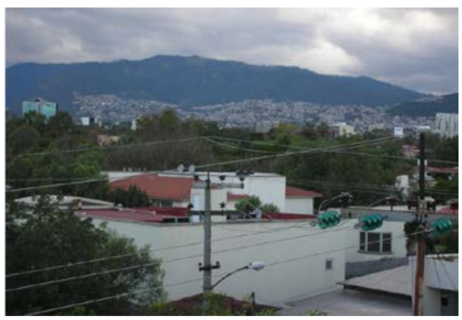
Audit of Ambient Air Monitoring Stations for the Sistema de Monitoreo Atmosférico de la Ciudad de México



Submitted to:

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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 30 September and 4 October 2013 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 Environics Model 6103 calibrator and API Model 701 clean air source. The performance audit consisted of challenging each nitrogen oxides (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO) and ozone (O_3) analyzer at four 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.

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

- Each operator carries a PDA to record site information that is downloaded and archived each day;
- The instrument diagnostic information collected during each multipoint calibration is checked during each site visit;
- 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. The only room for improvement is some inconsistency with the notation of arrival and departure times. All logs showed arrival times and a vast majority showed departure times, but a few operators didn't always record departure times. It should be noted that during each site visit the operator phones the main laboratory and prior to starting instrument work and phones again when they leave the site.

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.

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:

- Use of Teflon tubing for plumbing the Syntech 955 GCs;
- Use of zero/span ports for performing calibrations at some sites instead of performing these calibrations through sample ports.

These issues and possible implications are discussed further in this report.

Overall, the performance audit demonstrated that the sites were well run and were collecting valid and defensible data. Of the 37 instruments audited, none of the analyzers had responses that were greater than the audit objective of ±15% with the vast majority of the analyzers having average responses that were within ±5%. The 2012 audit also demonstrated that none of the analyzers had responses outside of the audit objective of ±15%.

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.

