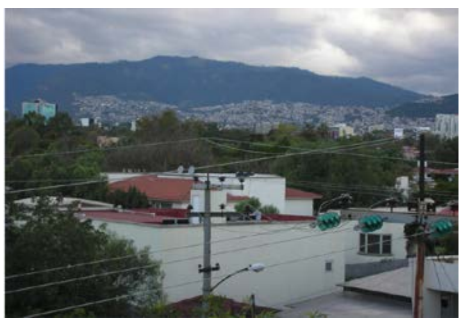
Audit of Ambient Air Monitoring Stations for the Sistema de Monitoreo Atmosférico de la Ciudad de México



Submitted to:

Dirección de Monitoreo Atmosférico
Dirección General de Gestión de la Calidad del Aire
Secretaría del Medio Ambiente
Ciudad de México

Submitted by:

Eric Anderson
EPA Systems, LLC
Austin, Texas
Roberto Toquero
Bettel Ecológica
México, D. F.

TABLE OF CONTENTS

List of Tables

List of Figures

APPENDICES

EXECUTIVE SUMMARY

Compañía Bettel Ecologica and EPA Systems, LLC were contracted by the Environmental Secretariat of the Government of the Federal District (*Secretaría del Medio Ambiente del Gobierno del Distrito Federal* (GDF)) to support the GDF in conducting Technical Systems and Performance (TS&P) audits of selected stations within the Mexico City ambient air monitoring network. Previously these audits were performed in 2003 and 2005 by the USEPA Office of Air Quality Planning and Standards (OAQPS) with follow-up audits conducted by GDF auditors. Prior to this, audits were performed as an adjunct to a research program in Mexico City by the USEPA Office of Research and Development (ORD).

This report details the results of the TS&P audits conducted between 24 – 28 November 2014 on nine of the GDF ambient systems plus the main laboratory's reference analyzers. The audits were performed using an independent Protocol 1 calibration standard and an Environics Model 6103 calibrator and API Model 701 clean air source. The performance audit consisted of challenging each nitrogen oxides (NO_x),ultralow reactive nitrogen oxides (NO_Y) sulphur dioxide (SO_2), carbon monoxide (CO) and ozone (O_3) analyzer at three to five upscale data values plus zero. In addition, the nitrogen dioxide (NO_2) convertor efficiency for each NO_x analyzer was tested using a gas-phase titration approach using three different NO concentrations and three different ozone concentrations. This test is designed to create difference NO2 concentrations by setting the O_3 and NO concentrations to yield approximately the same NO value (approximately 100 ppb).

The systems audit showed that GDF has an effective system for station operation and calibration. These operational protocols include:

- The instrument diagnostic information collected during each multipoint calibration is checked during each site visit;
- Technicians call the main laboratory each time work is done on the instruments so there is a record at the site and at the main laboratory;
- Control charts of all zero and span data from each instrument calibration is kept and reviewed during each site visit;
- Each station is configured in the same manner with ozone analyzer on top and CO analyzer on bottom. The sample lines to the manifold are also configured similarly. This makes it easier to work on and service the analyzers.
- A master list of maintenance and calibration activities (along with frequency and dates of activities) is posted in each shelter so that the operators know what activities are needed during each site visit; and
- Individual Standard Operating Procedures (SOPs) are available for each instrument make and model.

A review of the site log books showed the logs were signed and dated and that all activities during each site visit were recorded. Previous audits noted there were sometimes inconsistencies with the notation of arrival and departure times. Of the 2014 data entries reviewed, there were no log entries found that did not show both arrival and departure times.

The sites were all very clean and well-kept and the site instrumentation was neatly plumbed and wired making maintenance and servicing of the instrumentation much easier. The operators the auditor had the opportunity to meet and interact with demonstrated a strong commitment to performing quality work and expressed a lot of pride with the jobs they did.

There were a number of major changes to the network during 2014. All of the gaseous pollutant sites are now equipped with API 701 dilution calibrators and API 700 clean air sources. This now allows calibrations to be carried out remotely. The current practice is to perform a zero/span every week on Sunday night between 00:00 and 02:00. All of these calibrations are performed through the zero and span ports on the analyzers and not through the sample ports. In addition, the precision point (16% to 20% of span) is now no longer being performed. Quarterly multi-points are being performed manually as are the Gas-phase titrations (GPTs).

The auditor noted two issues that have the potential to impact data quality and are discussed further in Sections 3.1 and 4.0 of this report. They include:

- Not performing manual Precision checks through the sample lines on a bi-weekly basis; and
- Not performing GPTs per USEPA recommended guidance. These issues and possible implications are discussed further in this report.

The audit data are showing that all of the instruments are operating well within specification these are more deviations from existing established protocols. Because manual “through the system” multi-points are performed any issues with the system performance will always be caught within less than 90 days.

Additionally, the auditor would like to see a slight change in the GPT process where a three-point check for NO_2 are performed at levels recommended in 40 CFR 58 Appendix A Section 3.2.2.1. This is further discussed in Section 3.1.

Overall, the performance audit demonstrated that the sites were well run and were collecting valid and defensible data. Of the 41 instruments audited, none of the analyzers had responses that were greater than the audit objective of ±15%. The acceptance criterion for gaseous pollutants is 15% mean absolute percent difference and no more than 15% for each concentration level of each pollutant analyzer. For the vast majority of the analyzers the mean responses were within ±5%.

Figures ES-1 through ES-4 show the average audit responses at the ten sites for each of the four criteria pollutant analyzers.

Based on the 10 sites audited, the audit demonstrated that the GDF monitoring network has a good QA/QC system in place to operate the network and that performance-wise, the instrumentation is operating well within acceptable limits.

