andersen	Channel 2	16.86	16.85	0.06%
EPA, NERL	Andersen	Channel 3	7.21	7.27	-0.83%
EPA, NERL	Met One SASS	Channel 1	7.1	6.95	2.16%
EPA, NERL	Met One SASS	Channel 2	6.9	6.92	-0.29%
EPA, NERL	Met One SASS	Channel 3	6.5	6.49	0.15%
EPA, NERL	Met One SASS	Channel 4	6.8	6.77	0.44%

Table 5. Continuous Particle Instruments Audits

Researcher	Instrument Model	Serial No.	Indicated Flow (l/m)	Measured Flow (l/m)	Percent Difference
Unv. Of Riverside	Top Mass Spec	140AB2159097 C6- Cyclone	16.62	16.49	0.79%
Ga. Tech	CNC/IC	Cyclone	8.87	8.86	-0.1%
Ga. Tech	PCM #1	Cyclone 1	13.2	13.9	-5.01%
Ga. Tech	PCM #1	Cyclone 2	16.7	16.5	1.21%
Ga. Tech	PCM #1	Channel 4	16.7	16.0	3.75%
Ga. Tech	PCM #2	Cyclone 1	16.7	16.79	-0.54%
Ga. Tech	PCM #2	Cyclone 2	16.7	16.79	-0.54%
Ga. Tech	PCM #2	Cyclone 3	16.7	16.85	-0.89%
BYU	PC BOSS A	Side Flow	19.1	19.02	0.42%
BYU	PC BOSS A	Quartz filter	15.2	15.11	0.60%
BYU	PC BOSS A	Teflon/Nylon	14.8	14.66	0.95%
BYU	PC BOSS A	Side Flow	19.0	18.64	1.93%
BYU	PC BOSS A	Quartz	15.5	15.14	2.38%
BYU	PC BOSS A	Teflon/Nylon	15.1	14.95	1.00%
Aerodyne	Mass Spec	Cyclone	10.73	10.73	0.00%

4.2 Precision

The following data were taken from the meta-data files that were submitted to the Georgia Tech Supersite database. There are no criteria for reported precision.

Table 6. Reported Precision

Investigator	**Instrument**	**Precision**
B. Turpin	In-situ Carbon	2.7%
G. Allen	Aethelometer	5%
G. Allen	CAMM	9%
G. Allen	Continuous Nitrate	9%
H. Maring	MOUDI (mass)	2%
H. Maring	MOUDI (OC)	0.15 ug/m3
H Maring	MOUDI (EC)	0.05 ug/m3
R. Weber	Continuous IC – Cl	10%
R. Weber	Continuous IC – NO3	10%
R. Weber	Continuous IC – SO4	10%

R. Weber	Continuous IC – NH4	10%
R. Weber	Continuous IC - Na	10%
R. Weber	Continuous IC – K	10%
R. Weber	Continuous IC – Ca	10%

4.3 Method Detection Limits

The following data were taken from the meta-data that were submitted to the Georgia Tech Supersite database. There are no acceptance criteria for MDLs.

Table 7. Reported MDLs

Investigator	**Instrument**	**MDL**
B. Turpin	In-situ Carbon	0.33 ug C
D. Worsnop	AMS	NA
G. Allen	Aethelometer	<0.1 ug/m3
G. Allen	CAMM	7 ug/m3
G. Allen	Continuous Nitrate	0.2 ug/m3
Hal Maring	MOUDI (OC)	0.3 ug/m3
Hall Maring	MOUDI (EC)	0.1 ug/m3
K. Prather	TOF Spectrophotometer	NA
P. Jongejan	Continuous IC – Cl	0.025 ug/m3
P. Jongejan	Continuous IC – NO2	0.025 ug/m3
P. Jongejan	Continuous IC – NO3	0.030 ug/m3
P. Jongejan	Continuous IC – SO4	0.030 ug/m3
P. Jongejan	Continuous IC – NH3	0.015 ppb V
R. Weber	Continuous IC	0.1 ug/m3
R. Weber	Continuous IC – Cl	0.1 ug/m3
R. Weber	Continuous IC – NO3	0.1 ug/m3
R. Weber	Continuous IC – SO4	0.1 ug/m3
R. Weber	Continuous IC – NH4	0.1 ug/m3
R. Weber	Continuous IC – Na	0.1 ug/m3
R. Weber	Continuous IC – K	0.1 ug/m3
R. Weber	Continuous IC – Ca	0.1 ug/m3
R. Zika	GC/MS VOCs	0.001 ppb C
S Hering	Semi-Continuous NO3	0.01 ug/m3
S Hering	Semi-Continuous SO4	0.3 ug/m3
S Hering	Semi-Continuous Carbon	0.1 ug/m3
P. Solomon	Andersen – Sulfur	3.48 ng/m3
P. Solomon	Andersen – Silicon	8.48 ng/m3
P. Solomon	Andersen – Calcium	1.47 ng/m3
P. Solomon	Andersen – Potassium	2.11 ng/m3
P. Solomon	Andersen – Mangenese	0.54 ng/m3
P. Solomon	Andersen - Iron	1.47 ng/m3
P. Solomon	Andersen – Copper	0.69 ng/m3
P. Solomon	Andersen – Zinc	0.54 ng/m3
P. Solomon	Andersen – Lead	1.18 ng/m3
P. Solomon	Andersen – Arsenic	0.69 ng/m3
P. Solomon	Andersen – NO3 (Teflon)	0.015 ug/m3
P. Solomon	Andersen – NO3 (Quartz)	NA
P. Solomon	Andersen – NO3 Nylon	0.033 ug/m3
P. Solomon	Andersen – SO4 (Teflon)	0.01 ug/m3
P. Solomon	Andersen – SO4 (Quartz)	NA