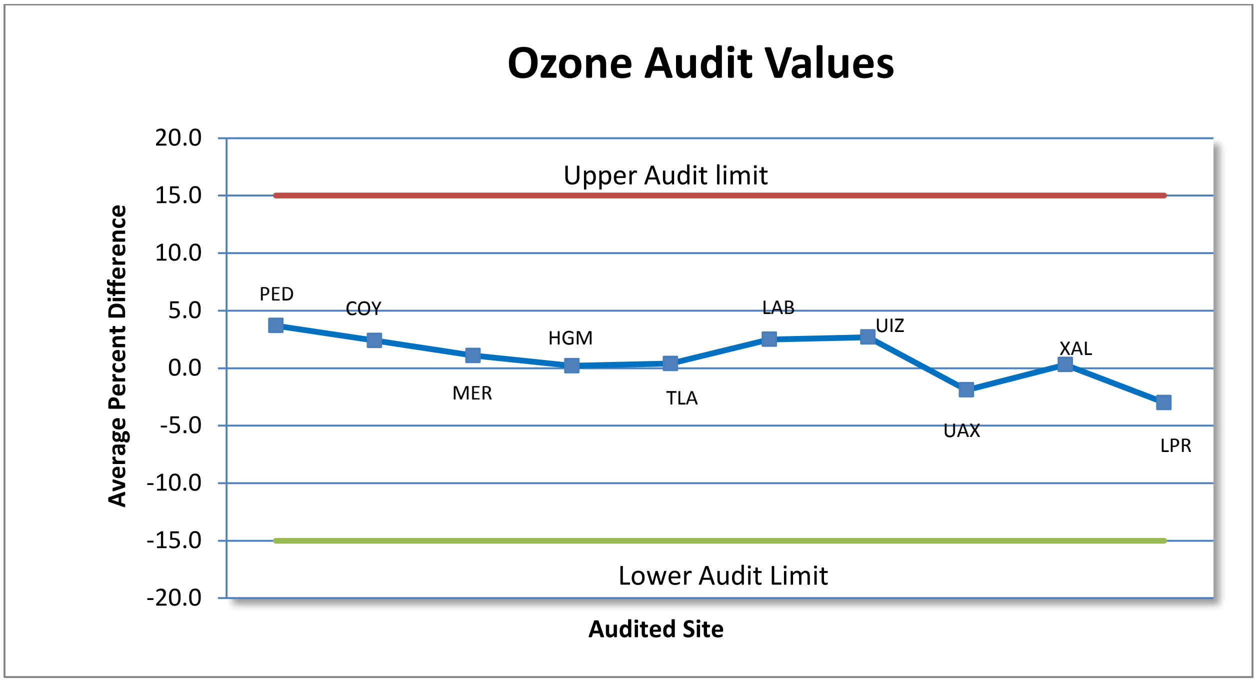


Figure ES- 1. Summary of Average Ozone Audit Results

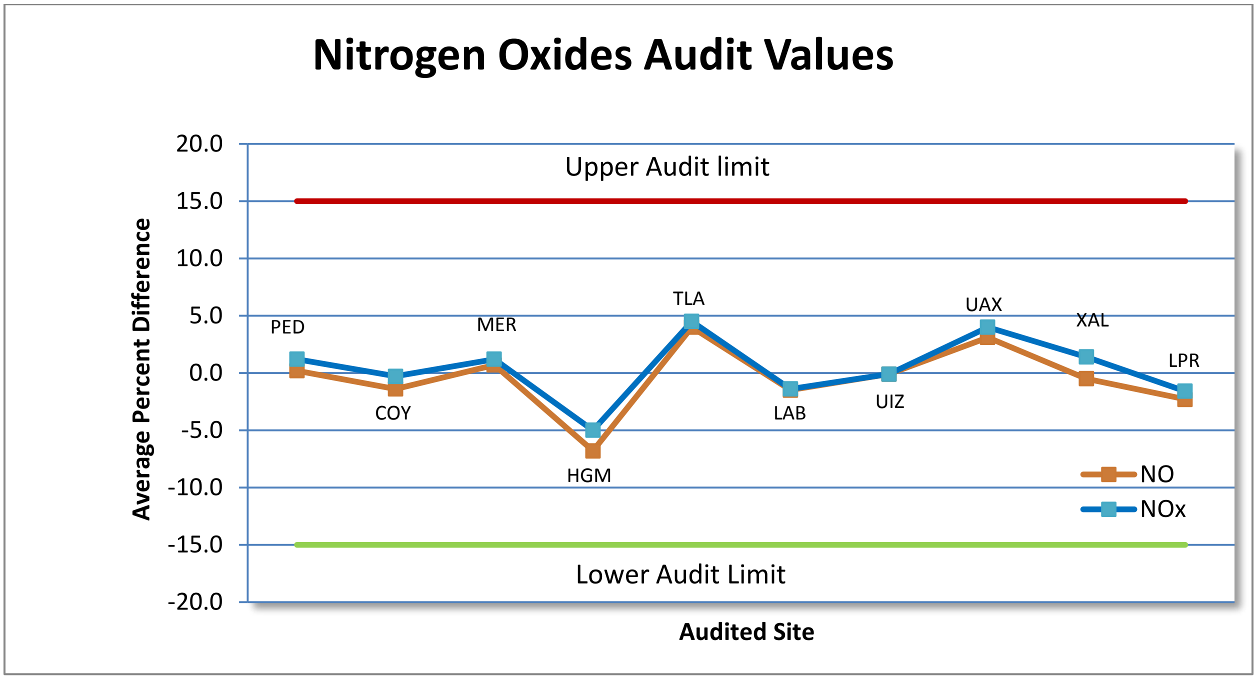


Figure ES- 2. Summary of Average Nitrogen Oxides Audit Results

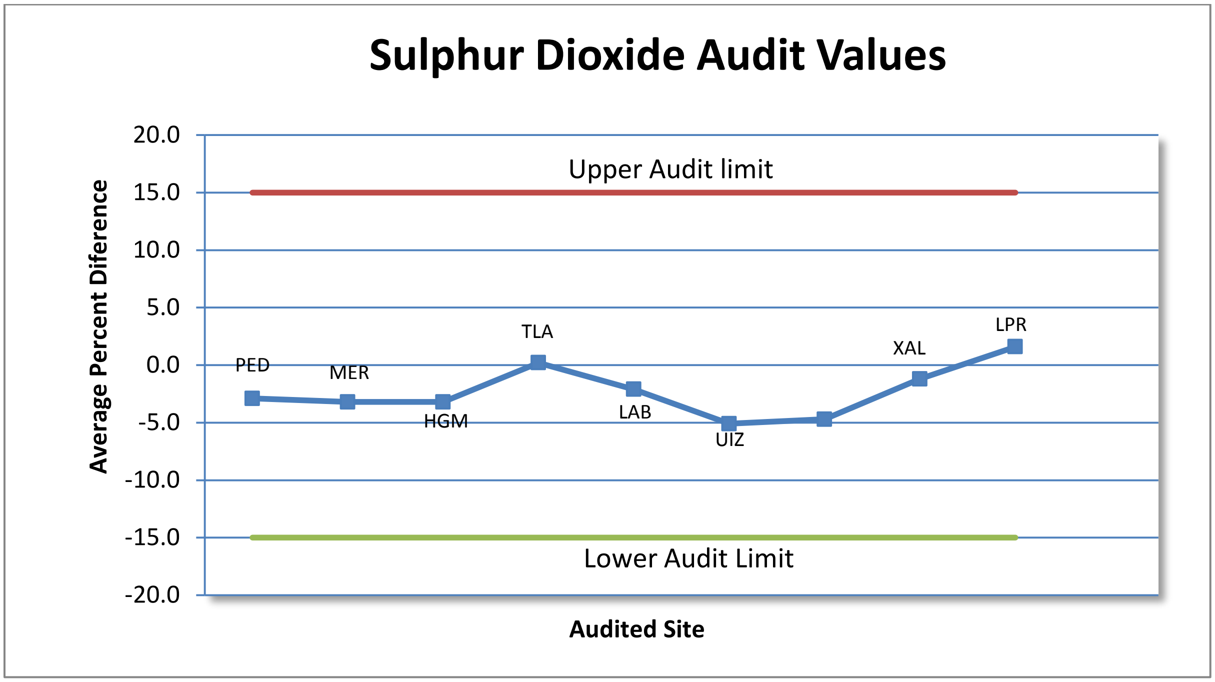


Figure ES- 3. Summary of Average Ozone Audit Results

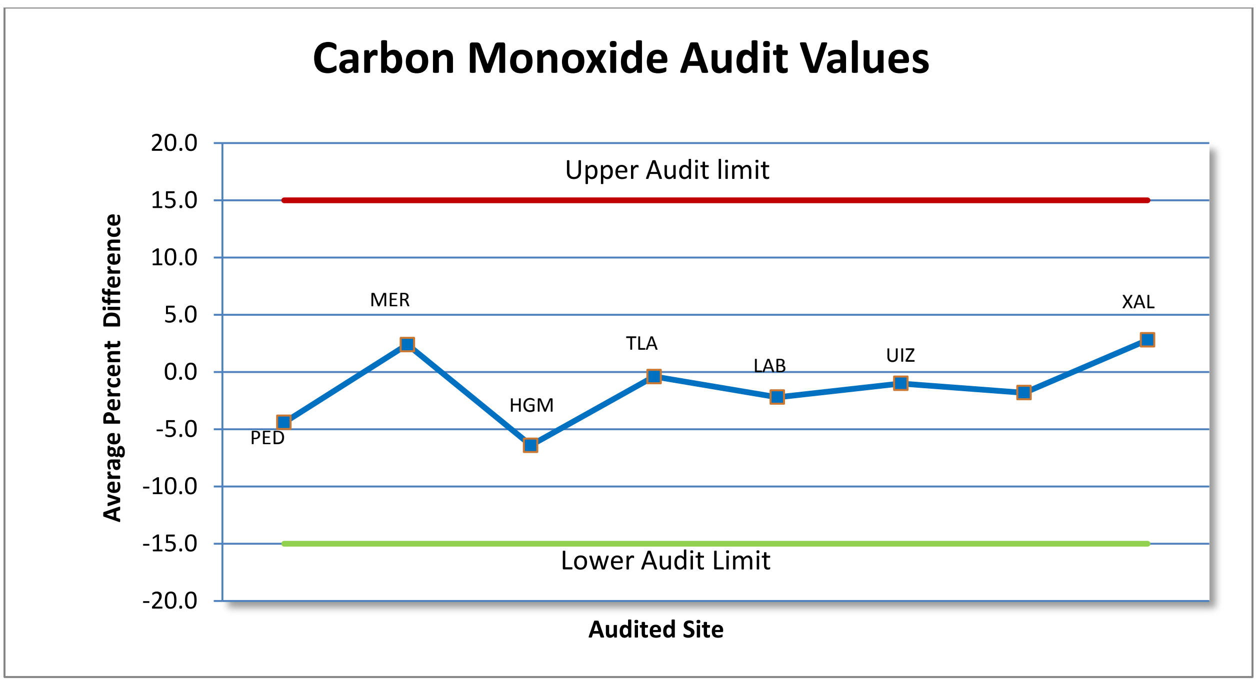


Figure ES- 4. Summary of Average Sulphur Dioxide Audit Results

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 29 automated stations for criteria gases and PM in and around Mexico City. The audit was conducted between 30 September and 4 October 2013 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 41 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 29 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), 18 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 29 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 Monitored
Pedregal	PED	30/09/2013	NO_x, CO, O_3, SO_2
Coyoacán	COY	30/09/2013	NO_x, O_3,
Merced	MER	1/10/2013	NO_x, CO, O_3, SO_2
Hospital General de México	HGM	1/10/2013	NO_x, CO, O_3, SO_2
Tlalnepantla	TLA	2/10/2013	NO_x, CO, O_3, SO_2
SIMAT Laboratory	LAB	2/10/2013	NO_x, CO, O_3, SO_2