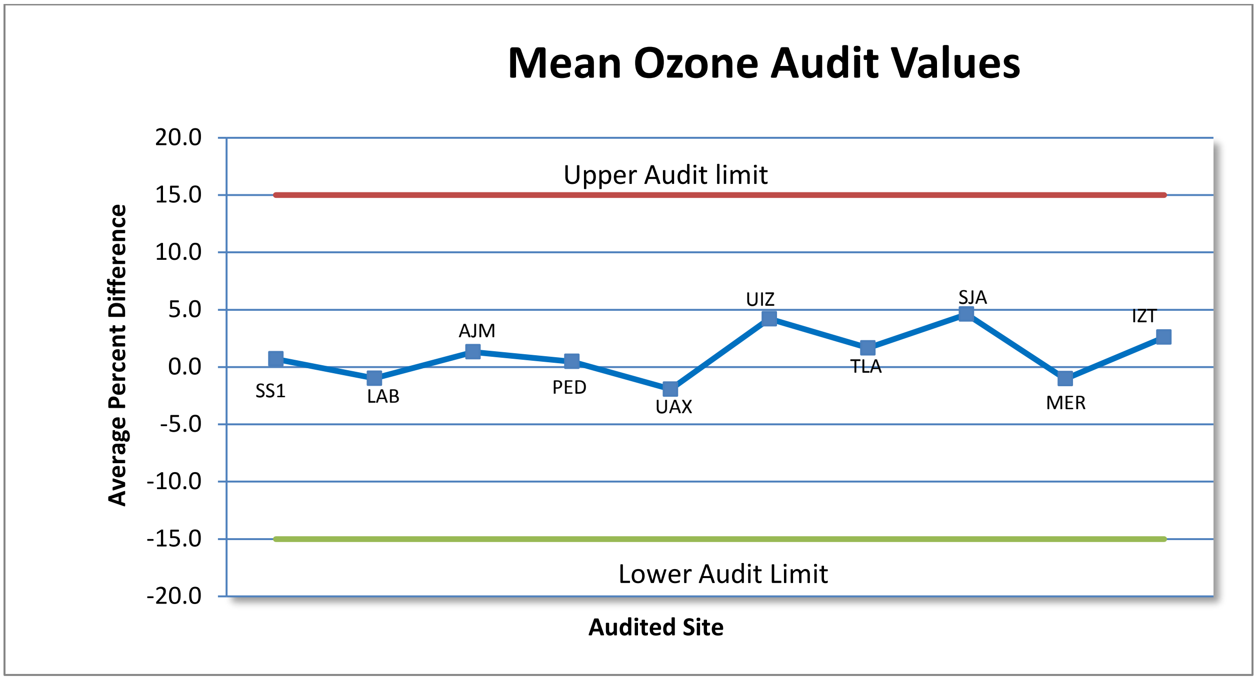


Figure ES- 1. Summary of Average Ozone Audit Results

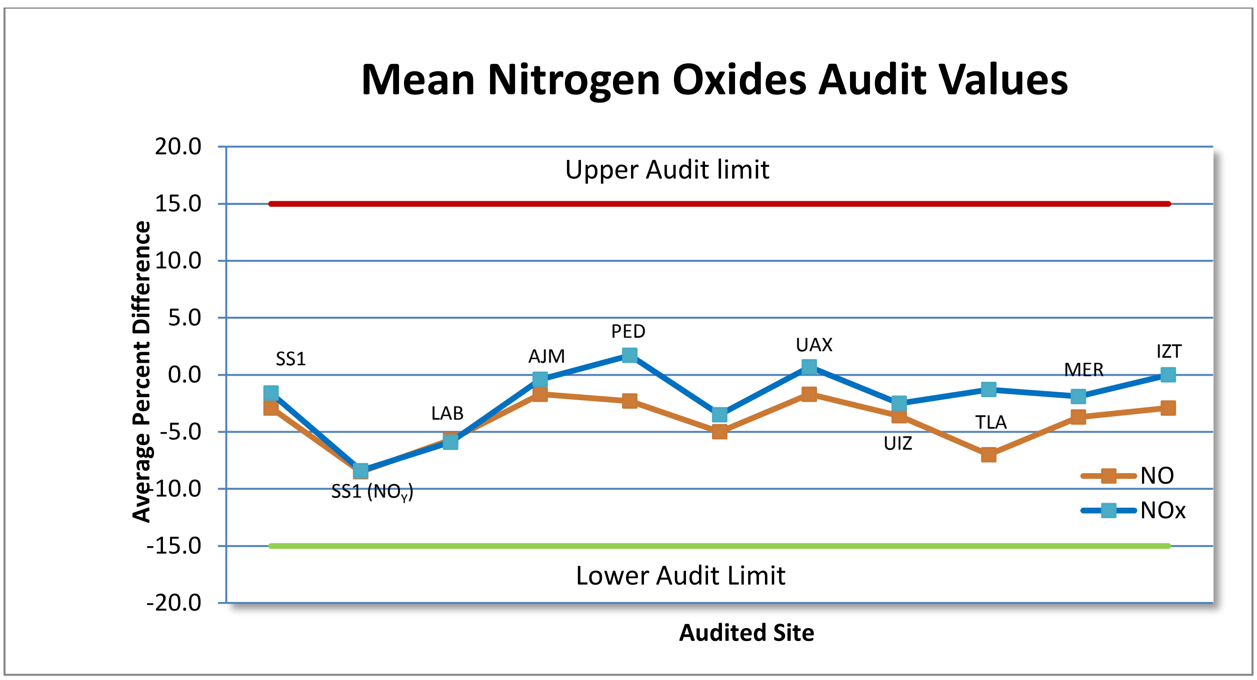


Figure ES- 2. Summary of Average Nitrogen Oxides Audit Results

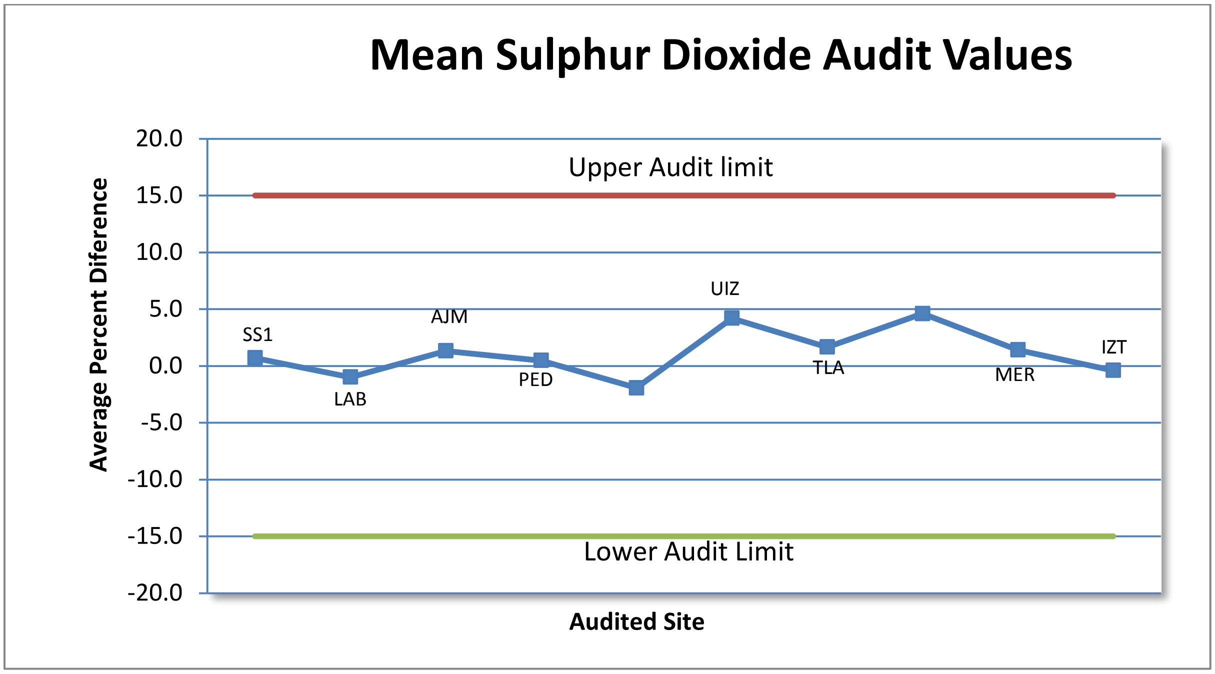


Figure ES- 3. Summary of Average Sulphur Dioxide Audit Results

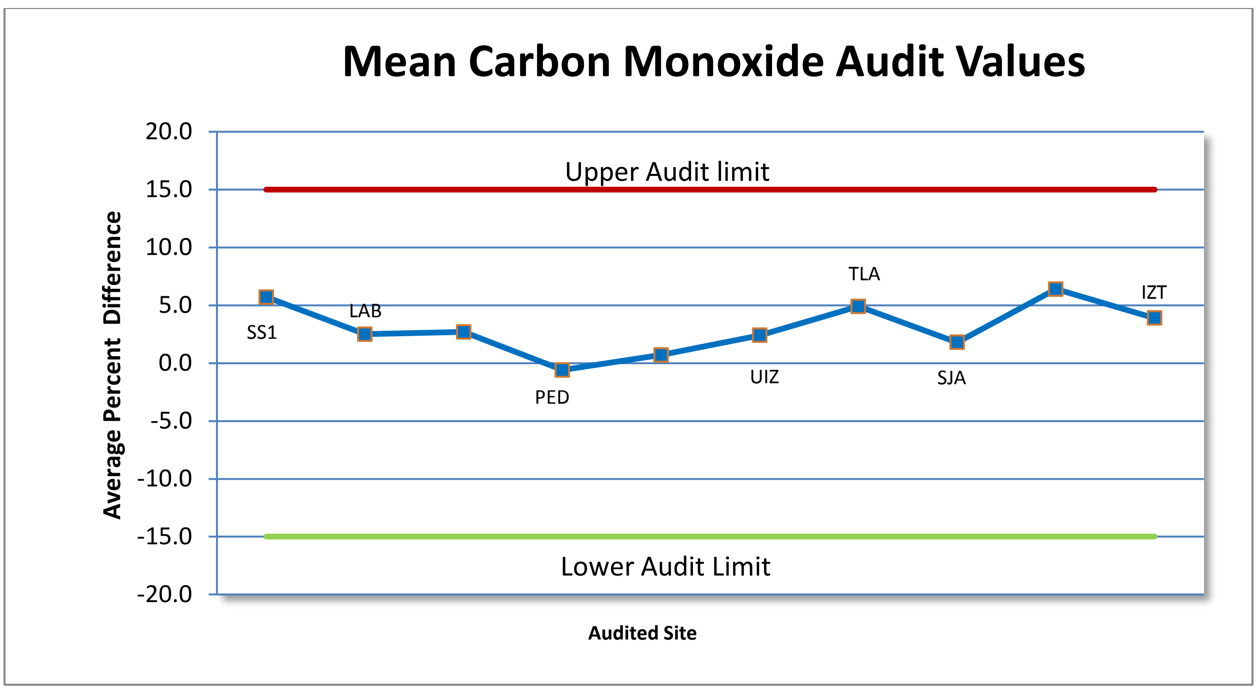


Figure ES- 4. Summary of Average Carbon Monoxide Audit Results

1.0 INTRODUCTION

This report details the Technical Systems and Performance (TS&P) audit conducted on ten (10) ambient air monitoring sites operated by Ciudad de Mexico. Mexico City Atmospheric Monitoring System (Sistema de Monitoreo Atmosférico de la Ciudad de México, SIMAT) operates a total of 30 automated stations for criteria gases and PM in and around Mexico City. The audit was conducted 24 – 28 November 2014 and was designed to determine the operational state of the individual criteria monitors (performance audit) as well as evaluate the systems and procedures used to calibrate and operate the network. Some monitoring stations also have particulate monitoring (manual and continuous) and meteorological monitoring, but these parameters were not part of the audit.

1.1 MEXICO CITY METROPOLITAN AREA

The Mexico City Metropolitan Area (MCMA) lies in an elevated basin at an altitude of 2,240 meter above mean sea level (amsl), near the center of the country (19º25' N latitude, 99º10' W longitude). The floor of the basin is confined on three sides by mountain ridges with a broad opening to the north and narrowed gap to the south-southwest. The surrounding peaks attain an elevation of nearly 4,000 meter asml. The metropolitan area is located on the southwest side of the basin and covers about 1500 km^2. The MCMA includes the 16 "delegaciones" within the Federal District and clusters of municipalities (municipios) including 37 in the State of Mexico. The Federal District (DF) is the country capital and is home to the national political institutions, the greatest concentration of economic investments and most of the country's industrial and financial infrastructure. MCMA has over 21 million inhabitants.

1.2 SECRETARÍA DEL MEDIO AMBIENTE DEL GOBIERNO DEL DISTRITO FEDERAL

The Secretariat of the Environment of the Federal District Government (Secretaría del Medio Ambiente del Gobierno del Distrito Federal) is responsible for environmental policies and programs, including implementing local and federal laws, in the Federal District. Since 1993, the Secretariat of the Environment of the Federal District Government has been the primary organization responsible for ambient air monitoring in the Mexico City Metropolitan Area and operates the Mexico City Atmospheric Monitoring System (Sistema de Monitoreo Atmosférico, SIMAT) for this purpose.

The Atmospheric Monitoring System consists of 44 monitoring stations, a support laboratory, an environmental information center, and an information technology support center. Monitoring is further segregated into an Automatic Ambient Air Monitoring Network (Red Automática de Monitoreo Atmosférico, RAMA), a Manual Particulate Monitoring Network, an Atmospheric Deposition Network, and a Meteorological Network. With the support of the environmental information center and the information technology support center, monitoring data are translated daily and hourly into the Metropolitan Area Air Quality Index (Índice Metropolitano de la Calidad del Aire, IMECA). The IMECA is widely distributed to public and private sector organizations in the Mexico City area to assist in making public health decisions.

Currently the SIMAT network consist of 31 automated stations (O_3, NO_X, SO_2, CO, PM_{10} and $PM_{2.5}$), 11 manual stations (TSP, PM_{10}, $PM_{2.5}$ and heavy metals), 20 meteorological stations (RH, T, WDR, WSP, P and UV radiation) and 16 atmospheric deposition stations (wet and dry atmospheric deposition).

The audit was performed at 9 of the 30 automatic station sites operated as part of the SIMAT network. In addition, as part of the audit, the reference analyzers of the SIMAT laboratory were audited. A summary of the audit schedule along with the parameters audited is summarized in Table 1-1 below. Table 1-2 shows the make, model, and serial number (S/N) of each audited gas-phase analyzer at the 10 sites. A map showing the location of the 10 sites is presented in Figure 1-1. Site descriptions for the 10 sites are presented below in Section 1.3.

Table 1.1. Summary of Site Parameters

Site Name	Initials	Date Audited	Parameters Audited
Super Site 1	SS1	24/11/2014	NO_x, NO_y, CO, O_3, SO_2
SIMAT Laboratory	LAB	24/11/2014	NO_x, CO, O_3, SO_2
Ajusco Medio	AJM	25/11/2014	NO_x, CO, O_3, SO_2
Pedregal	PED	25/11/2014	NO_x, CO, O_3, SO_2
UAM Xochimilco	UIZ	26/11/2014	NO_x, CO, O_3, SO_2
UAM Iztapalapa	UAX	26/11/2014	NO_x, CO, O_3, SO_2
Tlalnepantla	TLA	27/11/2014	NO_x, CO, O_3, SO_2
San Juan Aragon	SJA	27/11/2014	NO_x, CO, O_3, SO_2
Merced	MER	28/11/2014	NO_x, CO, O_3, SO_2
Iztacalco	IZT	28/11/2014	NO_x, CO, O_3, SO_2

Table 1.2. Summary of Analyzer Make, Model, and Serial Number at Each Site

Site	Analyte	Analyzer Make	Analyzer Model	Analyzer S/N
SS1	O_3	API	400E	112
	NO_X	API	200E	1611
	NO_y	API	T200U	65
	SO_2	Ecotech	Serinus 50	10-1788
	CO	Ecotech	Serinus 30	10-1753
LAB	O_3	API	400A	888
	NO_X	API	200A	2356
	SO_2	API	100A	1707
	CO	API	300	1781
AJM	O_3	Thermo	49i	1403660577
	NO_X	Thermo	42i	1403660574
	SO_2	Thermo	43i	1403660608
	CO	Thermo	48i	1403660606
PED	O_3	API	T400	77
	NO_X	API	200E	1629
	SO_2	API	100E	1336
	CO	API	300E	1292
UAX	O_3	Thermo	49i	5706
	NO_X	Thermo	42i	5698
	SO_2	Thermo	43i	5694
	CO	Thermo	48i	5702
UIZ	O_3	API	400E	1213
	NO_X	API	200E	1622
	SO_2	API	100E	1352
	CO	API	300E	1289
TLA	O_3	API	400E	1215
	NO_X	API	T200	73
	SO_2	API	T100	70
	CO	API	T300	1248
SJA	O_3	API	400E	1202
	NO_X	API	200	497
	SO_2	API	100E	1357
	CO	API	300E	1290
MER	O_3	API	T400	76
	NO_X	API	200E	1610
	SO_2	API	T100	72
	CO	API	T300	66
IZT	O_3	API	400E	1200
	NO_X	API	200E	1624
	SO_2	API	100E	1360
	CO	API	T300	65