P. Solomon	Andersen – NH4 (Teflon)	0.01 ug/m3
P. Solomon	Andersen - NH4 (Quartz)	NA
P. Solomon	Andersen – OC	0.134 ug/m3
P. Solomon	Andersen - EC	0.134 ug/m/3
P. Solomon	FRM – Sulfur	3.48 ng/m3
P. Solomon	FRM – Silicon	8.48 ng/m3
P. Solomon	FRM – Calcium	1.47 ng/m3
P. Solomon	FRM – Potassium	2.11 ng/m3
P. Solomon	FRM – Mangenese	0.54 ng/m3
P. Solomon	FRM - Iron	1.47 ng/m3
P. Solomon	FRM – Copper	0.69 ng/m3
P. Solomon	FRM – Zinc	0.54 ng/m3
P. Solomon	FRM – Lead	1.18 ng/m3
P. Solomon	FRM – Arsenic	0.69 ng/m3
P. Solomon	FRM – NO3 (Teflon)	NA
P. Solomon	FRM – NO3 (Quartz)	0.018 ug/m3
P. Solomon	FRM – NO3 Nylon	NA
P. Solomon	FRM – SO4 (Teflon)	NA
P. Solomon	FRM – SO4 (Quartz)	0.013 ug/m3
P. Solomon	FRM – NH4 (Teflon)	NA
P. Solomon	FRM - NH4 (Quartz)	0.013 ug/m3
P. Solomon	FRM – OC	0.059 ug/m3
P. Solomon	FRM – EC	0.059 ug/m3
P. Solomon	Met One – Sulfur	8.65 ng/m3
P. Solomon	Met One – Silicon	21.09 ng/m3
P. Solomon	Met One – Calcium	3.66 ng/m3
P. Solomon	Met One – Potassium	5.24 ng/m3
P. Solomon	Met One – Mangenese	1.34 ng/m3
P. Solomon	Met One - Iron	3.66 ng/m3
P. Solomon	Met One – Copper	1.71 ng/m3
P. Solomon	Met One – Zinc	1.34 ng/m3
P. Solomon	Met One – Lead	2.93 ng/m3
P. Solomon	Met One – Arsenic	1.71 ng/m3
P. Solomon	Met One – NO3 (Teflon)	0.036 ug/m3
P. Solomon	Met One – NO3 (Quartz)	NA
P. Solomon	Met One – NO3 Nylon	0.036 ug/m3
P. Solomon	Met One – SO4 (Teflon)	0.026 ug/m3
P. Solomon	Met One – SO4 (Quartz)	NA
P. Solomon	Met One – NH4 (Teflon)	0.026 ug/m3
P. Solomon	Met One – NH4 (Quartz)	NA
P. Solomon	Met One – OC	0.015 ug/m3
P. Solomon	Met One – EC	0.015 ug/m3
P. Solomon	R+P Dichot – Sulfur	3.87 ng/m3
P. Solomon	R+P Dichot – Silicon	9.42 ng/m3
P. Solomon	R+P Dichot – Calcium	1.63 ng/m3
P. Solomon	R+P Dichot – Potassium	2.34 ng/m3
P. Solomon	R+P Dichot – Mangenese	0.6 ng/m3
P. Solomon	R+P Dichot - Iron	1.63 ng/m3
P. Solomon	R+P Dichot – Copper	0.76 ng/m3
P. Solomon	R+P Dichot – Zinc	0.6 ng/m3
P. Solomon	R+P Dichot – Lead	1.31 ng/m3
P. Solomon	R+P Dichot – Arsenic	0.76 ng/m3

P. Solomon	R+P Dichot – NO3 (Teflon)	NA
P. Solomon	R+P Dichot – NO3 (Quartz)	NA
P. Solomon	R+P Dichot – NO3 Nylon	NA
P. Solomon	R+P Dichot – SO4 (Teflon)	NA
P. Solomon	R+P Dichot – SO4 (Quartz)	NA
P. Solomon	R+P Dichot – NH4 (Teflon)	NA
P. Solomon	R+P Dichot - NH4 (Quartz)	NA
P. Solomon	R+ P Dichot – OC	NA
P. Solomon	R + P Dichot – EC	NA
P. Solomon	R+P Spec. – Sulfur	5.8 ng/m3
P. Solomon	R+P Spec. – Silicon	14.13 ng/m3
P. Solomon	R+P Spec. – Calcium	2.45 ng/m3
P. Solomon	R+P Spec. – Potassium	3.51 ng/m3
P. Solomon	R+P Spec. – Mangenese	0.9 ng/m3
P. Solomon	R+P Spec. - Iron	2.45 ng/m3
P. Solomon	R+P Spec. – Copper	1.14 ng/m3
P. Solomon	R+P Spec. – Zinc	0.9 ng/m3
P. Solomon	R+P Spec. – Lead	1.96 ng/m3
P. Solomon	R+P Spec. – Arsenic	1.14 ng/m3
P. Solomon	R+P Spec. – NO3 (Teflon)	NA
P. Solomon	R+P Spec. – NO3 (Quartz)	0.29 ug/m3
P. Solomon	R+P Spec. – NO3 Nylon	0.24 ug/m3
P. Solomon	R+P Spec. – SO4 (Teflon)	NA
P. Solomon	R+P Spec. – SO4 (Quartz)	0.021 ug/m3
P. Solomon	R+P Spec. – NH4 (Teflon)	NA
P. Solomon	R+P Spec. - NH4 (Quartz)	0.021 ug/m3
P. Solomon	R+P Spec. – OC	0.098 ug/m3
P. Solomon	R+P Spec. – EC	0.098 ug/m3
P. Solomon	URG – Sulfur	3.48 ng/m3
P. Solomon	URG – Silicon	8.48 ng/m3
P. Solomon	URG – Calcium	1.47 ng/m3
P. Solomon	URG – Potassium	2.11 ng/m3
P. Solomon	URG – Mangenese	0.54 ng/m3
P. Solomon	URG - Iron	1.47 ng/m3
P. Solomon	URG – Copper	0.69 ng/m3
P. Solomon	URG – Zinc	0.54 ng/m3
P. Solomon	URG – Lead	1.18 ng/m3
P. Solomon	URG – Arsenic	0.69 ng/m3
P. Solomon	URG – NO3 (Teflon)	NA
P. Solomon	URG – NO3 (Quartz)	0.018 ug/m3
P. Solomon	URG – NO3 Nylon	0.015 ug/m3
P. Solomon	URG – SO4 (Teflon)	NA
P. Solomon	URG – SO4 (Quartz)	0.013 ug/m3
P. Solomon	URG – NH4 (Teflon)	NA
P. Solomon	URG - NH4 (Quartz)	0.013 ug/m3
P. Solomon	URG – OC	0.059 ug/m3
P. Solomon	URG EC	0.059 ug/m3
P. Solomon	VAPS – NO3 (Teflon)	NA
P. Solomon	VAPS – NO3 (Quartz)	0.019 ug/m3
P. Solomon	VAPS – NO3 Nylon	0.016 ug/m3
P. Solomon	VAPS – SO4 (Teflon)	NA
P. Solomon	VAPS – SO4 (Quartz)	0.014 ug/m3

P. Solomon	VAPS – NH4 (Teflon)	NA
P. Solomon	VAPS - NH4 (Quartz)	0.014 ug/m3
P. Solomon	VAPS – OC	0.065 ug/m3
P. Solomon	VAPS EC	0.065 ug/m3

4.4 Relative Bias

The target value for relative bias is the percent difference (%) to be within +/- 25% of the mean. Below are the tables comparing the relative bias versus the target goal.