UAM Iztapalapa	UIZ	3/10/2013	NO_x, CO, O_3, SO_2
UAM Xochimilco	UAX	3/10/2013	NO_x, CO, O_3, SO_2
Xalostoc	XAL	4/10/2013	NO_x, CO, O_3, SO_2,
La Presa	LPR	4/10/2013	NO_x, 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
PED	O_3	API	T400	77
	NO_X	API	200E	1629
	SO_2	API	100E	1336
	CO	API	300E	1292
COY	O_3	API	400E	1192
	NO_X	API	200E	1596
MER	O_3	API	T400	76
	NO_X	API	T200	70
	SO_2	API	T100	72
	CO	API	T300	66
HGM	O_3	Thermo	49i	5707
	NO_X	Thermo	42i	5699
	SO_2	Thermo	43i	5695
	CO	Thermo	48i	5703
TLA	O_3	API	400E	1215
	NO_X	API	T200	73
	SO_2	API	T100	70
	CO	API	T300	64
LAB	O_3	API	400A	888
	NO_X	API	200A	2356
	SO_2	API	100A	1707
	CO	API	300	1781
UIZ	O_3	API	400	792
	NO_X	API	200E	1631
	SO_2	API	100E	1352
	CO	API	300	1161
UAX	O_3	Thermo	49i	5706
	NO_X	Thermo	42i	5698
	SO_2	Thermo	43i	5694
	CO	Thermo	48i	5702
XAL	O_3	API	T400	80
	NO_X	API	T200	69
	SO_2	API	T100	71
	CO	API	T300	65
LPR	O_3	API	400E	1202
	NO_X	API	200E	1612
	SO_2	API	100	448

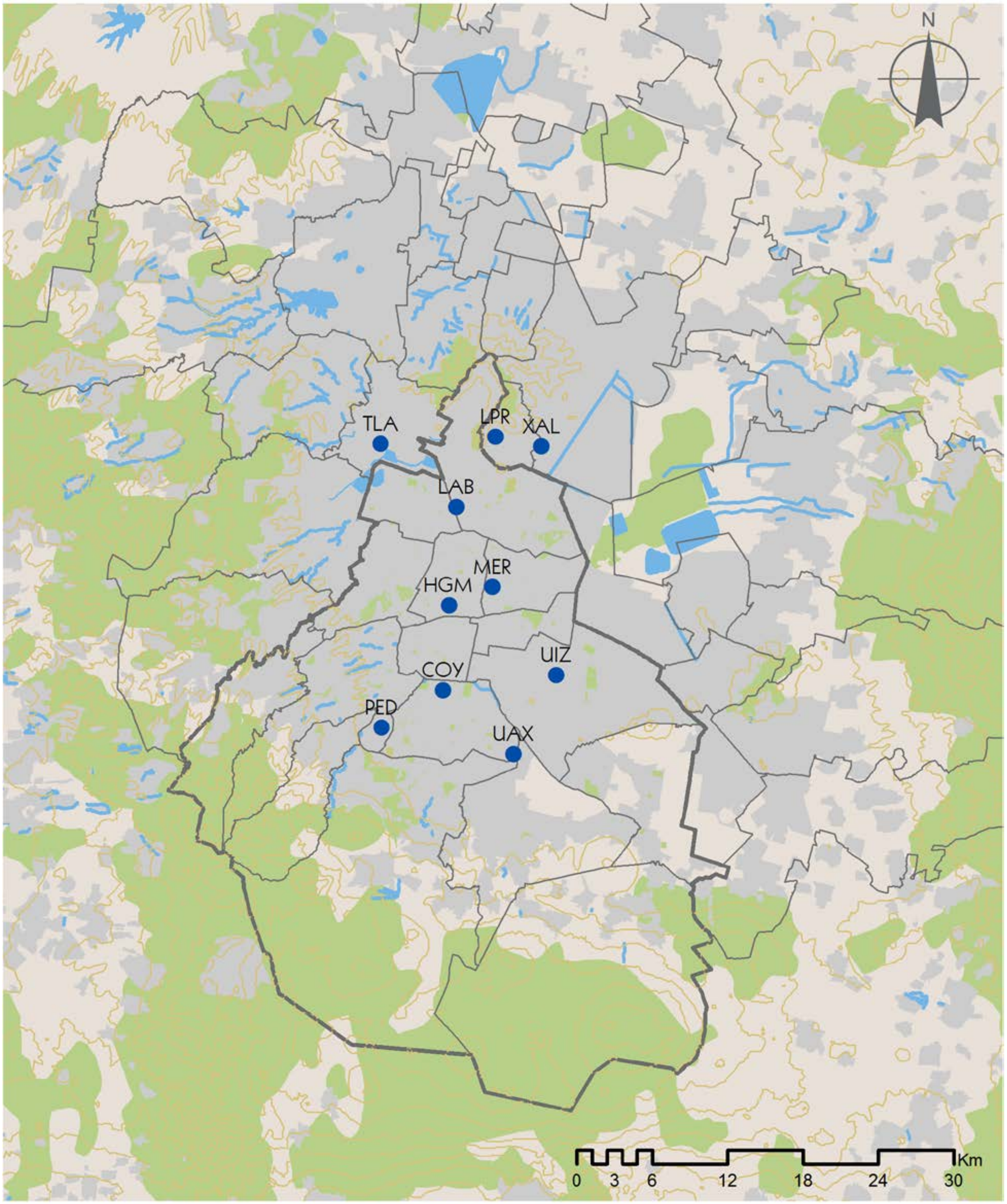


Figure 1-1. Map of Audited Mexico City Network Sites

1.3 SITE INFORMATION

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: Coyoacán (COY)