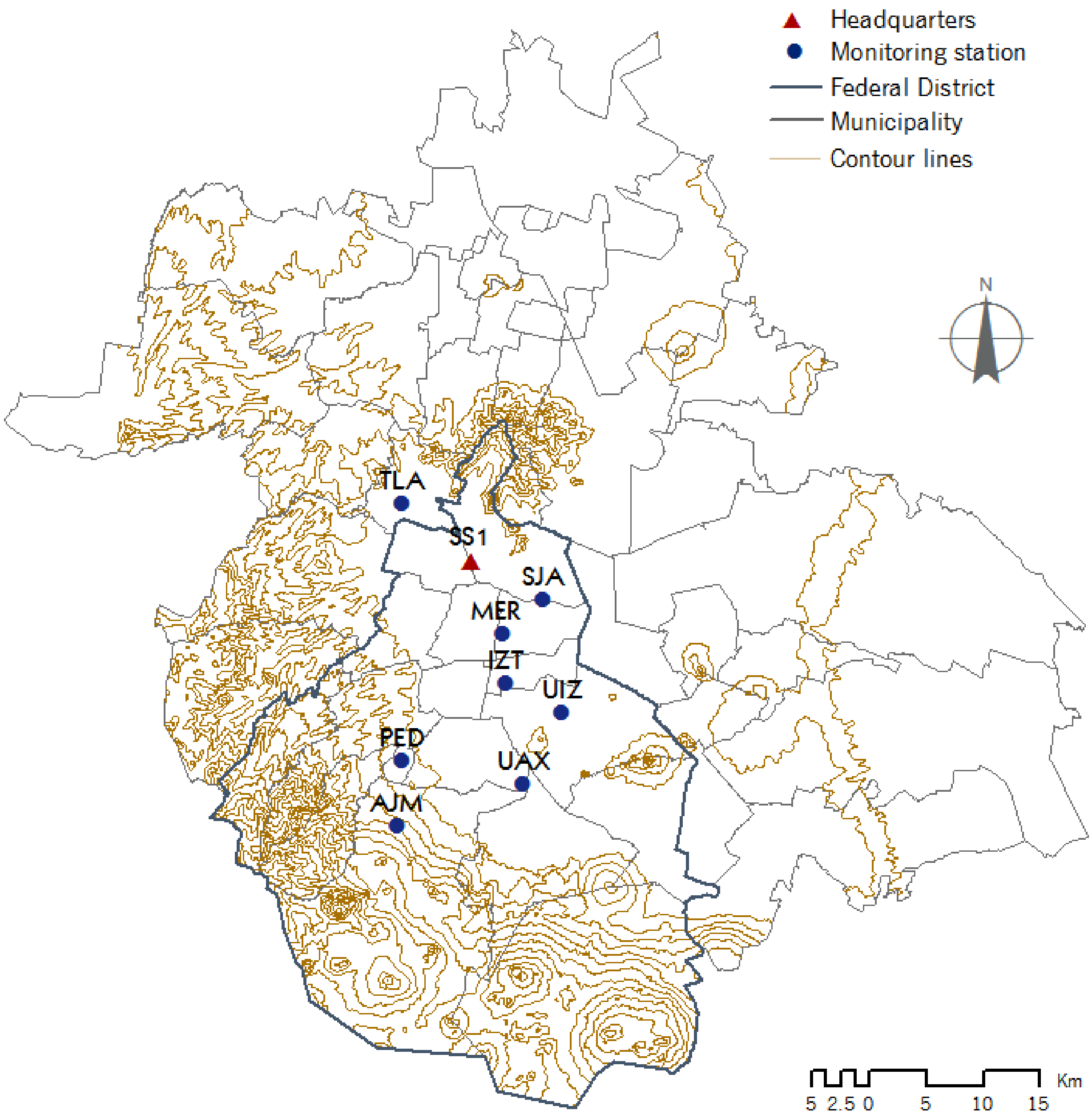


Figure 1-1. Map of Mexico City Automated Network Sites

1.3 SITE INFORMATION

Site: Super Site #1 (SS1)

Address:

Avenida Sur de los Cien Metros s/n, Colonia Nueva Vallejo, Delegación Gustavo A. Madero, Distrito Federal, CP 07750.

Geographic Location:

19º29’1.34’’ N latitude, 99º08’50.12’’ W longitude.

Description:

This is a new site located on the roof of the SIMAT Laboratory building. The site is housed in an Ekto Shelter and had been recently commissioned at the time of the audit. This is the headquarters of the Sistema de Monitoreo Amosférico de la Ciudad de México and houses

Site: SIMAT Laboratory

Address:

Avenida Sur de los Cien Metros s/n, Colonia Nueva Vallejo, Delegación Gustavo A. Madero, Distrito Federal, CP 07750.

Geographic Location:

19º29’1.34’’ N latitude, 99º08’50.12’’ W longitude.

Description:

This is the headquarters of the Sistema de Monitoreo Amosférico de la Ciudad de México and houses some of the network’s reference analyzers. These units are not typically used to monitor ambient air but rather are used to do comparisons to field analyzers.

Site: Ajusco Medio

Address:

Encinos # 41, col. Miguel Hidalgo 4ta sección, Tlalpan, C.P. 14250

Geographic Location:

19° 16´ 19.49´´ N latitude, 99° 12´ 27.28´´ W longitude.

Description: This station is located on the fourth floor roof of a new hospital. The instruments are housed in an Ekto Shelter with sample inlet approximately 25 m above ground level. The “green” roof is covered in plant material to absorb rain fall, minimize runoff, and reduce heat buildup. This site is also equipped with a digital camera system that captures city-wide photo every 10 minutes for haze evaluation.

Site: Pedregal (PED)

Address:

Calle Cañada No. 370 esquina con Avenida Cráter, Colonia Pedregal de San Ángel, Delegación Álvaro Obregón, Distrito Federal, CP 01900.

Geographic Location:

19º19’30.52’’ N latitude, 99º12’14.89’’ W longitude.

Description:

This station is in a high-income residential area at the southwest of Mexico City, housed in a shed on the top of the second floor of an elementary school. There are no major streets adjacent to the station. Sample inlet is 11 m above ground level.

Site: UAM Xochimilco (UAX)

Address:

Universidad Autónoma Metropolitana, Campus Xochimilco, Edificio H. Calzada del Hueso No. 1100, Colonia Villa Quietud, Delegación Coyoacán, Distrito Federal, CP 04960.

Geographic Location:

19º18’16.00’’ N latitude, 99º06’13.20’’ W longitude.

Description:

This station is located on the fourth floor roof of the science building at Universidad Autónoma Metropolitana Campus Xochimilco. The system was housed in a concrete building. The university is situated in a gated residential area with no major streets adjacent to the station. The sample inlet is approximately 20 m above ground level.

Site: UAM Iztapala (UIZ)

Address:

Universidad Autónoma Metropolitana Campus Iztapalapa, Edificio T. Av. San Rafael Atlixco No. 186, Colonia La Vicentina, Delegación Iztapalapa, Distrito Federal, CP 09340.

Geographic Location:

19º21’38.86’’ N latitude, 99º04’25.97’’ W longitude.

Description:

This station is located on the top of the third floor building at Universidad Autónoma Metropolitana Campus Iztapalapa and housed in an Ekto Shelter. There are no major streets adjacent to the station. Sample inlet is approximately 18 m above ground level.

Site: Tlalnepantla (TLA)

Address:

Glorieta de Atlacumulco. Avenida Toluca s/n, Glorieta Atlacomulco, Colonia Tlalnemex, Municipio de Tlalnepantla de Baz, Estado de México, CP 54070.

Geographic Location:

19º31’44.68’’ N latitude, 99º12’16.55’’ W longitude.

Description:

This station is located in a shed on the top of a 2 meter platform in the northwest of the city in the municipality of Tlalnepantla, Estado de México. This site is located at a municipal water facility in a generally residential neighborhood. There are no major streets adjacent to this site. This site is downwind from a major industrial area located north of the site. Sample Inlet is approximately 6.8 m above ground level.

Site: San Juan Aragón (SJA)

Address:

Av. 504 y 506 s/n 2a sección, Col. Unidad San Juan de Aragón, C.P. 07920

Geographic Location:

19° 27´ 19.33´´ N latitude, 99° 5´ 9.94´´ W longitude.

Description:

This station is located in an Ekto Shelter located on the roof of a three story elementary school There are no major streets adjacent to this site only small residential streets. Sample Inlet is approximately 15 m above ground level.

Site: Merced (MER)

Address:

Avenida Congreso de la Unión esquina con Stand de Tiro s/n, Colonia Merced Balbuena, Delegación Venustiano Carranza, Distrito Federal, CP 15860.

Geographic Location:

19º25’28.60’’ N latitude, 99º07’10.54’’ W longitude.

Description:

This station is near the downtown of Mexico City in a shed on the third floor roof of a junior high school. The streets around the station are wide and heavily traveled. There is an elevated Metro railway to the west. Sample Inlet is 17 m above ground level.

Site: Iztacalco (IZT)

Address:

Guillermo Prieto y Melchor Ocampo No. 73, Col. Campamento 2 de octubre, C.P. 08930

Geographic Location:

19° 23´ 3.88´´ N latitude, 99° 7´ 3.5´´ W longitude.

Description:

This station is located on the roof of a two story health center in a residential area. There are no major streets adjacent to the station with only local traffic. Instruments are housed in an Ekto Shelter with sample inlet approximately 12 m above ground level.

1.4 BACKGROUND

This section provides background on the organizations involved with this audit.

1.4.1 Secretaría del Medio Ambiente del Gobierno del Distrito Federal (GDF)

The Secretariat of the Environment of the Federal District Government (*Secretaría del Medio Ambiente del Gobierno del Distrito Federal*) is responsible for environmental policies and programs, including implementing local and federal laws, in the Mexico City metropolitan area (Federal District and adjoined municipalities in the State of Mexico). The GDF became the primary organization responsible for ambient air monitoring in the Mexico City area in 1993 when the Automatic Ambient Air Monitoring Network (RAMA) was transferred to the GDF.

Prior to the early 1970's, air quality monitoring in Mexico City was part of the Normalized Pan American Sampling Network (*Red Panamericana de Muestreo Normalizado*). In 1971, Mexico passed the "Law for Preventing and Controlling Environmental Contamination", (*Ley para Prevenir y Controlar la Contaminación Ambiental*). In 1972 the Sub-secretary for Environmental Improvement (Subsecretaría de Mejoramiento del Ambiente) was created under the Secretary of Health. These events led to the creation of a 48 station National monitoring network, with 22 of these stations being in the Mexico City air basin. Currently the Mexico City Atmospheric Monitoring System (SIMAT) consists of 41 monitoring stations, a support laboratory, an environmental information center, and an information technology support center. Monitoring is further segregated into an Automatic Monitoring Network (RAMA), a Manual Particulate Monitoring Network, an Atmospheric Deposition Network, and a Meteorological Network. With the support of the environmental information center and the information technology support center, monitoring data are translated daily and hourly into the Metropolitan Area Air Quality Index (*Índice Metropolitano de la Calidad del Aire* (IMECA). The IMECA is widely distributed to public and private sector organizations in the Mexico City area to assist in making public health decisions.

1.4.2 Secretariat of the Environment and Natural Resources (SEMARNAT)

The Secretariat of the Environment and Natural Resources (*Secretaría de Medio Ambiente y Recursos Naturales* (SEMARNAT)) is the primary federal agency responsible for environmental protection in the Country of Mexico. The Sub-secretary of Environmental Protection Management (*Subsecretaría de Gestión para la Protección Ambiental*) is the SEMARNAT organizational unit primarily responsible for environmental quality. However, the National Institute of Ecology (*Instituto Nacional de Ecología* (INE)) provides technical and research support for environmental issues (including monitoring).