Table 8. Relative Bias Results for the Elemental Parameters

Parameter	Sampler/PI	Relative Bias (% diff)	Meet Criteria
Sulfur	E. Edgerton filter	-49.5	No
	Andersen	1.0	Yes
	FRM Plt. A	6.1	Yes
	FRM Plt. B	1.1	Yes
	Met One	0.4	Yes
	R+P Spec.	9.6	Yes
	FRM Trailer	3.2	Yes
	URG	4.3	Yes
Silicon	E. Edgerton Filter	-38.4	No
	Andersen	10.1	Yes
	FRM Plt A	-1.3	Yes
	FRM Plt. B	-9.5	Yes
	Met One	-8.8	Yes
	R+P Spec.	83.1	No
	FRM Trailer	-15.6	Yes
	IURG	-7.3	Yes
Polonium	URG	-9.0	Yes
	Andersen	1.7	Yes
	FRM Plt. A	-6.2	Yes
	Met One	-9.8	Yes
	R+P Spec.	46.0	No
	FRM Trailer	-8.5	Yes
	FRM Plt. B	-9.7	Yes
	Dichot	0.3	Yes
Arsenic	J. Ondov	0.0	Yes
	FRM Plt A	-45.2	No
	R+P Dichot	-8.6	Yes
	URG	2.5	Yes
	Andersen	-3.0	Yes
Copper	J. Ondov	-62.3	No
	E Filter	-0.8	Yes
	FRM Plt B	-29.8	No
	RP Dichot	-0.0	Yes
	URG	-19.4	Yes
	Andersen	10.9	Yes
Iron	Andersen	-44.0	No
	E Edgerton filter	-24.8	Yes

	J. Ondov	NA	No
	FRM Plt B	-53.1	No
	FRM Plt A	1.9	Yes
	Met One	-2.2	Yes
	RP Spec	77.5	No
	FRM trail roof	-10.0	Yes
	URG	-5.5	Yes
	RP Dichot	15.0	Yes
Lead	J. Ondov	-36.8	No
	E. Edgerton filter	-26.2	No
	RP Dichot	5.7	Yes
	URG	-12.2	Yes
	Andersen	5.3	Yes
	FRM Trailer roof	14.4	Yes
	Met One	-1.9	Yes
	RP Spec	7.7	Yes
	FRM Plt A	6.0	Yes
Zinc	E. Edgerton filter	12.5	Yes
	FRM Plt. B	-46.8	No
	FRM Plt. A	8.5	Yes
	RP Dichot	2.5	Yes
	URG	-1.6	Yes
	Andersen	-2.5	Yes
	FRM Trailer roof	-0.2	Yes
	Met One	-14.2	Yes
	RP Spec	15.3	Yes
	FRM Plt. A	7.3	Yes
Manganese	J. Ondov	NA	No
	E. Edgerton filter	-7.5	Yes
	FRM Plt B	-3.7	Yes
	RP Dichot	18.0	Yes
	URG	-4.6	Yes
	Andersen	8.3	Yes
	FRM Trailer Roof	-8.8	Yes
	Met One	10.1	Yes
	RP Spec	19.7	Yes
	FRM Plt A	-26.3	No
	Average	-3.5	NA

Table 9. Relative Bias Results Ions and Carbon Parameters

Parameter	Sampler/PI	Relative Bias (%diff)	Meet Criteria
NO2	S. Dagupta	4.0	Yes
	P. Jongejan	-5.5	Yes
OC	K. Baumann	7.6	Yes
	R. Tanner	-34.0	Yes
	E. Edgerton.	-14.2	Yes
	G. Allen	-73.1	No

	B. Turpin	18.6	Yes
	S. Hering	-4.1	Yes
	E. Edgerton (R+P)	3.9	Yes
	Andersen	27.4	No
	FRM Trailer Roof	17.0	Yes
	Met One	28.1	No
	R+P Spec.	35.5	Yes
	URG	11.8	Yes
	VAPS	-13.2	Yes
	Moudi	-10.6	Yes
EC	PCM K. Baumann	-45.2	No
	R.Tanner (Boss)	12.2	Yes
	Filter E. Edgerton	35.9	No
	G. Allen (Aethl.)	74.1	No
	B. Turpin	56.1	No
	R+P E. Edgerton	81.5	No
	Andersen	-40.7	No
	FRM Plt. A	-51.3	No
	Met One	-43.0	No
	R+P Spec.	-44.2	No
	URG	-48.7	No
	VAPS	-46.5	No
	Moudi	-19.6	Yes
Nitrate	PCM K. Baumann	29.4	No
	S. Dasguta	-3.0	Yes
	R. Weber	-18.4	Yes
	R. Tanner	-30.0	Yes
	E, Edgerton Chemlinescensce.	7.4	Yes
	E, Edgerton Filter	46.3	No
	G. Allen -Nitrate instrument	4.2	Yes
	S. Hering	1.3	Yes
	P. Jongejan	-7.3	Yes
	D. Worsnop	-26.8	Yes
	Andersen	9.0	No
	FRM Plt. A	-59.8	No
	Met One	13.6	No
	R+P Spec.	18.8	No
	URG	-9.0	Yes
	VAPS	33.8	No
	Moudi	-71.8	No
Ammonium	PCM K. Baumann	7.8	Yes
	R. Tanner	-16.9	Yes
	E. Edgerton Chemil.	-6.3	Yes

	E. Edgerton Filter	2.4	Yes
	R. Weber	-4.9	Yes
	P. Jongejan	-5.1	Yes
	Andersen	0.2	Yes
	FRM Plt A	-3.1	Yes
	Met One	5.5	Yes
	R+P Spec.	3.6	Yes
	URG	10.2	Yes
	VAPS	-6.8	Yes
	Moudi	-12.8	Yes
Sulfate	PCM K. Baumann	96.6	No
	R. Tanner	1.8	Yes
	E. Edgerton Filter	-17.8	Yes
	P. Jongejan	-6.0	Yes
	R. Weber	16.9	Yes
	S. Dasgupta	12.4	Yes
	S. Hering	-19.7	Yes
	D. Worsnop	25.3	Yes
	Andersen	8.6	Yes
	FRM Plt A	-0.3	Yes
	Met One	-0.4	Yes
	URG	0.6	Yes
	R+P Spec.	3.7	Yes
	VAPS	-4.0	Yes
	Moudi	-8.8	Yes

Table 10. Relative Bias Results of the Gaseous Parameters

Parameter	PI	Relative Bias (% diff)	Meet Criteria
Carbon Monoxide	K. Baumann	-0.4	Yes
	E. Edgerton	3.1	Yes
Formaldehyde	S. Dasgupta	99.5	No
	K. Baumann	-90.5	No
Nitric Acid	P. Jongejan	-48.1	No
	E. Edgerton	71.7	No
	K. Baumann	11.4	Yes
	S. Dasgupta	-56.1	No
HONO	P. Jongejan	-30.9	No
	K. Baumann	40.8	No
Ammonia	P. Jongejan	-59.6	No
	K. Baumann	48.8	No
Nitric Oxide	K. Baumann	-15.5	Yes
	E. Edgerton	9.3	Yes
Reactive NOy	K. Baumann	-7.2	Yes
	E. Edgerton	6.3	Yes
Ozone	K. Baumann	-8.8	Yes
	E. Edgerton	10.6	Yes
Oxalic Acid	S. Dasgupta	-53.4	No

	K. Baumann	27.5	No
Sulfur Dioxide	K. Baumann	-7.3	Yes
	E. Edgerton	8.3	Yes
Average		-1.8	NA

Table 11. Relative Bias Results for Meteorological Parameters

Parameter	Sampler	Relative Bias (% diff)	Meet Criteria
Barometric Pressure	H. Maring	-0.2	Yes
	K. Baumann	0.2	Yes
	E. Edgerton	0.0	Yes
Temperature 1m	Thermometer E. Edgerton	4.1	Yes
	Thermometer K. Baumann	-4.1	Yes
Relative Humidity	Dew Point Sens. H.M.	-8.0	Yes
	Dew Point Sens. E.E.	-0.8	Yes
	Dew Point Sens. K.B.	8.1	Yes
Wind Speed	Cup Anemometer E.E.	-10.3	Yes
	Cup Anemometer K.B.	3.3	Yes
Wind Direction	Wind Vane E.E.	10.7	Yes
	Wind Vane K.B.	-2.3	Yes
Temperature 10m	Thermometer E.E.	8.1	Yes
	Thermometer K.B.	-1.1	Yes
Average		0.55	

4.5 Comparability

The target for comparability for this project was the mean +/- 1.96 times the standard deviation of the parameter data set. This gives us a 95% confidence level of the data.