Address:

Escuela Secundaria Técnica no. 17 "Artes decorativas", Avenida Miguel Hidalgo no. 62, Colonia Del Carmen

Geographic Location:

19°21'0.93" N latitude, 99°9'25.56"W Longitude.

Description:

This station is located at the campus of an elementary school and housed in an Ekto Shelter on the top of the fourth floor. This school is located in an upscale residential area with no major roadways directly surrounding the site. 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: Hospital General de México (HGM)

Address:

Hospital General de México, Avenida Doctor Balmis no. 148, Colonia Doctores, Delegación Cuauhtémoc,

Geographic Location:

19°24'41.82"N latitude, Long: 99°9'7.95"W longitude

Description:

This station is located on the fourth floor roof of the Oncology building of the Hospital General de Mexico Medical Complex. This site is surrounded by new construction as this will be a large medical complex with many additional buildings under construction. Sample Inlet is approximately 27 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: 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: 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: 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: Xalostoc (XAL)

Address:

Vía Morelos km 12.5, entre López Rayón y Av. Benito Juárez, Colonia Xalostoc, Municipio Ecatepec de Morelos, Estado de México, CP 54190.

Geographic Location:

19º31’33.58’’ N latitude, 99º04’56.64’’ W longitude.

Description:

This station is in an industrial/commercial/residential area, it is housed in a shed on the top of the four floor of a Regional Hospital. There is a major avenue near the station with heavy traffic. Sample inlet is 30 m above ground level.

Site: La Presa (LPR)

Address:

Centro de Salud "Lázaro Cárdenas", Asociación de Excursionistas del Distrito Federal s/n, Colonia Lázaro Cárdenas, Municipio de Tlalnepantla, Estado de México, C. P. 54189

Geographic Location:

19°32’5.02” N latitude, 99°7’3.79” W longitude.

Description:

This station is located at a small local hospital site at the base of a mountain face. The site is in a concrete block building on ground level at the site. Site exposure is not ideal but due to the drastic change in elevation in the area, the siting is as good as possible given the terrain and surrounding structures. The sample inlet was located approximately 1 meter above a large block retaining wall on the back-side of the shelter. Air flow is also potentially impacted by several trees very near the site, however there was still a 270° free air flow around the inlet.

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 sent to the US and was re-calibrated prior to the audit. The source and dilution mass flow controller calibrations were performed in Austin, Texas by EPA Systems using BIOS Model Defender 520 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 36 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 September 2012. 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 1.0000 and an intercept of 0.62 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 five different gas concentrations (four to five upscale points plus zero). In addition, a 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 then adding ozone at a concentration approximately 100 ppb lower than the NO concentration. This was done at three different ozone and NO concentrations to calculate the NO_2 converter efficiency. For the API analyzers the auditor used the STABIL function in each 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.

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 nine 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, most of the sites had continuous particulate monitors. These particulate monitors were typically either BAM 1020 beta attenuation analyzers or R&P Model 1400a tapered element oscillating microbalances (TEOM) measuring PM_{10} or were 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. Due to the cost of air sources, dilution calibrators, and individual gas standards, not all of the sites were configured for automatic calibration. Typically, only those sites with the most difficult site access were configured with zero air sources and dilution calibrators. For sites not configured with dilution calibrators and air sources, during bi-weekly calibrations an air source, calibrator, and gas standard are taken to each site to perform calibrations.

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

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

Table 2-2 summarizes the calibration frequency and calibration levels. 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	CB09813	29.85	03/09/2013	36
NO		31.44		
CO		3001		

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

Calibration Type	Recommended Frequency	Concentration Levels	Criteria
Zero	Weekly	Zero for CO, NO, SO_2, O_3	Zero ±3 ppb for O_3 Zero ±5 ppb for NO and SO_2 Zero ±0.5 ppm for CO
Level One Precision Check (performed though instrument's sample port) Note: This is referred to as zero and span calibrations by the network	Bi-Weekly	**Level 1** – 400 ppb for NO, SO_2, O_3, and 40 ppm for CO **Level 2** – 50 ppb NO, SO_2, O_3, and 5 ppm for CO **Level 3** – Zero	**Level 1 –** If instrument response is more than ±5% from standard values the analyzer is adjusted **Level 2 –** ±5 ppb for O_3, NO, SO_2 ±0.5 ppm for CO **Level 3 –** Zero ±3 ppb for O_3 Zero ±5 ppb for NO, SO_2 Zero ±0.5 ppm for CO
Gas Phase Titration (GTP) for NO_X analyzer converter efficiency	Bi-Weekly	400 ppb NO with 350 ppb O_3	Converter efficiency >96%
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.