Prior to the 2009 air monitoring audit, the United States Environmental Protection Agency (USEPA) performed the Mexico City ambient air monitoring network audits as requested by the Environmental Secretariat of the Government of the Federal District (*Secretaría del Medio Ambiente del Gobierno del Distrito Federal* (GDF)) and the Pan American Health Organization (PAHO). The physical audits were performed by the USEPA Office of Air Quality Planning and Standards (OAQPS) and were conducted in 2003 and 2005. Prior to this, audits were performed as an adjunct to a research program in Mexico City by the USEPA Office of Research and Development (ORD). No additional audits by any agency of the USEPA since 2005 have been performed.

2.0 DESCRIPTION OF AUDIT METHODOLOGY

Performance audits are intended to independently evaluate the performance of an organization's monitoring equipment, calibration equipment, standards, and all operating, calibration, maintenance, quality assurance, and quality control procedures. Performance audits involve independent audit equipment, an independent auditor, and independent gas standards to challenge the instrumentation. Gaseous pollutant audits were accomplished by challenging the instruments through the inlet to the sampling probe. The acceptance criterion for gaseous pollutants is 15% mean absolute difference and 15% for each concentration level of each pollutant analyzer. Monitors that exceed this criterion require corrective action. Also evaluated are the instruments response to individual audit concentrations, instrument linearity based on multiple standards, and zero checks.

Technical System Audits (TSAs) and Management System Reviews (MSRs) are reviews intended to evaluate how well the established quality system is working. TSAs are used to verify that appropriate technical and quality control procedures have been established and are being followed. For air monitoring organizations, some areas which are audited include:

- Written procedures;
- Documentation;
- Monitoring network design;
- Site appropriateness/siting requirements;
- Instrument operation;
- Laboratory procedures;
- Sample/data custody;
- Data handling systems;
- Data processing and calculation;
- Quality control; and
- Performance audit system.

Management System Reviews (MSRs) are evaluations of how effectively the QA program is working. These audits evaluate the overall quality system but may not effectively identify technical defects with the system. Possible elements of a MSR include the evaluation of:

- Organizational structure;
- Quality policy;
- Quality manager empowerment and effectiveness;
- Quality documentation;
- Corrective actions;
- Training and qualifications of staff;

- Commitment to quality by management and staff; and
- Overall effectiveness of the quality system.

The technical systems audit addressed a number of the issues outlined above.

2.1 PERFORMANCE AUDIT PROCEDURES

The station performance audits were performed using an Environics Model 6103 (S/N 4880) calibrator and an API Model 701 air source. An EPA Protocol 1 calibration standard manufactured by Airgas Specialty Gases of Holland, Ohio was used to make individual dilution concentrations for the NO_x, SO_2 and CO analyzers. Ozone concentrations were produced by the Environics calibrator using the on-board ozone generator and certified photometer.

The calibrator was certified prior to the audit. The source and dilution mass flow controller calibrations were performed in Austin, Texas by EPA Systems using BIOS Defender 510 H and L primary flow standards while the photometer was certified by the USEPA Region 6 laboratory in Houston, TX. Flow calibrations and USEPA ozone photometer certifications are shown in Appendix A.

Table 2-1 presents the concentrations of the individual criteria pollutant analytes with a copy of the gas certification provided in Appendix A. The cylinder's certification is considered valid for 96 months from manufacture. The ozone concentrations were generated by the Environics 6103 (S/N 4880) based on the ozone certification performed by USEPA Region 6 in November 2014. Acceptable ranges for primary standards are a slope of between 0.970 and to 1.030 and a range of intercepts of ±1 – 3 ppb. The Environics had a slope of 1.0036 and an intercept of -0.34 ppb. Ozone transfer standards need to be recertified every three months and primary standards need recertification every 12 months.

During the audit, each instrument was challenged with at least four different gas concentrations (three to five upscale points plus zero). In addition, a three-point gas-phase titration (GPT) was performed on each NO_x analyzer to test the NO_2 conversion efficiency. The GPT was performed by first creating a stable NO concentration and adding ozone at a concentration approximately 100 ppb lower than the NO concentration so that adjusted NO concentrations were between 80 and 120 ppb. This was done at three different ozone and NO concentrations to calculate the NO_2 converter efficiency.

To determine when the instrument readings were stable, the auditor used the STABIL function in each API analyzer to determine when the instrument reading was stable and could be recorded. A value at or below 2 ppb was used for O_3, NO_x, and SO_2 and a reading of 2 ppm was used for CO analyzers. This typically took 5 to 7 minutes for a stable reading to be obtained. For other instruments that didn't have this function the audit waited until the readings appeared stable and were no longer changing.

Because of site logistics, site security, and shortage of open space, most of the air quality stations in the Mexico City network are located on the roofs of governmental buildings, such as clinics, hospitals, schools, or universities. Each of the field sites and the main laboratory reference site were equipped with air quality monitors for nitrogen oxides (NO_x), sulphur dioxide (SO_2), ozone (O_3), and carbon monoxide (CO). In addition the SS1 site was also equipped with a trace level reactive nitrogen compounds NO_y analyzer.

In addition, most of the sites had continuous particulate monitors. These particulate monitors were typically Thermo Model 1405-DF FDMS combined PM_{10} / $PM_{2.5}$ samplers which measure $PM_{2.5}$ and PM_{10} simultaneously. In addition, many of the sites also had manual PM_{10} and $PM_{2.5}$ samplers along with meteorological sensors for wind speed and wind direction, ambient temperature, and solar radiation, however the audit scope did not include these parameters so they were not audited.

Other elements of the TSA and MSR audits included evaluating the physical condition of each site, site record keeping, operator knowledge and training, and overall operating procedures that can impact the data quality. For the first time this year, all of the sites audited were configured with air sources, dilution calibrators, and individual gas standards. All of these sites are zero and spanned on a weekly basis (Sunday night between 00:00 and 02:00).

The Mexico City operations staff conducts a series of calibrations at each site. These calibrations include:

- Instrument zero checks;
- Gas-phase titrations (GPTs); and
- Multipoint calibrations.

Table 2-2 summarizes the calibration frequency and calibration levels currently being implemented at the field sites. The audit results from each station are discussed below in Section 3.

Table 2.1. Summary of Gas Standard Concentrations

Gas Standard	Cylinder Number	Concentration (ppm)	Certification Date	Stability (months)
SO_2	CC453883	54.38	28//10/2014	96
NO		56.16		
CO		5440		

Table 2.2. Summary of Calibration Type, Frequency, and Acceptance Criteria

Calibration Type	Recommended Frequency	Concentration Levels	Criteria
Zero and Span Check	Weekly	**Level 1 –** 400 ppb for NO, SO_2, O_3, and 40 ppm for CO **Level 2 –** Zero	**Level 1 –** If instrument response is more than ±5% from standard values the analyzer is adjusted **Level 2 –** Zero ±3 ppb for O_3 Zero ±5 ppb for NO, SO_2 Zero ±0.5 ppm for CO
Gas Phase Titration (GPT)	During Each Multipoint Calibration	**Level 1** 400 ppb NO with 350 ppb O_3 **Level 2** 400 ppb NO with 50 ppb O_3	Converter Efficiency Greater than 96% or converter should be replaced
Multipoint Calibration performed through instrument's sample port	Quarterly	**Level 1** 400 ppb for NO, SO_2, O_3 and 40 ppm for CO **Level 2** 300 ppb for NO, SO_2, O_3 and 30 ppm for CO **Level 3** 200 ppb for NO, SO_2, O_3 and 20 ppm for CO **Level 4** 50 ppb for NO, SO_2, O_3 and 5 ppm for CO **Level 5** zero	If instrument response is more than ± 3% from standard values analyzer is re-calibrated

3.0 INDIVIDUAL SITE AUDIT RESULTS

This section describes the audit results for each of the nine field sites plus the main laboratory. During the audit, audit data were recorded into a formatted Excel spreadsheet that calculated percent difference from each known concentration value. In addition, each site was reviewed to check that the systems met general siting and operational specifications. This check assessed the overall site conditions including preventative maintenance, documentation, and overall system operation. In general, the audits followed US EPA guidelines for ambient air monitoring systems found in the following documents:

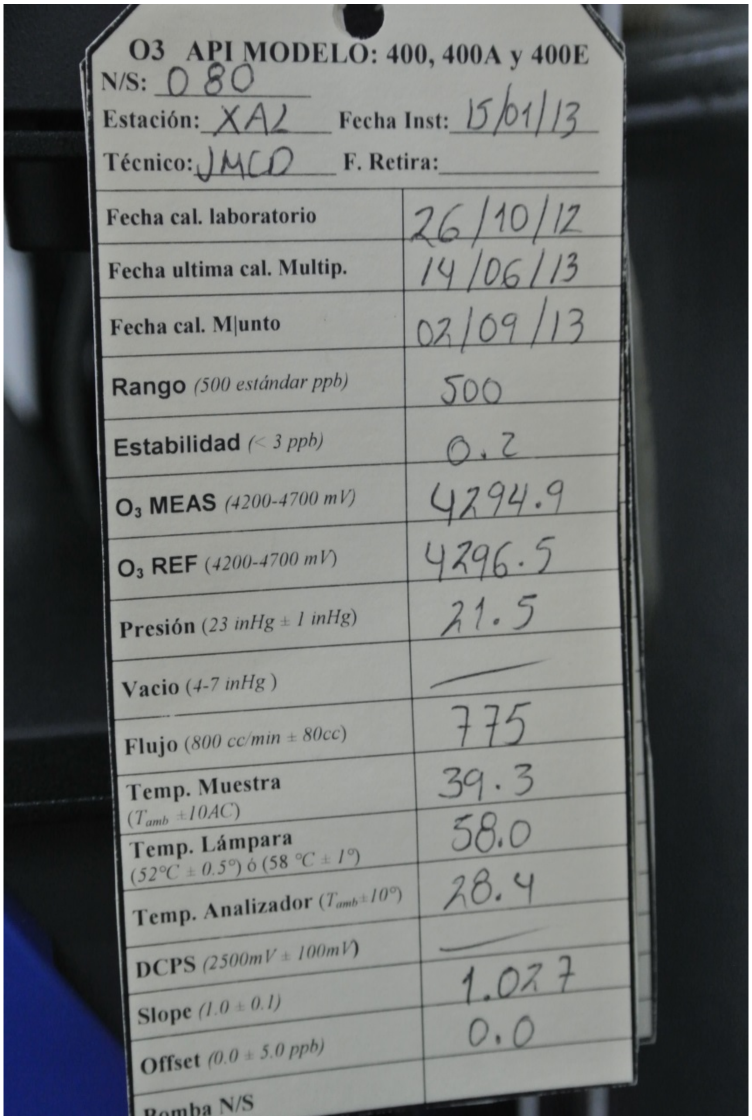
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II: Part 1, Ambient Air Quality Monitoring Program System Development, EPA-454/B-13-003, May 2013.
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I: A Field Guide to Environmental Quality Assurances, EPA/600/R-94/038a, April 1994.

3.1 GENERAL OBSERVATIONS

All of the sites were very well maintained, the plumbing and electrical wiring were well designed and consequently easy to work on, and finally, the shelters were quite clean. All of the glass sampling manifolds were found to be free of dirt and debris indicating that they were regularly cleaned and maintained. Standard protocols specify that each glass manifold is cleaned monthly as part of the network's preventative maintenance regime.