Table 12. Comparability Results for Elemental Parameters

Parameter	**Sampler**	**Study Average (ng/m3)**	**Meet Criteria**
Sulfur	E. Edgerton filter	2181.7	No
	Andersen.	4361.7	Yes
	FRM Plt. A	4584.5	Yes
	FRM Plt. B	4365.9	Yes
	Met One	4336.5	Yes
	R+P Spec.	4735.6	Yes
	FRM Trailer	4457.0	Yes
	URG	4504.3	Yes
	Mean	**4320.0**	
	UCL	**5258.9**	
	LCL	**3381.1**	
Silicon	E. Edgerton Filter	124.6	Yes
	Andersen	222.8	Yes
	FRM Plt A	199.7	Yes
	FRM Plt. B	183.3	Yes
	Met One	184.6	Yes
	R+P Spec.	370.6	No

	FRM Trailer	170.7	Yes
	URG	187.6	Yes
	Mean	**202.4**	
	UCL	**345.5**	
	LCL	**59.3**	
Polonium	URG	59.7	Yes
	Andersen	66.7	Yes
	FRM Plt. A	61.6	Yes
	Met One	59.2	Yes
	R+P Spec.	95.8	No
	FRM Trailer	60.0	Yes
	FRM Plt. B	59.3	Yes
	R+PDichot	65.8	Yes
	Mean	**65.6**	
	UCL	**88.5**	
	LCL	**42.7**	
Arsenic	J. Ondov	NA	No
	E. Edgerton filter	0.8	Yes
	R+P Dichot	1.4	Yes
	URG	1.5	Yes
	Andersen	1.4	Yes
	FRM Trailer Roof	1.4	Yes
	Met One	2.1	Yes
	R +P Spec	1.7	Yes
	FRM trailer roof	1.3	Yes
	Mean	1.5	
	UCL	**2.9**	
	LCL	**0.1**	
Copper	J. Ondov	1.5	Yes
	E. Edgerton Filter	3.9	Yes
	FRM Plt B	2.8	Yes
	R+P Dichot	3.9	Yes
	URG	3.2	Yes
	Andersen	4.4	Yes
	FRM Trailer Roof	4.3	Yes
	Met One	4.0	Yes
	RP Spec	4.3	Yes
	FRM Plt A	4.1	Yes
	Mean	**3.9**	
	UCL	**6.9**	
	LCL	**1.0**	

Iron	Andersen	72.1	Yes
	E. Edgerton filter	96.8	Yes
	J. Ondov	NA	No
	FRM Plt B	60.4	Yes
	FRM Plt A	131.2	Yes
	Met One	125.9	Yes
	RP Spec	228.5	No
	FRM trail roof	115.9	Yes
	URG	121.7	Yes
	R+P Dichot	148.0	Yes
	Mean	**128.7**	
	UCL	**221.8**	
	LCL	**35.7**	
Lead	J. Ondov	3.3	Yes
	E. Edgerton filter	3.9	Yes
	RP Dichot	5.6	Yes
	URG	4.6	Yes
	Andersen	5.6	Yes
	FRM Trailer roof	6.0	Yes
	Met One	5.2	Yes
	R+P Spec	5.7	Yes
	FRM Plt A	5.6	Yes
	Mean	**5.3**	
	UCL	**8.8**	
	LCL	**1.7**	
Zinc	E. Edgerton filter	16.8	Yes
	FRM Plt. B	7.9	Yes
	FRM Pt. A	16.2	Yes
	R+P Dichot	15.3	Yes
	URG	14.7	Yes
	Andersen	14.5	Yes
	FRM Trailer roof	14.9	Yes
	Met One	12.8	Yes
	R+P Spec	17.2	Yes
	Mean	**14.9**	
	UCL	**23.9**	
	LCL	**6.0**	

Manganese	J. Ondov	NA	No
	E. Edgerton filter	2.5	Yes
	FRM Plt B	2.6	Yes
	RP Dichot	3.2	Yes
	URG	2.6	Yes
	Andersen	3.0	Yes
	FRM Trailer Roof	2.5	Yes
	Met One	3.0	Yes
	R+P Spec	3.3	Yes
	FRM Plt A	2.0	Yes
	Mean	**2.7**	
	UCL	**4.6**	
	LCL	**0.8**	

Table 13. Comparability Results for Carbon, Mass and Ionic Parameters

Parameter	Sampler/PI	Mean	Meet Criteria
NO2	S. Dagupta	0.0785	Yes
	P. Jongejan	0.0714	Yes
	Mean	**0.0755**	
	UCL	**0.0963**	
	LCL	**0.0495**	
OC	K. Baumann	7.8233	Yes
	R. Tanner	4.8042	Yes
	E. Edgerton.	6.2389	Yes
	G. Allen	1.9584	Yes
	B. Turpin	8.6259	Yes
	S. Hering	6.9755	Yes
	EE (R+P)	7.5600	Yes
	Andersen	9.2645	Yes
	FRM Trailer Roof	8.5124	Yes
	Met One	9.3162	Yes
	R+P Spec.	9.8585	Yes
	URG	8.1310	Yes
	VAPS	6.3144	Yes
	Moudi	6.5020	Yes
	Mean	**7.2740**	
	UCL	**12.0025**	
	LCL	**2.5455**	
EC	PCM K. Baumann	0.8205	Yes
	R.Tanner (Boss)	1.6798	Yes
	Filter EE	2.0338	Yes
	G. Allen (Aethl.)	2.6051	Yes
	B. Turpin	2.3357	Yes

	R+P EE	2.7163	Yes
	Andersen	0.8879	Yes
	FRM Plt. A	0.7293	Yes
	Met One	0.8538	Yes
	R+P Spec.	0.8352	Yes
	URG	0.7676	Yes
	VAPS	0.8004	Yes
	Moudi	1.2040	Yes
	Mean	**1.4967**	
	UCL	**3.1646**	
	LCL	**-0.1713**	
Nitrate	PCM K. Baumann	0.6990	Yes
	S. Dasguta	0.5236	Yes
	R. Weber	0.4408	Yes
	R. Tanner	0.3780	Yes
	EE Cheml.	0.5797	Yes
	EE Filter	0.7900	Yes
	G. Allen -Nitrate instrument	0.5625	Yes
	S. Hering	0.5468	Yes
	P. Jongejan	0.5004	Yes
	D. Worsnop	0.3952	Yes
	Andersen	0.5886	Yes
	FRM Plt. A	0.2172	Yes
	Met One	0.6134	Yes
	R+P Spec.	0.6416	Yes
	URG	0.4914	Yes
	VAPS	0.7224	Yes
	Moudi	0.1522	Yes
	Mean	**0.5400**	
	UCL	**0.9600**	
	LCL	**0.1300**	
Ammonium	PCM K. Baumann	3.8962	Yes
	R. Tanner	3.0019	Yes
	EE Chemil.	3.3861	Yes
	EE Filter	3.6982	Yes
	R. Weber	3.4364	Yes
	P. Jongejan	3.4300	Yes
	Andersen	3.6217	Yes
	FRM Plt A	3.5014	Yes
	Met One	3.8100	Yes
	R+P Spec.	3.7420	Yes
	URG	3.9817	Yes
	VAPS	3.3680	Yes
	Moudi	3.1500	Yes
	Mean	**3.6130**	
	UCL	**4.8612**	
	LCL	**2.3647**	