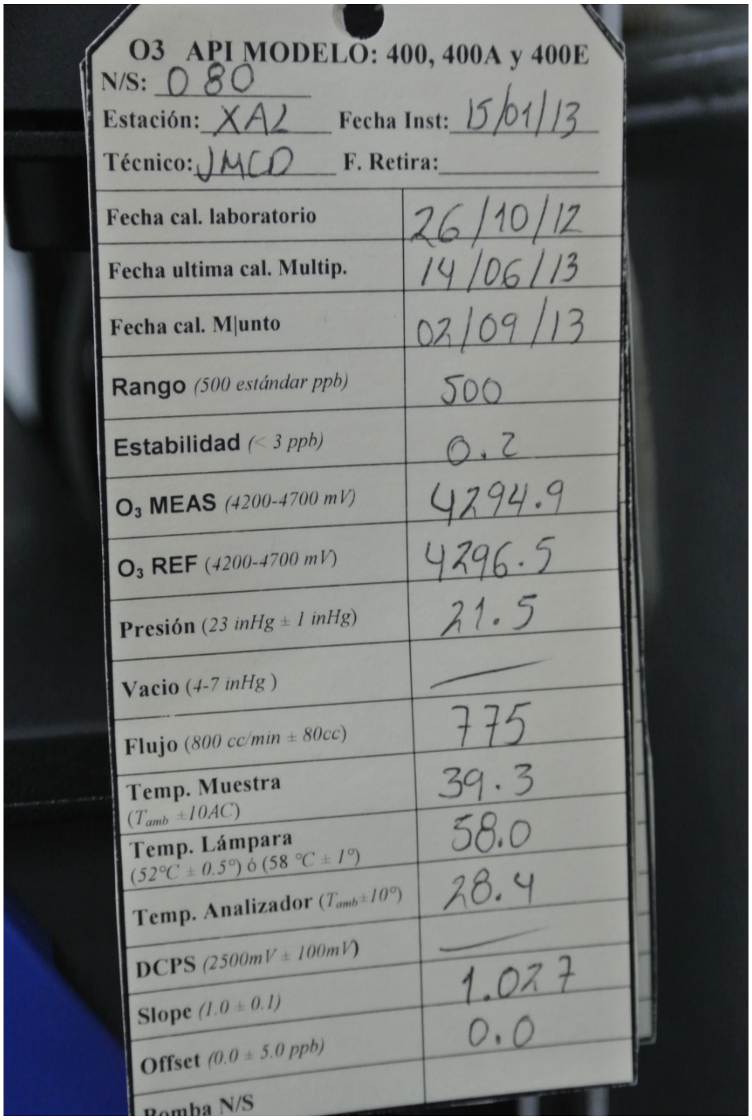
- Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I: A Field Guide to Environmental Quality Assurances, EPA/600/R-94/038a, April 1994.

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. For instance, all operators carry hand-held PDA's to record operating information from each site during each site visit. These data are then downloaded at the main laboratory so that changes in instrument performance can be tracked and monitored. 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, 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 usually the time in and out documented. The only deficiency noted with the log books was that while almost all entries had a starting time, a small number of the operator entries did not record finish times. While most of the operators were very reliable with time in and time out, a few were not. Therefore this small aspect of the documentation could be improved.

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 do 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 appeared to be very well operated, the operators appeared to be well trained, were very knowledgeable about QA/QC procedures and, clearly cared about the quality of their work.

There were three issues that are general in nature from the various sites that have the potential to impact the data quality. These include:

- For automated stations (e.g., those with calibrators and zero air systems) all calibrations are performed though the zero/span ports instead of the sample ports.
- The Mexico City Network operates several Syntech 955 GC instruments that analyze for a series of hydrocarbons (primarily BTEX but others as well). While not implicitly part of the audit, it was noted that the tubing used to transfer the sample from the glass sampling manifold to the instrument were plumbed with Teflon tubing.
- There is some confusion as to what is the lowest pressure within a calibration cylinder that renders the cylinder unusable and at what secondary regulator pressure the calibration gas should be at the calibrator.

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 second issue associated with the audit was the use of Teflon tubing instead of stainless steel tubing for plumbing the Syntech 955 GC's. Per the EPA Handbook section 7.3.1, Design of Probes and Manifolds for Automated Methods,

> "*Of the probe and manifold material looked at over the years, only Pyrex® glass and Teflon® have been found to be acceptable for use as intake sampling lines for all the reactive gaseous pollutants.*"

This section continues,

> "*For volatile organic compound (VOC) monitoring at PAMS, FEP Teflon® is unacceptable as the probe material because of VOC adsorption and desorption reactions on the FEP Teflon®. Borosilicate glass, stainless steel, or its equivalent, are acceptable probe materials for VOC and carbonyl sampling*."

It is possible or even likely that the ambient concentrations of VOCs, and particularly the BTEX compounds will absorb into the Teflon tubing resulting in bias or react with other absorbed compounds in the Teflon. This can be easily alleviated by replacing the short lengths of Teflon tubing with chromatographic grade (or Silcosteel ®) stainless steel tubing. This will help ensure better sample recovery and better analysis.

The third issue that came up during the audit concerned the calibration gas cylinders used to calibrate the analyzers. The first question was what is the minimum cylinder pressure that still allows a "reliable" calibration and what pressure should be used on the regulator's second stage leading to the calibrator. The USEPA "Green Book" as well most calibration certifications stipulates that no cylinder should be used below 100 psig. In addition, it is very important to always keep some pressure in the cylinder when returning them to the manufacturer for refilling to help prevent cylinder contamination. Some manufacturers will not refill cylinders that have been vented to atmosphere because of the issue with cylinder contamination.

It was noted by site operators that a number of the cylinders that were purchased locally in Mexico exhibited calibration issues when the cylinder pressure dropped below 400 psig. According to experts in specialty gas preparation, this may be a symptom of a cylinder that was not properly cleaned or passivated between fillings. If there is any particulate matter or water present in the cylinder (water in low part-per-trillion (ppt)) levels may cause the reactive gases to react and result in inaccurate calibrations. US specialty gas companies use different propriety (and expensive) techniques to ensure that the cylinders are very clean and fully passivated so that reactive gases are very stable and that cylinders can be used down to 100 psig with no degradation of performance. Based on the symptoms described by the site supervisor, the auditor believes this is a result of improperly handled cylinders by the local gas manufacturer. As such, the only recourse is to stop using locally sources cylinders when there appear to be unusual responses with a calibration cylinder. It is also wise to check new cylinders instrument response against old cylinder response to help assess if a cylinder may be miss-blended.

There was also a question on the pressure to use for calibrators. This will depend a little on the calibrator, as Environics recommends approximately 25 psig to the calibrator while API recommends 25 to 30 psig. Never should the pressures to any instrument exceed 35 psig as damage may occur to the mass flow controllers.

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

3.2 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 (3.7%), NO (0.2%), NO_x (1.2%), SO_2 (-2.9%), and CO (-4.4%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 101.6%. Audit results for each of the analyzers at this site are shown in Tables 3-1 to 3-6.