There were a number of "best practices" that the network uses to help ensure quality. There are Standard Operating Procedures (SOPs) for each analyzer make and model that can be referred to for new operators or used for training. During each quarterly multipoint calibration, instrument diagnostics information and instrument performance parameters are recorded for each instrument and written on a heavy paper tag that is affixed to each analyzer. A photograph of one of these tags is shown in Figure 3-1. Each time an operator goes to a site to perform calibrations or other maintenance activities, the current operational parameters are reviewed based on the values listed on each instruments performance tag. Any significant changes from the values on the tag may be indicative of a possible instrument malfunction or degraded performance. As this information is typically available (depending on how long an individual instrument has been at a site) for a given instrument for at least one year if not much longer, these tags allow an operator to very quickly determine if the current instrument performance has degraded (such as PMT voltage) since last multipoint calibration.

Figure 3-1. Photo of Instrument Information Tag



A review of the site operator logs showed that the operators were very good at documenting their on-site activities, entries were written in ink, cross-outs were properly done, entries were signed and dated, and the time in and out documented.

Operator logs are needed to reproduce data or determine the extent and rationale for any system downtime. It needs to be noted that site operators call the main laboratory each time they arrive or leave a site, so this information is documented in the main laboratory logs as well as the site logs.

Another best practice noted at each site included control charting of the zero and span data for each analyzer at the site. These data were kept at each site so the operator could quickly see if an analyzer's performance was different from previous results or if an analyzer's performance was slowly changing.

Overall, the nine ambient stations plus the laboratory reference analyzers appeared to be very well operated, the operators appear to be well trained, were very knowledgeable about QA/QC procedures and, clearly cared about the quality of their work.

During 2014, all of the continuous monitoring sites were equipped with equipment necessary to performed automated calibrations. This included API T700 dynamic dilution calibrators and API 701 clean air sources. The systems are configured to allow calibrations through each instrument's zero and span ports. Automated calibrations are now performed weekly at each site on Sunday night between 00:00 and 02:00. This calibration has now replaced the previously manual calibrations performed bi-weekly on each analyzer through the sample ports.

US EPA guidance requires that instrument zero's and span's be performed on a weekly basis (either manually or automatically). In addition on weekly zero/span calibration, bi-weekly precision checks are required. This three point calibration (zero, span, and a point 16% – 20% of span) must be through the instrument's sample line and as much of the sample system as practical. Prior to the full automation of the site this was being manually performed.

There are currently plans to evaluate the addition of the precision check point to the automated calibration sequence and perform this on a weekly basis and this is anticipated to be implemented during the first quarter of 2015.

There were two slight deviations from US EPA guidance. These include:

- Once implemented the precision check sample will still not be performed though the instrument sample ports.
- During quarterly multi-point calibration the GPTs should be performed at three points generally keeping the NO value constant.

Each of these issues is discussed further below.

The USEPA allows daily zero's and span's to be performed automatically through the zero/span ports but all other calibrations (Level One's or Precision checks, multipoint calibrations, and GPTs) must be performed using the sample ports. The USEPA "*Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II Ambient Air Quality Monitoring Program* (May 2013) states in Appendix F:

> *"The integration of DAS, solenoid switches, and MFC into an automated configuration can bring an additional level of complexity to the monitoring station. Operators must be aware that this additional complexity can create situations where leaks can occur. For instance, if a solenoid switch fails to open, then the inlet flow of an analyzer may not be switched back to the ambient manifold, but instead will be sampling interior room air. When the calibrations occur, the instrument will span correctly, but will not return to ambient air sampling. In this case, the data collected must be invalidated. These problems are usually not discovered until there is an external "Through-the Probe" audit, but by then extensive data could be lost. It is recommended that the operator remove the calibration line from the calibration manifold on a routine basis and challenge the sampling system from the inlet probe. This test will discover any leak or switching problems within the entire sampling system."*

This is to ensure that if a leak develops in the sample valve, then this leak will be found and repaired quickly. Otherwise a large bias may result from a leaking sample valve but the calibrations are still correct based on the zero/span port calibrations. Some networks perform automated calibrations by using a series of solenoid valves to switch between sample line and calibration line but feed all sample through the sample ports. When purchasing new instrumentation, this configuration is normally much cheaper than purchasing the optional zero/span ports.

The current lack of a precision check sample may allow a problem with an instrument's linearity to go unnoticed. However, since all multipoint calibrations are performed manually, this time period will never exceed three months. Once the precision check sample point is added to the automated calibration, leakage with a sample valve could still go unnoticed between multipoint calibrations.

The second issue concerns the GPT points. Currently they perform the GPT at two points, using a constant NO concentration and varying the O_3 concentration (e.g., 400 ppb NO with 350 and 50 ppb of O_3. US EPA recommends that NO_2 should be checked at the following concentration ranges (40 CFR Part 58 Appendix A, section 3.2.2.1):

- 0.006 and .010 ppm
- 0.11 and 0.30 ppm, and
- 0.31 and 0.60 ppm.

This is commonly performed by titrating various levels of NO with various levels of O_3 to yield approximately 100 ppb of NO at each point. For example;

- 450 ppb of NO with 350 ppb of $O_{3;}$
- 300 ppb of NO with 200 ppb of $O_{3;}$ and
- 200 ppb of NO with 100 ppb of $O_{3.}$

These three points each yield approximately 100 ppb of NO and 0.35 ppm, 0.20 ppm and 0.10 ppm of NO_2, values within the above guidelines.

While the audit results solidly demonstrate that all of the analyzers are performing well within acceptable limits, these small deviations from US EPA guidance leave open the potential to not capture possible future instrument problems in a timely manner.

Further discussions and audit results from each of the individual sites are presented in the sections presented below.

3.2 SUPER SITE NO. 1 (SS1)

This is a new site located on the roof of the SIMAT air monitoring laboratory. At the time of the audit the instrument inlet was not connected due to painting and maintenance activities at the school next to the station. All of the instruments were running, however, just the inlet had been disconnected to prevent potential contamination of the instruments. This site contained the standard set of criteria instruments but was also equipped with an ultralow reactive nitrogen oxides analyzer (NO_y). The audit results showed that all of the parameters {O_3 (0.7%), NO (-2.9%), NO_x (-1.6%), NO_y (-8.5%), $NO_{x(y)}$ (-8.4%), SO_2 (-1.9%), CO (5.7%)} were well within the audit objective of ± 15%. In addition, the GPT showed that the NO_x analyzer's NO_2 convertor efficiency was 101.5% and the NO_y analyzer's NO_2 convertor efficiency was 100.2%. Audit results for each of the analyzers at this site are shown in Tables 3-1 to 3-9. Photos of the site are shown in Figure 3-2.

Table 3.1. Summary of Ozone (O_3) Audit Results, SS1 Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.000	---	***Slope:***	0.97801
0.051	0.054	5.5%	***Intercept:***	0.00168
0.202	0.199	-1.7%	***Correlation:***	0.99996
0.399	0.392	-1.8%		

[1] Objective ±15%

Table 3.2. Summary of Nitrogen Oxides (NO_X) Audit Results, SS1 Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NOx	NO
0.000	0.002	0.002	---	---	***Slope:***	0.96866	0.97107
0.049	0.051	0.049	2.9%	-0.8%	***Intercept:***	0.00163	-0.00011
0.099	0.098	0.097	-1.9%	-2.6%	***Correlation:***	0.99995	0.99985
0.200	0.192	0.190	-3.9%	-4.9%			
0.300	0.294	0.288	-2.1%	-3.9%			
0.450	0.438	0.440	-2.7%	-2.2%			

[1] Objective ±15%

Table 3.3. Summary of Nitrogen Oxides (NO_x) Audit Results, SS1 Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NOx	NO	NO_X	NO	
Off	0.438	0.440	0.451	0.454	---
0.365	0.443	0.125	0.456	0.129	0.129
Off	0.294	0.288	0.301	0.297	---
0.200	0.291	0.117	0.298	0.121	0.121
Off	0.192	0.190	0.196	0.195	---
0.100	0.195	0.107	0.200	0.110	0.110

Table 3.4. Summary of Nitrogen Oxides (NO_x) GPT Results, SS1 Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	NO_2 Response (ppm-v)	NO_2 Percent Difference	NO_2 Converted (ppm-v)	NO_2 Analyzer	Regression Data
0.000	0.000	---	---	***Slope:***	0.97354
0.085	0.088	3.6%	0.089	***Intercept:***	0.00245
0.176	0.174	-1.4%	0.173	***Correlation:***	0.99988
0.325	0.318	-2.1%	0.330	***Converter Efficiency***[1]	**101.5%**

[1] **Acceptance Criteria >96%**

Table 3.5. Summary of Nitrogen Oxides (NO_y) Audit Results, SS1 Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NOx	NO
0.000	0.002	0.002	---	---	***Slope:***	0.91432	0.91671
0.049	0.046	0.045	-6.9%	-7.9%	***Intercept:***	0.00060	0.00004
0.099	0.090	0.090	-9.1%	-9.1%	***Correlation:***	0.99996	0.99997
0.200	0.181	0.181	-9.1%	-9.1%			
0.300	0.274	0.274	-8.6%	-8.5%			
0.450	0.414	0.414	-8.1%	-8.0%			

[1] Objective ±15%

Table 3.6. Summary of Nitrogen Oxides (NO_y) Audit Results, SS1 Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NOx	NO	NO_X	NO	
Off	0.414	0.414	0.452	0.451	---
0.365	0.412	0.111	0.450	0.121	0.121
Off	0.274	0.274	0.299	0.299	---
0.200	0.276	0.105	0.301	0.114	0.114
Off	0.181	0.181	0.198	0.198	---
0.100	0.182	0.099	0.198	0.108	0.108

Table 3.7. Summary of Nitrogen Oxides (NO_y) GPT Results, SS1 Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	NO_2 Response (ppm-v)	NO_2 Percent Difference	NO_2 Converted (ppm-v)	NO_2 Analyzer	Regression Data
0.000	0.001	---	---	***Slope:***	0.91275
0.090	0.083	-8.3%	0.090	***Intercept:***	0.00092
0.185	0.171	-7.6%	0.187	***Correlation:***	0.99998
0.330	0.302	-8.6%	0.328	***Converter Efficiency[1]***	**100.2%**

[1] Acceptance Criteria >96%

Table 3.8. Summary of Sulphur Dioxide (SO_2) Audit Results, SS1 Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.001	---	***Slope:***	0.98440
0.048	0.052	8.0%	***Intercept:***	0.00128
0.096	0.092	-4.8%	***Correlation:***	0.99986
0.193	0.192	-0.8%		
0.290	0.289	-0.3%		
0.435	0.429	-1.5%		

[1] Objective ±15%

Table 3.9. Summary of Carbon Monoxide (CO) Audit Results, SS1 Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	0.1	---	***Slope:***	1.02703
4.77	5.3	11.1%	***Intercept:***	0.26818
9.61	10.3	7.2%	***Correlation:***	0.99997
19.31	20.0	3.6%		
29.01	30.0	3.4%		
43.52	45.0	3.4%		

[1] Objective ±15%

Figure 3-2. Photo of SS1 Site on the Roof of the SIMAT Laboratory Facility

3.3 SIMAT AIR MONITORING LABORATORY (LAB) SITE

The air monitoring laboratory maintains a series of analyzers used as reference instruments and are not used to monitor air quality. The audit results showed that all of the parameters {O_3 (-1.0%), NO (-5.7%), NO_x (-5.9%), SO_2 (-0.4%), CO (2.5%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 100.3%. Audit results for each of the analyzers at this site are shown in Tables 3-10 to 3-15. Photos of the laboratory instrumentation are shown in Figure 3-3.