Sulfate	PCM K. Baumann	11.2185	Yes
	R. Tanner	9.0511	Yes
	EE. Filter	10.3583	Yes
	P. Jongejan	12.8777	Yes
	R. Weber	12.3792	Yes
	S. Dasgupta	8.8465	Yes
	S. Hering	13.8097	Yes
	D. Worsnop	11.9662	Yes
	Andersen	10.9786	Yes
	FRM Plt A	10.9690	Yes
	Met One	11.0824	Yes
	URG	11.4262	Yes
	R+P Spec.	10.5740	Yes
	VAPS	10.0432	Yes
	Moudi	9.1200	Yes
	Mean	**11.0172**	
	UCL	**15.8234**	
	LCL	**6.2109**	
	P10Mass Dichot	47.6293	
	Pm2.5 Mass Tucker	35.7486	
	PM2.5 Mass Yorkville	28.3018	
	PM2.5 Mass Fort Mc.	31.0337	
	Course Mass (Dichot)	12.2348	
	FRM on Trailer	31.2352	
	Moudi Mass	26.0900	
Other parameters	P2.5 BC GA	1.9607	
	P2.5 Formate KB	0.4608	
	P2.5 Acetate KB	0.5919	
	P2.5 Oxalate KB	0.0320	

Table 14. Comparability Results for Gaseous Parameters

Parameter	**Sample/PI**	**Avg. (ppbv)**	**eet Criteria**
Carbon Monoxide	K. Baumann	581.4	Yes
	E. Edgerton	601.7	Yes
	Mean	**583.9**	
	UCL	**730.4**	
	LCL	**437.4**	
Formaldehyde	S. Dasgupta	7.9	Yes
	K. Baumann	0.4	Yes
	Mean	**4.0**	
	UCL	**11.8**	
	LCL	**-3.9**	

Nitric Acid	P. Jongejan	1.1	Yes
	E. Edgerton	3.5	Yes
	K. Baumann	2.3	Yes
	S. Dasgupta	0.9	Yes
	Mean	**2.0**	
	UCL	**5.0**	
	LCL	**-0.9**	
HONO	P. Jongejan	0.8	Yes
	K. Baumann	1.6	Yes
	Mean	**1.2**	
	UCL	**2.7**	
	LCL	**-0.3**	
Ammonia	P. Jongejan	0.6	Yes
	K. Baumann	2.3	Yes
	Mean	**1.6**	
	UCL	**4.0**	
	LCL	**-0.9**	
Nitric Oxide	K. Baumann	10.7	Yes
	E. Edgerton	13.9	Yes
	Mean	**12.7**	
	UCL	**18.3**	
	LCL	**7.1**	
Reactive NOy	K. Baumann	44.8	Yes
	E. Edgerton	51.3	Yes
	Mean	**48.3**	
	UCL	**59.7**	
	LCL	**36.8**	
Ozone	K. Baumann	43.3	Yes
	E. Edgerton	52.5	Yes
	Mean	**47.5**	
	UCL	**59.1**	
	LCL	**35.8**	
Oxalic Acid	S. Dasgupta	0.0	Yes
	K. Baumann	0.0	Yes
	Mean	**0.0**	
	UCL	**0.1**	
	LCL	**0.0**	
Sulfur Dioxide	K. Baumann	4.9	Yes
	E. Edgerton	5.7	Yes
	Mean	**5.2**	
	UCL	**6.8**	
	LCL	**3.7**	

Table 15. Comparability Results for the Meteorological Parameters

Parameter	**PI**	**Average**	**Meet Criteria**
Barometric	H. Maring	978.1 mm Hg	Yes
Pressure	K. Baumann	981.3 mm Hg	Yes
	E. Edgerton	980.0 mm Hg	Yes
	Mean	**979.9 mm Hg**	
	UCL	**984.0 mm Hg**	
	LCL	**975.8 mm Hg**	
Relative	HM	49.3 %	Yes
Humidity	E. Edgerton	53.2 %	Yes
	K. Baumann	57.9 %	Yes
	Mean	**53.6 %**	
	UCL	**68.9 %**	
	LCL	**38.3 %**	
Wind Speed	E. Edgerton	1.7 m/s	Yes
Scalar	K. Baumann	2.0 m/s	Yes
	Mean	**1.9 m/s**	
	UCL	**2.3 m/s**	
	LCL	**1.5 m/s**	
Wind Direction	E. Edgerton	234.3 deg.	No
Scalar	K. Baumann	206.9 deg.	Yes
	Mean	**211.7 deg.**	
	UCL	**232.9 deg.**	
	LCL	**190.5 deg.**	
Ambient	E. Edgerton	30.6 deg. C	No
Temperature	K. Baumann	28.0 deg. C	Yes
10 meters	**Mean**	**28.3** deg. C	
	UCL	**30.1** deg. C	
	LCL	**26.5** deg. C	
Ambient	HM	30.7 deg. C	Yes
Temperature	K. Baumann	28.3 deg. C	Yes
1 meter	**Mean**	**29.5** deg. C	
	UCL	**34.4** deg. C	
	LCL	**24.6** deg. C	
Solar Radiation	E. Edgerton	313.6 w/m3	
Visible Irradiance	K. Baumann	347.3 w/m3	
Ultraviolet light	K. Baumann	0.8 w/m3	
Rainfall	E. Edgerton	0.0 in.	
Rainfall	K. Baumann	1.0 in.	

4.6 Completeness

The target completeness for the study was 75%. Below are the tables comparing the completeness vs. the target goals.