Photos of this site are shown in Figure 3-2 below.

Table 3.1. 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	0.001	---	**Slope:**	1.02168
0.081	0.086	6.5%	**Intercept:**	0.00185
0.200	0.206	2.7%	**Correlation:**	0.99998
0.302	0.311	2.8%		
0.401	0.411	2.6%		

[1] Objective ±15%

Table 3.2. 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	0.001	0.000	---	---	**Slope:**	1.00193	0.99715
0.050	0.052	0.050	3.7%	1.1%	**Intercept:**	0.00092	0.00041
0.100	0.102	0.100	1.5%	0.4%	**Correlation:**	1.00193	0.99715
0.200	0.200	0.200	0.0%	-0.1%			
0.300	0.300	0.299	-0.1%	-0.3%			
0.400	0.403	0.399	0.9%	-0.1%			

[1] Objective ±15%

Table 3.3. 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	0.403	0.399	0.402	0.400	---
0.300	0.402	0.110	0.400	0.110	0.110
Off	0.300	0.299	0.298	0.299	---
0.200	0.303	0.110	0.301	0.110	0.110
Off	0.200	0.200	0.198	0.200	---
0.090	0.202	0.121	0.201	0.121	0.121

Table 3.4. 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	0.001	---	---	*Slope:*	1.00544
0.079	0.081	2.5%	0.082	*Intercept:*	0.00147
0.189	0.193	2.1%	0.192	*Correlation:*	0.99997
0.290	0.292	0.7%	0.288	*Converter Efficiency*	101.6%

Table 3.5. 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:***	0.97311
0.047	0.046	-3.6%	***Intercept:***	0.00021
0.095	0.091	-3.5%	***Correlation:***	0.99999
0.190	0.185	-2.4%		
0.285	0.278	-2.4%		
0.380	0.369	-2.7%		

[1] **Objective ±15%**

Table 3.6. Summary of Carbon Monoxide (CO) Audit Results, PED Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.0	0.0		***Slope:***	0.98002
4.8	4.3	-9.5%	***Intercept:***	-0.18667
9.5	9.1	-4.3%	***Correlation:***	0.99996
19.1	18.5	-2.9%		
28.6	27.8	-2.9%		
38.2	37.3	-2.3%		

[1] Objective ±15%

Figure 3-2. Front and Side Views of the PED Site Shelter

3.3 COYOACÁN (COY) SITE

This station is located on the fourth floor roof of an elementary school in a residential area in southwest Mexico City. The system is housed in an EKTO shelter. The shelter was in excellent condition. This site was only equipped with an API NO_x and O_3 gas analyzers and a TEOM 1400A with 8500 FDMS $PM_{2.5}$ particulate matter analyzer. There were no met sensors at this site. The audit results showed that all of the parameters {O_3 (2.4%), NO (-1.4%), NO_x (-0.3%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 102.4%. Audit results for each of the analyzers at this site are shown in Tables 3-7 to 3-10.

A photo of this site is shown in Figure 3-3 below.

Table 3.7. Summary of Ozone (O_3) Audit Results, COY Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	-0.001	---	**Slope:**	1.01494
0.076	0.079	3.4%	**Intercept:**	0.00077
0.201	0.206	2.7%	**Correlation:**	0.99994
0.301	0.308	2.3%		
0.401	0.406	1.1%		

[1] Objective ±15%

Table 3.8. Summary of Nitrogen Oxides (NO_X) Audit Results, COY 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:**	0.99416	0.99717
0.049	0.050	0.048	0.7%	-2.2%	**Intercept:**	0.00050	-0.00118
0.099	0.100	0.098	0.1%	-1.8%	**Correlation:**	0.99998	0.99998
0.200	0.197	0.197	-1.2%	-1.5%			
0.300	0.298	0.297	-0.6%	-1.1%			
0.450	0.449	0.449	-0.2%	-0.2%			

[1] Objective ±15%

Table 3.9. Summary of Nitrogen Oxides (NO_x) Audit Results, COY Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.449	0.449	0.451	0.451	---
0.365	0.451	0.107	0.453	0.108	0.108
Off	0.298	0.297	0.300	0.299	---
0.200	0.303	0.110	0.304	0.111	0.111
Off	0.197	0.197	0.198	0.198	---
0.100	0.202	0.108	0.202	0.109	0.109

Table 3.10. Summary of Nitrogen Oxides (NO_x) GPT Results, COY 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:*	0.99921
0.089	0.094	5.2%	0.093	*Intercept:*	0.00330
0.188	0.193	2.7%	0.192	*Correlation:*	0.99991
0.343	0.345	0.5%	0.345	*Converter Efficiency*	102.4%

[1] Objective $\pm$15%

Figure 3-3. Front View of COY Site Shelter

3.4 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 (1.1%), NO (0.7%), NO_x (1.2%), SO_2 (-3.2%), and CO (2.4%)} were well within the audit objective of ± 15%. The GPT showed a NO_2 convertor efficiency of 102.0%. Audit results for each of the analyzers at this site are shown in Tables 3-11 to 3-16. Photo showing s of this site is shown in Figure 3-4 below.

Table 3.11. 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	-0.0004	---	***Slope:***	0.99223
0.079	0.0821	3.9%	***Intercept:***	0.00204
0.200	0.2019	0.9%	***Correlation:***	0.99991
0.301	0.3023	0.4%		
0.401	0.3977	-0.8%		

[1] **Objective ±15%**

Table 3.12. 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	0.000	-0.001	---	---	***Slope:***	0.97596	0.97551
0.050	0.048	0.048	-3.3%	-3.3%	***Intercept:***	0.00259	0.00077
0.100	0.100	0.099	0.5%	-0.5%	***Correlation:***	0.99989	0.99998
0.200	0.204	0.203	2.1%	1.6%			
0.300	0.309	0.307	3.0%	2.4%			
0.450	0.466	0.465	3.5%	3.3%			

[1] Objective ±15%

Table 3.13. Summary of Nitrogen Oxides (NO_x) Audit Results, MER Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.466	0.465	0.451	0.452	---
0.365	0.460	0.109	0.445	0.108	0.108
Off	0.309	0.307	0.300	0.299	---
0.200	0.311	0.109	0.302	0.108	0.108
Off	0.204	0.203	0.199	0.199	---
0.100	0.211	0.110	0.205	0.109	0.109