Table 3.10. Summary of Ozone (O_3) Audit Results, LAB Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.002	---	***Slope:***	0.95591
0.050	0.052	3.4%	***Intercept:***	0.00286
0.201	0.196	-2.5%	***Correlation:***	0.99998
0.401	0.386	-3.8%		

[1] Objective ±15%

Table 3.11. Summary of Nitrogen Oxides (NO_x) Audit Results, LAB Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NO_X	NO
0.000	0.001	0.000	---	---	***Slope:***	0.96706	0.96971
0.050	0.046	0.046	-7.4%	-8.2%	***Intercept:***	-0.00253	-0.00272
0.099	0.091	0.093	-8.1%	-7.0%	***Correlation:***	0.99988	0.99992
0.200	0.187	0.188	-6.1%	-5.9%			
0.300	0.286	0.287	-4.5%	-4.2%			
0.450	0.435	0.436	-3.3%	-3.2%			

[1] Objective ±15%

Table 3.12. Summary of Nitrogen Oxides (NO_x) Audit Results, LAB Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.435	0.436	0.452	0.452	---
0.365	0.436	0.093	0.453	0.098	0.098
Off	0.286	0.287	0.299	0.299	---
0.200	0.286	0.098	0.298	0.103	0.103
Off	0.187	0.188	0.196	0.196	---
0.100	0.188	0.099	0.197	0.104	0.104

Table 3.13. Summary of Nitrogen Oxides (NO_x) GPT Results, LAB Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	**NO_2 Response (ppm-v)**	**NO_2 Percent Difference**	**NO_2 Converted (ppm-v)**	**NO_2 Analyzer**	**Regression Data**
0.000	0.001	---	---	***Slope:***	0.96709
0.092	0.089	-3.4%	0.093	***Intercept:***	0.00011
0.196	0.188	-3.9%	0.195	***Correlation:***	0.99998
0.354	0.343	-3.1%	0.355	***Converter Efficiency[1]***	**100.3%**

[1] Acceptance Criteria >96%

Table 3.14. Summary of Sulphur Dioxide (SO_2) Audit Results, LAB Site

SO_2 Input (ppm-v)	**SO_2 Response (ppm-v)**	**Percent Difference [1]**	**SO_2 Analyzer Regression Data**	
0.000	-0.001	---	***Slope:***	1.01616
0.048	0.046	-4.6%	***Intercept:***	-0.00290
0.096	0.094	-2.8%	***Correlation:***	0.99997
0.193	0.192	-0.7%		
0.290	0.292	0.7%		
0.436	0.441	1.2%		

[1] Objective ±15%

Table 3.15. Summary of Carbon Monoxide (CO) Audit Results, LAB Site

CO Input (ppm-v)	**CO Response (ppm-v)**	**Percent Difference[1]**	**CO Analyzer Regression Data**	
0.00	0.0		***Slope:***	1.04123
4.81	5.0	4.0%	***Intercept:***	-0.21266
9.63	9.7	0.7%	***Correlation:***	0.99985
19.33	19.5	0.9%		
29.04	29.8	2.6%		
43.58	45.5	4.4%		

[1] Objective ±15%

Figure 3-3. Front and Back View of the SIMIT Laboratory Reference Analyzers

3.4 AJUSCO MEDIO (AJM) SITE

The air monitoring laboratory maintains a series of analyzers used as reference instruments and are not used to monitor air quality. The audit results showed that all of the parameters {O_3 (1.3%), NO (-1.7%), NO_x (-0.4%), SO_2 (-2.8%), CO (2.7%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 99.1%. Audit results for each of the analyzers at this site are shown in Tables 3-16 to 3-21. Photos of the site are shown in Figures 3-4 and 3-5.

Table 3.16. Summary of Ozone (O_3) Audit Results, AJM Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.001	---	***Slope:***	1.00019
0.052	0.053	1.0%	***Intercept:***	0.00182
0.200	0.206	3.0%	***Correlation:***	0.99988
0.401	0.401	0.0%		

[1] Objective ±15%

Table 3.17. Summary of Nitrogen Oxides (NO_x) Audit Results, AJM Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NOx	NO
0.000	0.002	0.000	---	---	***Slope:***	0.98985	0.98735
0.050	0.050	0.049	0.8%	-1.6%	***Intercept:***	0.00098	-0.00053
0.099	0.099	0.097	-0.2%	-1.9%	***Correlation:***	0.99998	0.99999
0.199	0.198	0.196	-1.0%	-1.8%			
0.299	0.296	0.294	-1.1%	-1.8%			
0.449	0.447	0.444	-0.5%	-1.2%			

[1] Objective ±15%

Table 3.18. Summary of Nitrogen Oxides (NO_x) Audit Results, AJM Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.447	0.444	0.451	0.450	---
0.365	0.443	0.099	0.447	0.101	0.101
Off	0.296	0.294	0.298	0.298	---
0.200	0.295	0.105	0.297	0.107	0.107
Off	0.198	0.196	0.199	0.199	---
0.100	0.197	0.105	0.198	0.107	0.107

Table 3.19. Summary of Nitrogen Oxides (NO_x) GPT Results, AJM Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	**NO_2 Response (ppm-v)**	**NO_2 Percent Difference**	**NO_2 Converted (ppm-v)**	**NO_2 Analyzer**	**Regression Data**
0.000	0.002	---	---	***Slope:***	0.98003
0.092	0.092	0.0%	0.091	***Intercept:***	0.00220
0.191	0.190	-0.5%	0.190	***Correlation:***	1.00000
0.349	0.344	-1.4%	0.345	***Converter Efficiency[1]***	**99.1%**

[1] Acceptance Criteria >96%

Table 3.20. Summary of Sulphur Dioxide (SO_2) Audit Results, AJM Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.000	---	***Slope:***	0.97010
0.048	0.047	-1.9%	***Intercept:***	0.00059
0.096	0.092	-3.9%	***Correlation:***	0.99990
0.193	0.188	-2.5%		
0.290	0.286	-1.3%		
0.435	0.420	-3.4%		

Mexico City Network TS&P Audit December 2014

[1] Objective ±15%

Table 3.21. Summary of Carbon Monoxide (CO) Audit Results, AJM Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	0.4	---	***Slope:***	1.02602
4.80	5.0	4.2%	***Intercept:***	0.09034
9.62	9.7	1.1%	***Correlation:***	0.99992
19.32	19.7	1.8%		
29.00	30.0	3.4%		
43.52	44.8	2.9%		

[1] Objective ±15%

Figure 3-4. Photo of AJM Ambient Site Shelter on Roof of Hospital

Figure 3-5. View of Mexico City from top of Shelter Roof

3.5 PEDREGAL (PED) SITE

This station is in a high-income residential area in southwest Mexico City housed in a shed on the top of the second floor of an elementary school. The shelter was very old and cramped but the equipment was well maintained. This site was equipped with API Model 700 calibrator and Model 701 air source to perform calibrations. An automated timer was used to automatically turn on the air source and calibrator and perform automatic calibrations. This was used instead of using a data logger and associated software. The audit results showed that all of the parameters {O_3 (0.5%), NO (-2.3%), NO_x (1.7%), SO_2 (0.6%), and CO (-0.6%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 98.3%. Audit results for each of the analyzers at this site are shown in Tables 3-22 to 3-27. Photos of this site are shown in Figure 3-6 below.

Table 3.22. Summary of Ozone (O_3) Audit Results, PED Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.000	---	**Slope:**	0.97857
0.050	0.052	4.0%	**Intercept:**	0.00174
0.201	0.200	-0.7%	**Correlation:**	0.99996
0.401	0.393	-1.9%		

[1] Objective ±15%

Table 3.23. Summary of Nitrogen Oxides (NO_x) Audit Results, PED Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NO_X	NO
0.000	0.004	-0.001	---	---	**Slope:**	0.98837	0.99605
0.050	0.053	0.049	7.2%	-1.7%	**Intercept:**	0.00366	-0.00206
0.099	0.100	0.093	0.9%	-6.2%	**Correlation:**	0.99998	0.99987
0.200	0.201	0.195	0.5%	-2.5%			
0.298	0.299	0.299	0.4%	0.2%			
0.450	0.448	0.445	-0.4%	-1.0%			

[1] Objective ±15%

Table 3.24. Summary of Nitrogen Oxides (NO_x) Audit Results, PED Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.448	0.445	0.450	0.449	---
0.365	0.445	0.108	0.447	0.111	0.111
Off	0.299	0.299	0.299	0.302	---
0.200	0.298	0.107	0.297	0.109	0.109
Off	0.201	0.195	0.200	0.198	---
0.090	0.198	0.105	0.197	0.107	0.107

Table 3.25. Summary of Nitrogen Oxides (NO_x) GPT Results, PED Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	NO_2 Response (ppm-v)	NO_2 Percent Difference	NO_2 Converted (ppm-v)	NO_2 Analyzer	Regression Data
0.000	0.005	---	---	*Slope:*	0.98172
0.091	0.094	3.0%	0.088	*Intercept:*	0.00394
0.193	0.191	-1.2%	0.191	*Correlation:*	0.99991
0.338	0.337	-0.2%	0.335	*Converter Efficiency*	**98.3%**

Table 3.26. Summary of Sulphur Dioxide (SO_2) Audit Results, PED Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.001	---	***Slope:***	1.00921
0.048	0.050	4.0%	***Intercept:***	0.00035
0.096	0.096	-0.2%	***Correlation:***	0.99997
0.194	0.194	0.3%		
0.289	0.293	1.5%		
0.436	0.440	1.0%		

[1] **Objective ±15%**

Table 3.27. Summary of Carbon Monoxide (CO) Audit Results, PED Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	-0.1	---	***Slope:***	1.03728
4.81	4.5	-6.4%	***Intercept:***	-0.42028
9.63	9.4	-2.4%	***Correlation:***	0.99992
19.36	19.4	0.2%		
28.89	29.6	2.5%		
43.57	44.9	3.1%		

[1] Objective ±15%

Figure 3-6. Front and Side Views of the PED Site Shelter

3.6 UAM Xochimilco (UAX) Site

This station is located on the fourth floor roof of the science building at Universidad Autónoma Metropolitana Campus Xochimilco. The system was housed in a concrete building. The audit results showed that all of the parameters {O_3 (-1.9%), NO (5.0%), NO_x (-3.5%), SO_2 (-0.9%), and CO (0.7%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 101.5%. Audit results for each of the analyzers at this site are shown in Tables 3-28 to 3-33. Photos of the site are shown in Figures 3-7 and 3-8.