Table 16. Completeness Results for Elemental Parameters

Parameter	Sampler/PI	% recovery	Meet Criteria
Sulfur	E. Edgerton Filter	100.0	Yes
	Andersen	100.0	Yes
	FRM Plt A	92.9	Yes
	FRM Plt B	100.0	Yes
	Met One	100.0	Yes
	R+P Spec.	92.9	Yes
	FRM Trailer	100.0	Yes
	URG	92.9	Yes
Silicon	E. Edgerton Filter	100.0	Yes
	Andersen	100.0	Yes
	FRM Plt A	92.9	Yes
	FRM Plt. B	100.0	Yes
	Met One	100.0	Yes
	R+P Spec.	92.9	Yes
	FRM Trailer	100.0	Yes
	URG	92.9	Yes
Polonium	URG	92.9	Yes
	Andersen	100.0	Yes
	FRM Plt. A	92.9	Yes
	Met One	100.0	Yes
	R+P Spec.	92.9	Yes
	FRM Trailer roof	100.0	Yes
	FRM Plt. B	100.0	Yes
	R+P Dichot	100.0	Yes
Arsenic	J. Ondov	0.0	No
	FRM Plt B	50.0	No
	R+P Dichot	100.0	Yes
	URG	92.9	Yes
	Andersen	100.0	Yes
	FRM Trailer Roof	92.9	Yes
	Met One	100.0	Yes
	R+P Spec	92.9	Yes
Copper	J. Ondov	3.6	No
	E. Edgerton Filter	100.0	Yes
	FRM Plt B	50.0	No
	R+P Dichot	100.0	Yes
	URG	92.9	Yes
	Andersen	100.0	Yes
	FRM Trailer Roof	92.9	Yes
	Met One	100.0	Yes
	RP Spec	92.9	Yes

	FRM Plt A	100.0	Yes
Iron	Andersen	50.0	No
	E. Edgerton filter	100.0	Yes
	J. Ondov	0.0	No
	FRM Plt B	50.0	No
	FRM Plt A	92.9	Yes
	Met One	100.0	Yes
	RP Spec	92.9	Yes
	FRM Trailer Roof	100.0	Yes
	URG	92.9	Yes
	R+P Dichot	100.0	Yes
Lead	J. Ondov	3.6	No
	E. Edgerton filter	100.0	Yes
	R+P Dichot	100.0	Yes
	URG	92.9	Yes
	Andersen	100.0	Yes
	FRM Trailer roof	92.9	Yes
	Met One	100.0	Yes
	R+P Spec	92.9	Yes
	FRM Plt A	100.0	Yes
Zinc	E. Edgerton filter	100.0	Yes
	FRM Plt. B	50.0	No
	R+P Dichot	100.0	Yes
	URG	92.9	Yes
	Andersen	100.0	Yes
	FRM Trailer roof	92.9	Yes
	Met One	100.0	Yes
	R+P Spec	92.9	Yes
	FRM Plt. A	100.0	Yes
Mangenese	J. Ondov	0.0	No
	E. Edgerton filter	100.0	Yes
	FRM Plt B	100.0	Yes
	R+P Dichot	100.0	Yes
	URG	92.9	Yes
	Andersen	100.0	Yes
	FRM Trailer Roof	92.9	Yes
	Met One	100.0	Yes
	R+P Spec	92.9	Yes
	FRM Plt A	100.0	Yes
Calcium	FRM Plt A	100.0	Yes
Average		87.8	Yes

Table 17. Completeness Results for Carbon, Mass and Ionic Parameters

Parameter	Sampler/PI	% Recovery	Meet Criteria
NO2	S. Dagupta	96.6	Yes
	P. Jongejan	100.0	Yes
OC	K. Baumann	93.1	Yes

	R. Tanner	96.6	Yes
	E. Edgerton.	100.0	Yes
	G. Allen	100.0	Yes
	B. Turpin	86.2	Yes
	S. Hering	82.8	Yes
	EE (R+P)	100.0	Yes
	Andersen	100.0	Yes
	FRM Trailer Roof	100.0	Yes
	Met One	100.0	Yes
	R+P Spec.	93.1	Yes
	URG	100.0	Yes
	VAPS	86.2	Yes
	Moudi	100.0	Yes
EC	PCM K. Baumann	93.1	Yes
	R.Tanner (Boss)	96.6	Yes
	Filter EE	100.0	Yes
	G. Allen (Aethl.)	100.0	Yes
	B. Turpin	86.2	Yes
	R+P EE	100.0	Yes
	Andersen	100.0	Yes
	FRM Plt. A	100.0	Yes
	Met One	100.0	Yes
	R+P Spec.	93.1	Yes
	URG	100.0	Yes
	VAPS	86.2	Yes
	Moudi	100.0	Yes
Nitrate	PCM K. Baumann	96.6	Yes
	S. Dasguta	96.6	Yes
	R. Weber	48.3	Yes
	R. Tanner	96.6	Yes
	EE Cheml.	75.9	Yes
	EE Filter	100.0	Yes
	G. Allen -Nitrate instrument	27.6	No
	S. Hering	93.1	Yes
	P. Jongejan	100.0	Yes
	D. Worsnop	37.9	No
	Andersen	100.0	Yes
	FRM Plt. A	100.0	Yes
	Met One	100.0	Yes
	R+P Spec.	86.2	Yes
	URG	100.0	Yes
	VAPS	86.2	Yes
	Moudi	100.0	Yes

Ammonium	PCM K. Baumann	96.6	Yes
	R. Tanner	100.0	Yes
	EE Chemil.	79.3	Yes
	EE Filter	100.0	Yes
	R. Weber	48.3	No
	P. Jongejan	75.9	Yes
	Andersen	100.0	Yes
	FRM Plt A	100.0	Yes
	Met One	100.0	Yes
	R+P Spec.	86.2	Yes
	URG	100.0	Yes
	VAPS	86.2	Yes
	Moudi	100.0	Yes
Sulfate	PCM K. Baumann	96.6	Yes
	R. Tanner	100.0	Yes
	EE. Filter	100.0	Yes
	P. Jongejan	100.0	Yes
	R. Weber	48.3	No
	S. Dasgupta	100.0	Yes
	S. Hering	100.0	Yes
	D. Worsnop	86.2	Yes
	Andersen	100.0	Yes
	FRM Plt A	100.0	Yes
	Met One	100.0	Yes
	URG	100.0	Yes
	R+P Spec.	86.2	Yes
	VAPS	86.2	Yes
	Moudi	100.0	Yes
	P10Mass Dichot	100.0	Yes
	Pm2.5 Mass Tucker	100.0	Yes
	PM2.5 Mass Yorkville	100.0	Yes
	PM2.5 Mass Fort Mc.	100.0	Yes
	Course Mass (Dichot)	100.0	Yes
	FRM on Trailer	100.0	Yes
	Moudi Mass	100.0	Yes
Other parameters	P2.5 BC GA	100.0	Yes
	P2.5 Formate KB	96.6	Yes
	P2.5 Acetate KB	96.6	Yes
	P2.5 Oxalate KB	96.6	Yes
	Average	92.9	

Table 18. Completeness Results for Gaseous Parameters

Parameter	Sampler	% Recovery	Meet Criteria
Carbon Monoxide	K. Baumann	88.3	Yes
	E. Edgerton	71.5	Yes
Formaldehyde	S. Dasgupta	92.1	Yes
	K. Baumann	53.1	No
Nitric Acid	P. Jongejan	89.4	Yes
	E. Edgerton	99.8	Yes
	K. Baumann	53.1	No
	S. Daspugta	77.0	Yes
HONO	P. Jongejan	89.5	Yes
	K. Baumann	30.3	No
Ammonia	P. Jongejan	70.9	Yes
	K. Baumann	53.1	No
	K. Baumann	47.8	No
	E. Edgerton	100.0	Yes
NOy	K. Baumann	44.8	No
	E. Edgerton	100.0	Yes
Ozone	K. Baumann	97.9	Yes
	E. Edgerton	100.0	Yes
	S. Dasgupta	77.0	Yes
	K. Baumann	53.1	No
Sulfur Dioxide	K. Baumann	98.1	Yes
	E. Edgerton	100.0	Yes
Volatile Carbon	B. Turpin	38.8	No
Formic Acid	K. Baumann	53.1	No
Acetic Acid	K. Baumann	77.9	Yes
Carbon Dioxide	E. Edgerton	77.9	Yes
Peroxides	S. Dasgupta	93.1	Yes
Hydrochloric Acid		89.4	Yes
Nitrogen Dioxide	E. Edgerton	100.0	Yes
Average		76.5	Yes