Table 3.14. 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	0.001	---	---	***Slope:***	1.01243
0.090	0.101	12.2%	0.096	***Intercept:***	0.00556
0.191	0.202	5.8%	0.193	***Correlation:***	0.99957
0.344	0.351	2.0%	0.338	***Converter Efficiency[1]***	102.0%

[1] Acceptance Criteria >96%

Table 3.15. 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:***	0.99652
0.047	0.048	1.7%	***Intercept:***	-0.00100
0.095	0.090	-4.8%	***Correlation:***	0.99988
0.190	0.185	-2.5%		
0.2847	0.284	-0.2%		
0.4275	0.426	-0.4%		

[1] Objective ±15%

Table 3.16. Summary of Carbon Monoxide (CO) Audit Results, MER Site

CO Input (ppm-v)	**CO Response (ppm-v)**	**Percent Difference[1]**	**CO Analyzer Regression Data**	
0.0	0.1	---	***Slope:***	1.00851
4.7	5.0	5.5%	***Intercept:***	0.20656
9.5	9.9	4.2%	***Correlation:***	0.99997
19.1	19.5	2.3%		
28.6	29.0	1.3%		
43.0	42.4	-1.3%		

[1] Objective ±15%

Figure 3-4. Photo of Side View of the MER Site

3.5 HOSPITAL GENERAL DE MÉXICO (HGM) SITE

This station is located on the 4th floor of the Oncology building of the Hospital General de Mexico. This is a large hospital complex with continuing construction on all sides. The general exposure of this site is quite good. There was a lot of construction surrounding this site that may contribute to the pollutant levels, particularly PM. The audit results showed that all of the parameters {O_3 (0.2%), NO (-6.8%), NO_x (-5.0%) SO_2 (-3.2%), and CO (-6.4%)} were well within the audit objective of ± 15%. The GPT showed a NO_2 convertor efficiency of 100.9%. Audit results for each of the analyzers at this site are shown in Tables 3-17 to 3-22. Photos of this site are shown in Figure 3-5 below.

Table 3.17. Summary of Ozone (O_3) Audit Results, HGM Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.000	---	***Slope:***	0.99678
0.081	0.081	-0.6%	***Intercept:***	0.00093
0.200	0.203	1.5%	***Correlation:***	0.99990
0.300	0.302	0.7%		
0.400	0.397	-0.8%		

[1] **Objective ±15%**

Table 3.18. Summary of Nitrogen Oxides (NO_x) Audit Results, HGM 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	-0.001	---	---	***Slope:***	0.94968	0.94600
0.050	0.047	0.046	-4.5%	-8.4%	***Intercept:***	0.00003	-0.00153
0.100	0.095	0.092	-5.2%	-7.4%	***Correlation:***	0.99999	0.99999
0.200	0.189	0.186	-5.7%	-6.7%			
0.300	0.285	0.282	-5.0%	-6.0%			
0.450	0.428	0.425	-4.9%	-5.6%			

[1] Objective ±15%

Table 3.19. Summary of Nitrogen Oxides (NO_x) Audit Results, HGM Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.428	0.425	0.451	0.451	---
0.365	0.426	0.090	0.449	0.097	0.097
Off	0.285	0.282	0.300	0.300	---
0.200	0.285	0.098	0.300	0.105	0.105
Off	0.189	0.186	0.198	0.199	---
0.100	0.191	0.099	0.201	0.106	0.106

Table 3.20. Summary of Nitrogen Oxides (NO_x) GPT Results, HGM 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:**	0.94367
0.093	0.092	-1.1%	0.096	**Intercept:**	0.00259
0.195	0.187	-4.1%	0.195	**Correlation:**	0.99996
0.354	0.336	-5.1%	0.352	**Converter Efficiency[1]**	**100.9%**

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

Table 3.21. Summary of Sulphur Dioxide (SO_2) Audit Results, HGM Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.001	---	***Slope:***	0.98423
0.047	0.044	-5.7%	***Intercept:***	-0.00129
0.095	0.091	-3.4%	***Correlation:***	0.99995
0.190	0.184	-3.3%		
0.285	0.278	-2.4%		
0.427	0.421	-1.5%		

[1] Objective ±15%

Table 3.22. Summary of Carbon Monoxide (CO) Audit Results, MER Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.0	-0.11		***Slope:***	0.95555
4.74	4.25	-10.3%	***Intercept:***	-0.21751
9.51	8.75	-8.0%	***Correlation:***	0.99990
19.07	18.08	-5.2%		
28.63	27.40	-4.3%		
42.97	41.20	-4.1%		

[1] Objective ±15%

Figure 3-5. Rear and Side Views of HGM Site

3.6 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 (0.4%), NO (4.0%), NO_x (4.5%), SO_2 (0.2%), and CO (-0.4%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 102.9%. 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 3-23 to 3-28. Photo of the site is shown in Figures 3-6.

Table 3.23. 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	0.000	---	***Slope:***	0.99033
0.080	0.082	2.3%	***Intercept:***	0.00164
0.201	0.202	0.2%	***Correlation:***	0.99998
0.302	0.301	-0.3%		
0.399	0.396	-0.8%		

[1] Objective ±15%

Table 3.24. 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)	NO_X	NO	Parameter	NO_X	NO
0.000	0.001	0.001	---	---	***Slope:***	1.07909	1.06595
0.050	0.050	0.049	0.9%	-1.1%	***Intercept:***	-0.00318	-0.00211
0.100	0.102	0.105	2.4%	5.4%	***Correlation:***	0.99987	0.99987
0.200	0.209	0.206	4.5%	3.0%			
0.300	0.320	0.319	6.7%	6.4%			
0.450	0.485	0.479	7.7%	6.4%			

[1] Objective ±15%

Table 3.25. 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	0.485	0.479	0.452	0.451	---
0.365	0.490	0.109	0.457	0.104	0.104
Off	0.320	0.319	0.299	0.301	---
0.200	0.321	0.111	0.300	0.106	0.106
Off	0.209	0.206	0.197	0.195	---
0.100	0.216	0.111	0.203	0.106	0.106