Table 3.28. Summary of Ozone (O_3) Audit Results, UAX Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	---	---	***Slope:***	0.97976
0.051	0.050	-1.8%	***Intercept:***	0.00007
0.201	0.197	-2.0%	***Correlation:***	1.00000
0.401	0.393	-2.0%		

[1] **Objective ±15%**

Table 3.29. Summary of Nitrogen Oxides (NO_x) Audit Results, UAX Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NO_X	NO
0.000	0.002	0.001	---	---	***Slope:***	0.96537	0.95310
0.050	0.048	0.048	-2.3%	-4.1%	***Intercept:***	0.00014	-0.00028
0.099	0.095	0.093	-4.3%	-6.4%	***Correlation:***	0.99996	0.99998
0.199	0.190	0.190	-4.6%	-4.7%			
0.300	0.289	0.284	-3.4%	-5.1%			
0.449	0.435	0.429	-3.2%	-4.6%			

[1] Objective ±15%

Table 3.30. Summary of Nitrogen Oxides (NO_x) Audit Results, UAX Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.435	0.429	0.451	0.450	---
0.365	0.441	0.097	0.457	0.102	0.102
Off	0.289	0.284	0.300	0.298	---
0.200	0.289	0.103	0.299	0.109	0.109
Off	0.190	0.190	0.197	0.200	---
0.100	0.193	0.100	0.200	0.105	0.105

Table 3.31. Summary of Nitrogen Oxides (NO_x) GPT Results, UAX Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	**NO_2 Response (ppm-v)**	**NO_2 Percent Difference**	**NO_2 Converted (ppm-v)**	**NO_2 Analyzer**	**Regression Data**
0.000	0.001	---	---	***Slope:***	0.98573
0.095	0.093	-2.3%	0.098	***Intercept:***	0.00010
0.189	0.185	-2.0%	0.188	***Correlation:***	0.99997
0.348	0.344	-1.1%	0.354	***Converter Efficiency[1]***	**101.5%**

[1] Acceptance Criteria >96%

Table 3.32. Summary of Sulphur Dioxide (SO_2) Audit Results, UAX Site

SO_2 Input (ppm-v)	**SO_2 Response (ppm-v)**	**Percent Difference [1]**	**SO_2 Analyzer Regression Data**	
0.000	0.001	---	***Slope:***	0.99212
0.048	0.049	1.7%	***Intercept:***	0.00039
0.096	0.095	-1.6%	***Correlation:***	0.99998
0.193	0.192	-0.5%		
0.290	0.287	-1.0%		
0.435	0.433	-0.5%		

[1] Objective ±15%

Table 3.33. Summary of Carbon Monoxide (CO) Audit Results, UAX Site

CO Input (ppm-v)	**CO Response (ppm-v)**	**Percent Difference[1]**	**CO Analyzer Regression Data**	
0.00	0.1	---	***Slope:***	1.01262
4.80	4.8	0.7%	***Intercept:***	-0.01110
9.64	9.6	-0.9%	***Correlation:***	0.99996
19.32	19.5	0.8%		
29.01	29.6	2.0%		
43.54	44.0	1.1%		

[1] Objective ±15%

Figure 3-7. Front View of UAX Shelter

Figure 3-8. Side View of UAX Shelter

3.7 UAM IZTAPALAPA (UIZ) SITE

This station is located on the top of the third floor building at Universidad Autónoma Metropolitana Campus Iztapalapa and housed in an Ekto Shelter. The audit results showed that all of the parameters {O_3 (4.2%), NO (-1.7%), NO_x (0.7%) SO_2 (1.9%), and CO (2.4%)} were well within the audit objective of ± 15%. The GPT showed a NO_2 convertor efficiency of 101.2%. Audit results for each of the analyzers at this site are shown in Tables 3-34 to 3-40. Photos of the site are shown in Figures 3-9 and 3-10.

Table 3.34. Summary of Ozone (O_3) Audit Results, UIZ Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.002	---	***Slope:***	0.98615
0.048	0.054	11.5%	***Intercept:***	0.00436
0.201	0.205	1.7%	***Correlation:***	0.99992
0.403	0.401	-0.6%		

[1] **Objective ±15%**

Table 3.35. Summary of Nitrogen Oxides (NO_x) Audit Results, UIZ Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NO_X	NO
0.000	0.006	0.003	---	---	***Slope:***	0.97291	0.97928
0.049	0.053	0.049	6.9%	-0.2%	***Intercept:***	0.00436	0.00113
0.099	0.101	0.096	1.5%	-3.1%	***Correlation:***	0.99994	0.99996
0.199	0.196	0.196	-1.7%	-1.9%			
0.299	0.294	0.296	-1.8%	-1.3%			
0.450	0.444	0.441	-1.3%	-1.8%			

[1] Objective ±15%

Table 3.36. Summary of Nitrogen Oxides (NO_x) Audit Results, UIZ Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.444	0.441	0.452	0.449	---
0.365	0.444	0.102	0.452	0.103	0.103
Off	0.294	0.296	0.298	0.301	---
0.200	0.297	0.106	0.301	0.107	0.107
Off	0.196	0.196	0.197	0.199	---
0.100	0.198	0.106	0.199	0.107	0.107

Table 3.37. Summary of Nitrogen Oxides (NO_x) GPT Results, UIZ Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	**NO_2 Response (ppm-v)**	**NO_2 Percent Difference**	**NO_2 Converted (ppm-v)**	**NO_2 Analyzer**	**Regression Data**
0.000	0.003	---	---	***Slope:***	0.97955
0.092	0.092	0.0%	0.094	***Intercept:***	0.00223
0.194	0.191	-1.5%	0.197	***Correlation:***	0.99998
0.346	0.342	-1.2%	0.346	***Converter Efficiency[1]***	**101.2%**

[1] Acceptance Criteria >96%

Table 3.38. Summary of Sulphur Dioxide (SO_2) Audit Results, UIZ Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.002	---	***Slope:***	1.01743
0.048	0.049	2.5%	***Intercept:***	0.00075
0.096	0.097	1.5%	***Correlation:***	0.99999
0.193	0.197	2.0%		
0.290	0.296	2.0%		
0.435	0.444	2.0%		

[1] Objective ±15%

Table 3.39. Summary of Carbon Monoxide (CO) Audit Results, UIZ Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	0.1	---	***Slope:***	1.04148
4.78	4.7	-0.9%	***Intercept:***	-0.11727
9.60	9.8	1.8%	***Correlation:***	0.99996
19.31	19.9	3.1%		
29.00	30.3	4.5%		
43.54	45.2	3.7%		

[1] Objective ±15%

Figure 3-9. Rear View of the UIZ Ekto Shelter

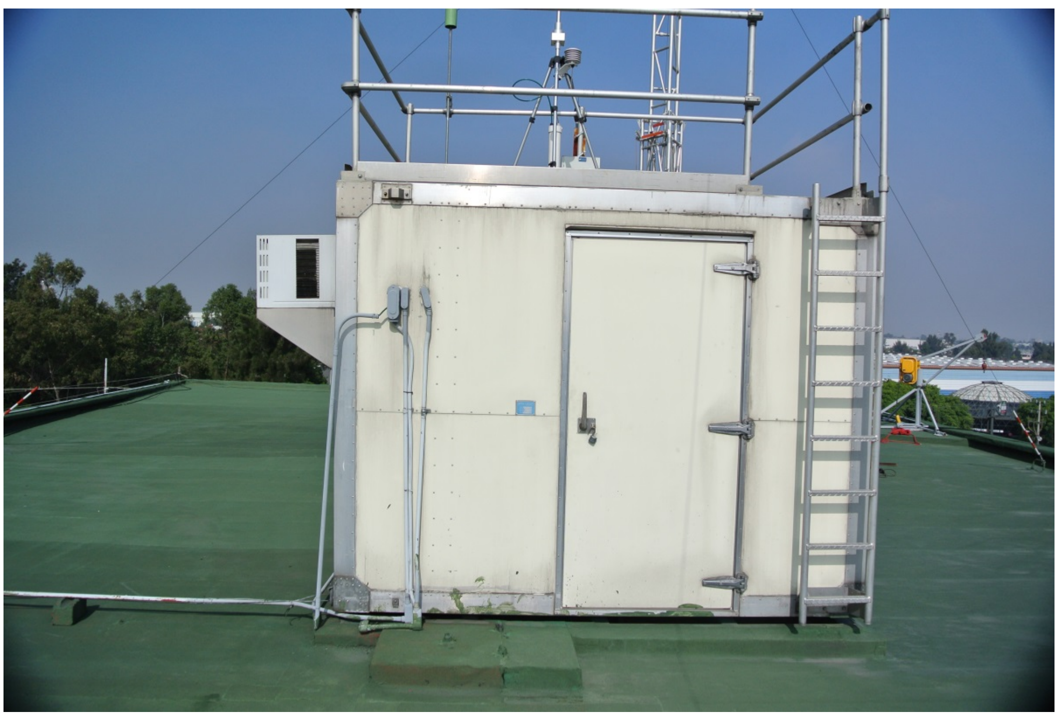


Figure 3-10. Front View of the UIZ Ekto Shelter

3.8 TLALNEPANTLA (TLA) SITE

This site was located in a shed about 2 meters above ground level adjacent to a municipal water storage tank. This was an older site but was well maintained and relatively clean. The audit results showed that all of the parameters {O_3 (1.7%), NO (-3.6%), NO_x (-2.5%), SO_2 (1.5%), and CO (4.9%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 98.49%. This site had previously held a PM_{10} analyzer, but at the time of the audit, the particulate analyzer had been removed. Audit results for each of the analyzers at this site are shown in Tables 3-40 to 3-45. Photo of the site is shown in Figures 3-11.

Table 3.40. Summary of Ozone (O_3) Audit Results, TLA Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.002	---	***Slope:***	0.98789
0.052	0.054	3.3%	***Intercept:***	0.00318
0.201	0.206	2.7%	***Correlation:***	0.99984
0.402	0.398	-1.0%		

[1] Objective ±15%

Table 3.41. Summary of Nitrogen Oxides (NO_x) Audit Results, TLA Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NOx	NO	Parameter	NO_X	NO
0.000	0.002	-0.001	---	---	***Slope:***	0.98716	0.97218
0.050	0.047	0.050	-4.6%	0.1%	***Intercept:***	-0.00074	-0.00147
0.099	0.097	0.092	-2.4%	-7.3%	***Correlation:***	0.99987	0.99991
0.199	0.196	0.191	-1.6%	-4.2%			
0.300	0.291	0.289	-3.0%	-3.7%			
0.449	0.446	0.437	-0.8%	-2.7%			

[1] Objective ±15%

Table 3.42. Summary of Nitrogen Oxides (NO_x) Audit Results, TLA Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.446	0.437	0.452	0.451	---
0.365	0.441	0.102	0.447	0.107	0.107
Off	0.291	0.289	0.295	0.298	---
0.200	0.296	0.108	0.301	0.112	0.112
Off	0.196	0.191	0.200	0.198	---
0.100	0.191	0.101	0.194	0.106	0.106

Table 3.43. Summary of Nitrogen Oxides (NO_x) GPT Results, TLA Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	NO_2 Response (ppm-v)	NO_2 Percent Difference	NO_2 Converted (ppm-v)	NO_2 Analyzer	Regression Data
0.000	0.002	---	---	*Slope:*	0.98187
0.092	0.090	-2.5%	0.086	*Intercept:*	0.00204
0.186	0.189	1.4%	0.192	*Correlation:*	0.99980
0.344	0.338	-1.6%	0.339	*Converter Efficiency*[1]	98.4%

[1] Acceptance Criteria >96%

Table 3.44. Summary of Sulphur Dioxide (SO_2) Audit Results, TLA Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.001	---	*Slope:*	1.02127
0.048	0.048	-0.4%	*Intercept:*	-0.00058
0.096	0.096	0.1%	*Correlation:*	0.99997
0.193	0.196	1.3%		
0.290	0.297	2.5%		
0.435	0.444	1.9%		

[1] Objective ±15%

Table 3.45. Summary of Carbon Monoxide (CO) Audit Results, TLA Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	0.1	---	*Slope:*	1.03734
4.80	5.1	6.2%	*Intercept:*	0.14274
9.61	10.1	5.0%	*Correlation:*	0.99994
19.31	20.1	4.1%		
29.02	30.6	5.5%		
43.53	45.1	3.6%		

[1] Objective ±15%

Figure 3-11. Side Views of the TLA Site

3.9 SAN JUAN ARAGON (SJA) SITE

This site was located on the third floor roof of an elementary school approximately 15 meters above ground level with monitoring equipment housed in an Ekto shelter. This site has a number a large trees higher than the roof line of the building and about even with the shelter's inlet that could pose some air flow restrictions. The audit results showed that all of the parameters {O_3 (4.6%), NO (-7.0%), NO_x (-1.3%), SO_2 (1.1%), and CO (1.8%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 100.4%. Audit results for each of the analyzers at this site are shown in Tables 3-46 to 3-51. Photos of the site are shown in Figures 3-12 and 3-13.