Table 19. Completeness Results for Meteorological Parameters

Parameter	Sampler/PI	% Recovery	Meet Criteria
Barometric Pressure	H. Maring	100.0	Yes
	K. Baumann	100.0	Yes
	E. Edgerton	41.4	No
Temperature 1m	H. Maring	100.0	Yes
	K. Baumann	100.0	Yes
Relative Humidity	H. Maring	100.0	Yes
	E. Edgerton	41.4	No
	K. Baumann	100.0	Yes
Wind Speed	E. Edgerton	41.4	No
	K. Baumann	79.3	Yes
Wind Direction	E. Edgerton	41.4	No
	K. Baumann	79.3	Yes
Temperature 10 m	E. Edgerton	41.4	No

	K. Baumann	100.0	Yes
Solar Radiation	E. Edgerton	41.4	No
Visible Irradiance	K. Baumann	89.7	Yes
Ultra Violet Radiation	K. Baumann	89.7	Yes
Rainfall	E. Edgerton	41.4	No
Rainfall	K. Baumann	51.7	No
Average		72.6	No

The overall average for the study was 82.4%, which exceeds the study goal of 75%.

4.7 Representativeness

Generally, representativeness expresses how closely a sample reflects the characteristics of the surrounding environment. This is usually quantified in terms of monitoring scale. 40 CFR 58, Appendix D[5] discusses monitoring scale in great detail. It is not the scope of this manual to discuss monitoring scale in detail, however, monitoring scale must be understood for the project. The major components of the Supersite are ozone, ozone precursors, fine and coarse particles. The 40 CFR 58 recommends that ozone monitoring represent urban or regional scale. For Atlanta, urban scale represents the overall citywide exposure with dimensions in the order of 4 to 50 kilometers. On the other hand, fine and coarse particle scale is recommend to be neighborhood scale, which is defined as representing an area in the order of 0.5 to 4.0 kilometers. The Supersite project was conducted at the Georgia Power Company facility located at 829 Jefferson Street NW, Atlanta. The site was previously established for the SEARCH and ARIES programs and the capabilities will be expanded to accommodate the 1999 Atlanta Supersite Experiment. Please see the map in Figure 2 for an overview of the location in relationship to other parts of Atlanta. The location of the site is within the greater Atlanta area. The exposure of the surrounding environs do represent urban scale for ozone and it precursors and neighborhood scale for particle monitoring.

During the first week of operation of the Atlanta Supersite, the QAM identified and measured all obstruction and measured the distance to the nearest roadways. The symbols illustrated in Figure 1 below correspond to the distance in Table 20. 40 CFR58 Appendix E has the recommendations and guidance for placement inlet probes of ambient air monitoring shelter. Distances from roadways, obstructions such as building or large trees (i.e., trees that are taller that the sampler inlets) and local sources. Table 20 illustrates the measured distances relative to the recommended minimum distances detailed in 40 CFR 58 Appendix E.

Symbol	Distance (meters)	Description	EPA Requirments[6]
A	113.9	Univ. Delaware shelter to Jefferson Street	50 meters (40kADT)
B	55.4	GIT shelter to large tree (~15.4 m tall)	20 meters
C	21.5	GIT shelter to large tree (12.3 m tall)	20 meters
D	27.0	Platform A to fence line	10 meters (10k ADT)
E	9.5	RASS to fence line	NA
F	10.6	Platform B to fence line shrubs	10 meters
G	10.1	Platform B to shrub inside fence line	10 meters
H	17.0	Platform A to fence line	10 meters
I	23.1	Platform A to parking lot	NA
J	12.3	Platform B to fence line	10 meters
K	28.9	ARA shelter to fence line	10 meters
L	24.3	Inlet from 2 shelters to parking lot	NA

As can be seen from the comparison of the EPA siting requirements and distances to roadways, obstructions, shrubs and trees, all of the distances meet the siting requirements. To the south of the monitoring site, across the street of the entrance gate is a local bus line garage and storage facility. The distance to the entrance of the garage is approximately 130 meters from the monitoring site. Diesel buses were observed entering and leaving the garage during the day. However, the garage did close in the evening and no bus traffic was observed at night. The QAM deemed the bus diesel traffic to not have a significant impact on this site since the design of the experiment was to be in an urban setting. One of the objectives of the study was to capture an "urban signature," characterize and identify those signatures. To the west, there are two large trees, however, the distance to these trees is greater than 20 meters, therefore, and they did not pose
as an obstruction. The shrubs along the fence line to the north were 3 meters in height. The inlet of the of samplers on platform B were at or above 3 meters, therefore the shrubs were not deemed to be obstructive. To the east, there was a parking lot that the Supersite investigators used to park their vehicles. Everyone involved in the Supersite experiment were advised to park at least 50 meters from the monitoring site. During the QAM's

visits, this appeared to observed. The property is a maintenance yard for the Southern Company, a local power generator. To the east, approximately 100 meters away is the maintenance headquarters. Light duty trucks and cars were observed entering and exiting the maintenance headquarters. This was deemed to not have an impact on the sampling at the monitoring site.

Figure 1. Overhead photograph illustrating the distances to roadways and obstructions

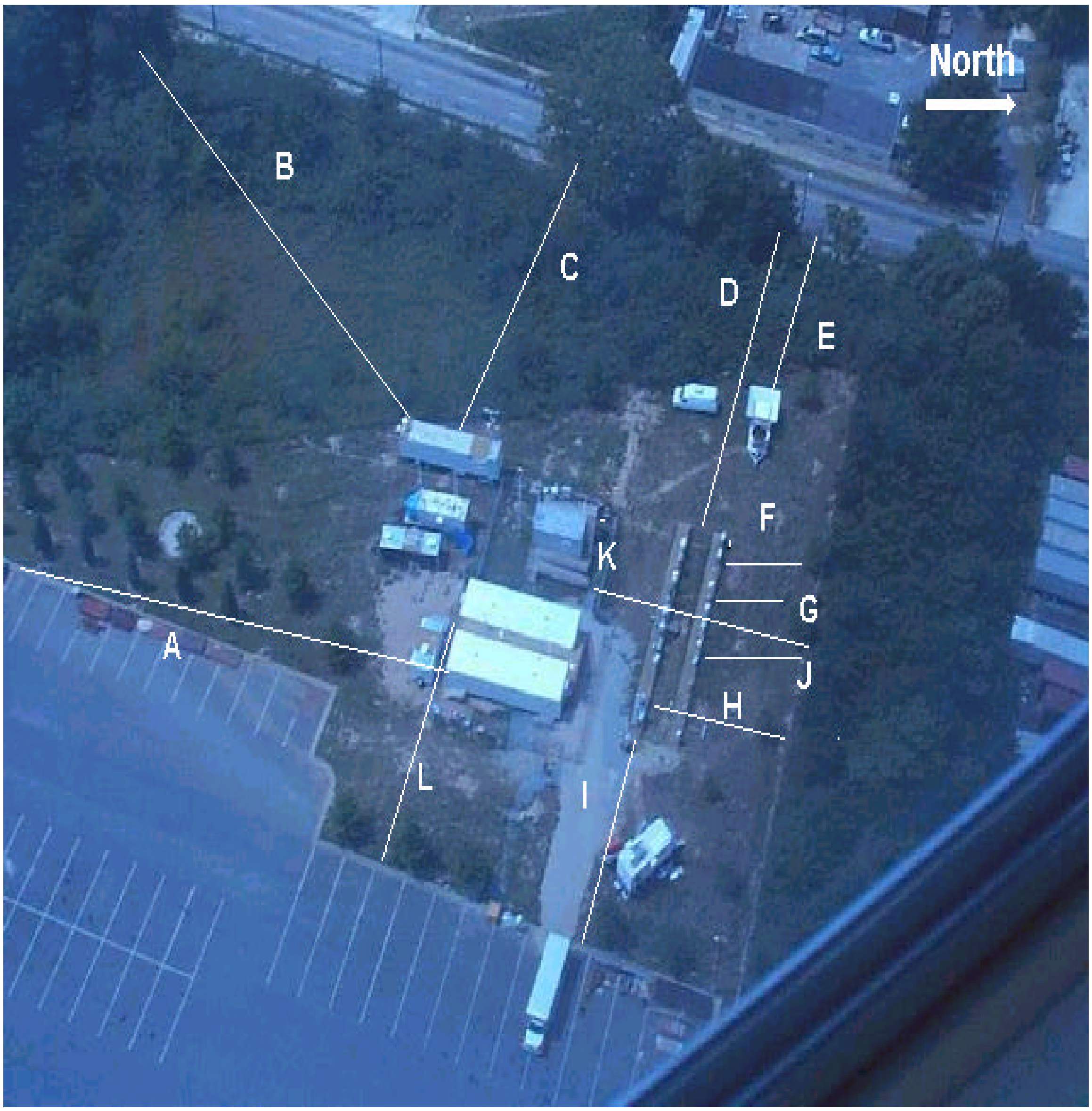
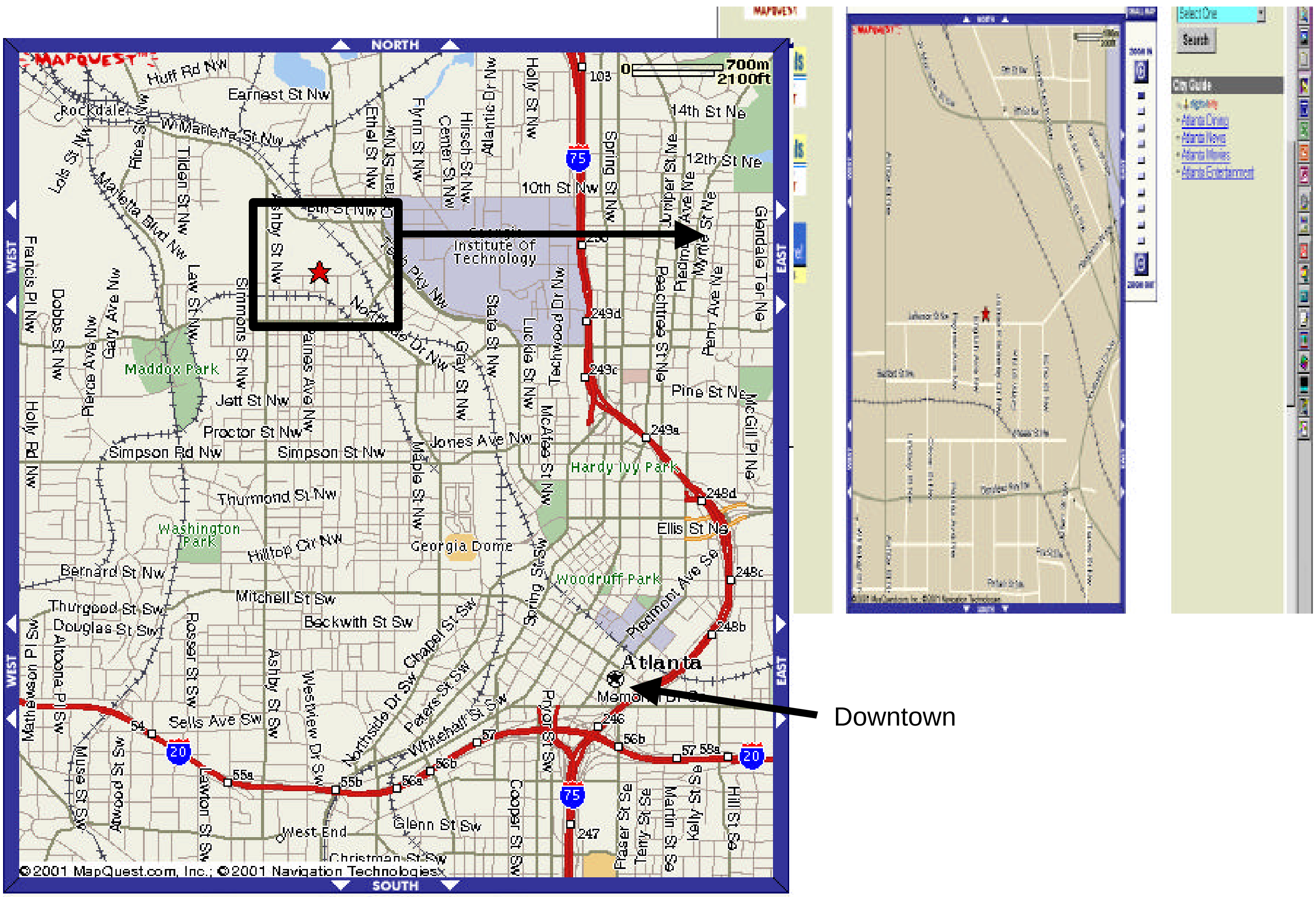


Figure 2. Map of Atlanta illustrating the location of the Supersite



5.0 References

1. Solomon P., et al., October 2001, Overview of the 1999 Atlanta Supersite Project. Journal Geophysical Research - Atmospheres, Special Issue for the Atlanta Supersites Project. Submitted for publication.
2. PM Measurement Workshop Report, "Atmospheric Observations: Helping Build the Scientific Basis for Decisions Related to Air Borne Particulate Matter" EPA/NARSTO, October 1998
3. Cooperative Agreement between the National Exposure Research Laboratory at Research Triangle Park of the U.S. Environmental Protection Agency and The Georgia Institute of Technology for The Southern Oxidant Study Phase II Program on Analysis and Assessment of Alternate Strategies, June 1, 1996
4. Quality Assurance Project Plan for the Southern Oxidant Study Atlanta Supersite Field Experiment, 1999, Revision 1.1, November 1999.
5. Code of Federal Regulations, Title 40 Part 136, Appendix B
6. Code of Federal Regulations, Title 40 Part 58, Appendix E