Table 3.46. Summary of Ozone (O_3) Audit Results, SJA Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.002	---	***Slope:***	1.00459
0.051	0.057	10.8%	***Intercept:***	0.00399
0.200	0.205	2.7%	***Correlation:***	0.99996
0.401	0.406	1.3%		

[1] **Objective ±15%**

Table 3.47. Summary of Nitrogen Oxides (NO_X) Audit Results, SJA Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NOx	NO	Parameter	NOx	NO
0.000	0.004	-0.001	---	---	***Slope:***	0.97250	0.96078
0.049	0.051	0.044	2.9%	-10.4%	***Intercept:***	0.00207	-0.00333
0.099	0.098	0.091	-1.8%	-8.6%	***Correlation:***	0.99992	0.99994
0.199	0.193	0.186	-3.1%	-6.8%			
0.300	0.292	0.284	-2.6%	-5.1%			
0.450	0.442	0.430	-1.8%	-4.3%			

[1] Objective ±15%

Table 3.48. Summary of Nitrogen Oxides (NO_X) Audit Results, SJA Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.442	0.430	0.452	0.451	---
0.365	0.443	0.092	0.454	0.100	0.100
Off	0.292	0.284	0.298	0.299	---
0.200	0.291	0.098	0.297	0.105	0.105
Off	0.193	0.186	0.197	0.197	---
0.100	0.195	0.097	0.198	0.104	0.104

Table 3.49. Summary of Nitrogen Oxides (NO_x) GPT Results, SJA Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	**NO_2 Response (ppm-v)**	**NO_2 Percent Difference**	**NO_2 Converted (ppm-v)**	**NO_2 Analyzer**	**Regression Data**
0.000	0.005	---	---	***Slope:***	0.98180
0.093	0.098	5.1%	0.094	***Intercept:***	0.00520
0.194	0.194	-0.3%	0.193	***Correlation:***	0.99995
0.351	0.351	-0.1%	0.353	***Converter Efficiency[1]***	100.4%

[1] Acceptance Criteria >96%

Table 3.50. Summary of Sulphur Dioxide (SO_2) Audit Results, SJA Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.003	---	***Slope:***	1.00737
0.048	0.049	3.0%	***Intercept:***	0.00135
0.096	0.097	1.2%	***Correlation:***	0.99998
0.193	0.195	0.9%		
0.290	0.294	1.2%		
0.435	0.441	1.2%		

[1] Objective ±15%

Table 3.51. Summary of Carbon Monoxide (CO) Audit Results, SJA Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	0.0	---	***Slope:***	1.04433
4.79	4.7	-1.9%	***Intercept:***	-0.23465
9.62	9.7	0.8%	***Correlation:***	0.99995
19.32	19.7	2.0%		
29.02	30.2	4.1%		
43.55	45.3	4.0%		

[1] Objective ±15%

Figure 3-12. Side View of Ekto Shelter at SJA Site, Looking West

Figure 3-13. Side View of Ekto Shelter at SJA site, Looking East

3.10 MERCED (MER) SITE

This station is near the downtown of Mexico City in a shed on the third floor roof of a junior high school. The streets around the station are wide and heavily traveled and there is an elevated Metro railway to the west. The audit results showed that all of the parameters {O_3 (-1.0%), NO (-3.7%), NO_x (-1.9%), SO_2 (1.4%), and CO (6.4%)} were well within the audit objective of ± 15%. The GPT showed a NO_2 convertor efficiency of 105.6%. Audit results for each of the analyzers at this site are shown in Tables 3-52 to 3-57. Photo showing s of this site is shown in Figure 3-14 below.

Table 3.52. Summary of Ozone (O_3) Audit Results, MER Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.001	---	***Slope:***	0.97516
0.051	0.051	0.4%	***Intercept:***	0.00152
0.200	0.198	-1.3%	***Correlation:***	0.99999
0.401	0.392	-2.2%		

[1] **Objective ±15%**

Table 3.53. Summary of Nitrogen Oxides (NO_x) Audit Results, MER Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NO_X	NO
0.000	0.005	0.001	---	---	***Slope:***	0.97099	0.97714
0.050	0.049	0.047	-1.1%	-4.5%	***Intercept:***	0.00196	-0.00121
0.099	0.099	0.094	0.0%	-4.9%	***Correlation:***	0.99983	0.99995
0.199	0.190	0.192	-4.7%	-3.9%			
0.299	0.295	0.291	-1.6%	-2.8%			
0.450	0.440	0.439	-2.2%	-2.2%			

[1] Objective ±15%

Table 3.54. Summary of Nitrogen Oxides (NO_x) Audit Results, MER Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NOx	NO	NO_X	NO	
Off	0.440	0.439	0.451	0.451	---
0.365	0.451	0.097	0.463	0.101	0.101
Off	0.295	0.291	0.301	0.299	---
0.200	0.301	0.102	0.308	0.105	0.105
Off	0.190	0.192	0.194	0.197	---
0.100	0.199	0.102	0.203	0.106	0.106

Table 3.55. Summary of Nitrogen Oxides (NO_x) GPT Results, MER Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	NO_2 Response (ppm-v)	NO_2 Percent Difference	NO_2 Converted (ppm-v)	NO_2 Analyzer Regression Data	
0.000	0.004	---	---	***Slope:***	1.00026
0.091	0.096	5.9%	0.100	***Intercept:***	0.00458
0.194	0.199	2.7%	0.201	***Correlation:***	0.99998
0.350	0.354	1.2%	0.362	***Converter Efficiency[1]***	105.6%

[1] Acceptance Criteria >96%

Table 3.56. Summary of Sulphur Dioxide (SO_2) Audit Results, MER Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.001	---	***Slope:***	1.02367
0.048	0.049	1.3%	***Intercept:***	-0.00100
0.096	0.097	1.0%	***Correlation:***	0.99992
0.193	0.194	0.4%		
0.290	0.294	1.3%		
0.435	0.447	2.7%		

[1] Objective ±15%

Table 3.57. Summary of Carbon Monoxide (CO) Audit Results, MER Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	0.1	---	***Slope:***	1.02914
4.80	5.2	8.4%	***Intercept:***	0.38619
9.61	10.5	9.2%	***Correlation:***	0.99981
19.32	20.4	5.6%		
29.01	30.7	5.8%		
43.54	44.8	2.9%		

[1] Objective ±15%

Figure 3-14. Photo of Side View of the MER Site

3.11 IZTACALCO (IZT) SITE

The IZT site is located on the second floor roof of a health care center in a residential area. The center is surrounded by 2 – 3 story homes with additional construction across the street. The audit results showed that all of the parameters {O_3 (2.6%), NO (-2.9%), NO_x (0.0%), SO_2 (-0.4%), CO (3.9%)} were well within the audit objective of ± 15%. The GPT showed a NO_2 convertor efficiency of 101.3%. Sample results for each of the analyzers at this site are shown in Tables 3-58 to 3-63. A photo of this site is shown in Figures 3-15.

Table 3.58. Summary of Ozone (O_3) Audit Results, IZT Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.003	---	***Slope:***	0.98333
0.053	0.057	7.0%	***Intercept:***	0.00448
0.201	0.204	1.6%	***Correlation:***	0.99996
0.400	0.397	-0.8%		

[1] Objective +15%

Table 3.59. Summary of Nitrogen Oxides (NO_x) Audit Results, IZT Site

NO_X / NO Input (ppm-v)	Response		Percent Difference[1]		NO_x Analyzer Regression Data		
	NO_X (ppm-v)	NO (ppm-v)	NO_X	NO	Parameter	NOx	NO
0.000	0.006	0.001	---	---	**Slope**	0.97649	0.97581
0.050	0.051	0.047	2.8%	-4.3%	***Intercept:***	0.00379	-0.00020
0.099	0.100	0.097	0.9%	-2.2%	***Correlation:***	0.99995	0.99998
0.199	0.197	0.194	-1.3%	-2.8%			
0.300	0.296	0.291	-1.3%	-3.0%			
0.450	0.444	0.440	-1.2%	-2.2%			

[1] Objective +15%

Table 3.60. Summary of Nitrogen Oxides (NO_x) Audit Results, IZT Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NOx	NO	NO_X	NO	
Off	0.444	0.440	0.451	0.451	---
0.365	0.449	0.093	0.456	0.095	0.095
Off	0.296	0.291	0.299	0.298	---
0.200	0.297	0.098	0.300	0.101	0.101
Off	0.197	0.194	0.198	0.199	---
0.100	0.199	0.100	0.200	0.102	0.102

Table 3.61. Summary of Nitrogen Oxides (NO_x) GPT Results, IZT Site

NO_2 Audit Data					
NO_2 Input (ppm-v)	NO_2 Response (ppm-v)	NO_2 Percent Difference	NO_2 Converted (ppm-v)	NO_2 Analyzer	Regression Data
0.000	0.006	---	---	***Slope:***	0.98705
0.097	0.099	2.1%	0.099	***Intercept:***	0.00455
0.197	0.199	1.0%	0.198	***Correlation:***	0.99998
0.356	0.356	0.1%	0.361	***Converter Efficiency[1]***	**101.3%**

[1] **Acceptance Criteria >96%**

Table 3.62. Summary of Sulphur Dioxide (SO_2) Audit Results, IZT Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.001	---	***Slope:***	1.00138
0.048	0.047	-2.8%	***Intercept:***	-0.00062
0.096	0.095	-0.9%	***Correlation:***	0.99998
0.193	0.191	-0.9%		
0.290	0.290	0.1%		
0.435	0.436	0.1%		

[1] **Objective ±15%**

Table 3.63. Summary of Carbon Monoxide (CO) Audit Results, IZT Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	0.2	---	***Slope:***	1.02923
4.80	5.0	4.2%	***Intercept:***	0.14940
9.62	10.1	4.9%	***Correlation:***	0.99998
19.31	19.9	3.1%		
29.02	30.2	4.1%		
43.54	44.9	3.1%		

[1] Objective ±15%

Figure 3-15. Front View of IZT Shelter

4.0 RESPONSE REQUIREMENTS

This section summarizes the primary and secondary concerns and observations from the audit. Table 4-1 presents a summary of the audit observations and concerns. Primary concerns are those that may affect the ability of the measurement system to produce data within the data quality objectives (DQOs) of the program while secondary concerns are minor issues that likely do not have any impact on the DQOs.

Primary concerns or observations identified in this audit report require a written response by the appropriate personnel assigned to each portion of the monitoring program. The purpose of a written response is to insure that all project team members are aware of the area of concern and that a corrective action plan is in place to prevent reoccurrence. Once the written response is received, the auditor can review the action or actions and close the audit. Based on the results of the previuos audit there are two primary concerns associated with calibration methodology that differ from US EPA guidance. It needs to be noted that these concerns, at the time of the audit, were NOT impacting data quality.

Table 4.1. Summary of 2014 Audit Observations and Concerns

Site	Description of Concern or Observation	Recommendation
Primary Concerns		
All Sites	GPTs are only being performed at two concentrations instead of three per US EPA guidance	Beginning with the next multipoint / GPT calibration, perform a three point GPT Calibration per 40 CFR Part 58 Appendix A (see section 3-1 for more detail)
All Sites	Since the stations have been automated the precision check (Level One) calibration is no longer performed through the sample line on a bi-weekly basis.	The precision check standard (16% to 20% of span) should be added to the automatic calibration. Preferably this calibration would be performed through the instrument's sample line but due to staff limitations this is not feasible. Not performing this calibration through the sample port may result in a leaking sample valve that is not found until a multipoint calibration is performed.