Table 3.26. 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	0.000	---	---	***Slope:***	1.08820
0.089	0.105	18.0%	0.095	***Intercept:***	0.00234
0.195	0.210	7.7%	0.196	***Correlation:***	0.99962
0.347	0.381	9.8%	0.352	***Converter Efficiency[1]***	102.9%

[1] Acceptance Criteria >96%

Table 3.27. 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	0.000	---	***Slope:***	1.01307
0.047	0.049	3.8%	***Intercept:***	-0.00169
0.095	0.091	-3.8%	***Correlation:***	0.99987
0.190	0.187	-1.4%		
0.285	0.287	0.8%		
0.427	0.433	1.3%		

[1] Objective ±15%

Table 3.28Table 3-51. 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	0.00	---	***Slope:***	0.99784
4.73	4.70	-0.6%	***Intercept:***	0.01798
9.51	9.60	0.9%	***Correlation:***	0.99997
19.06	19.00	-0.3%		
28.62	28.60	-0.1%		
42.97	42.20	-1.8%		

[1] Objective ±15%

Figure 3-6. Side Views of the TLA Site

3.7 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 (2.5%), NO (-1.5%), NO_x (-1.4%), SO_2 (-2.1%), CO (-2.2%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 99.6%. Audit results for each of the analyzers at this site are shown in Tables 3-29 to 3-34. Photos of the instrument laboratory instrumentation are shown in Figure 3-7.

Table 3.29. 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	0.0007	--	***Slope:***	1.00589
0.080	0.0847	5.9%	***Intercept:***	0.00230
0.201	0.2050	2.0%	***Correlation:***	0.99997
0.301	0.3043	1.1%		
0.400	0.4046	1.2%		

[1] Objective ±15%

Table 3.30. 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	0.000	0.000			***Slope:***	1.00753	1.01156
0.050	0.048	0.048	-4.5%	-4.3%	***Intercept:***	-0.00204	-0.00265
0.100	0.097	0.097	-2.3%	-2.7%	***Correlation:***	0.99997	0.99993
0.200	0.197	0.197	-1.1%	-1.3%			
0.300	0.301	0.300	0.2%	-0.2%			
0.450	0.452	0.455	0.5%	1.0%			

[1] Objective ±15%

Table 3.31. 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	0.452	0.455	0.451	0.452	---
0.365	0.451	0.098	0.450	0.099	0.099
Off	0.301	0.300	0.300	0.299	---
0.200	0.298	0.105	0.298	0.106	0.106
Off	0.197	0.197	0.198	0.197	---
0.100	0.198	0.103	0.198	0.105	0.105

Table 3.32. 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	0.000	---	---	***Slope:***	1.00009
0.092	0.094	2.6%	0.092	***Intercept:***	0.00089
0.193	0.193	0.2%	0.191	***Correlation:***	0.99998
0.353	0.354	0.2%	0.352	***Converter Efficiency[1]***	**99.6**

[1] Acceptance Criteria >96%

Table 3.33. 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	0.0001	---	***Slope:***	0.98433
0.047	0.0456	-3.4%	***Intercept:***	-0.00031
0.095	0.0923	-2.4%	***Correlation:***	0.99999
0.189	0.1867	-1.4%		
0.285	0.2804	-1.5%		
0.427	0.4198	-1.7%		

[1] Objective ±15%

Table 3.34. 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:***	0.96857
4.75	4.7	-1.1%	***Intercept:***	0.04521
9.51	9.3	-2.2%	***Correlation:***	0.99998
19.04	18.4	-3.4%		
28.62	27.8	-2.9%		
42.95	42.2	-1.7%		

[1] Objective ±15%

Figure 3-7. Front and Back View of the SIMIT Laboratory Reference Analyzers

3.8 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 (2.7%), NO (-0.1%), NO_x (-0.1%) SO_2 (-5.1%), and CO (-1.0%)} were well within the audit objective of ± 15%. The GPT showed a NO_2 convertor efficiency of 101.6%. Audit results for each of the analyzers at this site are shown in Tables 3-35 to 3-40. Photos of the site are shown in Figures 3-8 and 3-9.

Table 3.35. 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	-0.0001	---	***Slope:***	1.01851
0.081	0.0836	3.2%	***Intercept:***	0.00116
0.201	0.2073	3.1%	***Correlation:***	0.99993
0.300	0.3091	3.0%		
0.401	0.4071	1.5%		

[1] **Objective ±15%**

Table 3.36. 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	0.002	0.000	---	---	***Slope:***	1.00945	1.01351
0.050	0.049	0.048	-0.5%	-3.1%	***Intercept:***	-0.00079	-0.00120
0.100	0.099	0.099	-0.9%	-0.3%	***Correlation:***	0.99994	0.99999
0.200	0.198	0.201	-0.8%	0.8%			
0.300	0.301	0.302	0.4%	0.7%			
0.450	0.455	0.456	1.2%	1.2%			

[1] Objective ±15%

Table 3.37. 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	0.455	0.456	0.452	0.451	
0.365	0.453	0.105	0.450	0.105	0.105
Off	0.301	0.302	0.299	0.299	
0.200	0.305	0.109	0.303	0.109	0.109
Off	0.198	0.201	0.197	0.200	
0.100	0.201	0.107	0.200	0.106	0.106

Table 3.38. 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	0.002	---	---	***Slope:***	1.00416
0.094	0.095	0.5%	0.097	***Intercept:***	0.00172
0.190	0.196	2.9%	0.194	***Correlation:***	0.99990
0.346	0.348	0.5%	0.344	***Converter Efficiency***[1]	**101.6%**

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

Table 3.39. 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	0.0004	---	***Slope:***	0.97210
0.047	0.0431	-8.5%	***Intercept:***	-0.00195
0.095	0.0890	-5.9%	***Correlation:***	0.99995
0.190	0.1815	-4.3%		
0.285	0.2738	-3.9%		
0.427	0.4149	-2.9%		

[1] **Objective ±15%**

Table 3.40. 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:***	0.96270
4.74	4.9	3.4%	***Intercept:***	0.23217
9.51	9.5	-0.1%	***Correlation:***	0.99995
19.07	18.5	-3.0%		
28.63	27.8	-2.9%		
42.96	42.0	-2.2%		

[1] **Objective ±15%**

Figure 3-8. Rear View of the UIZ Ekto Shelter

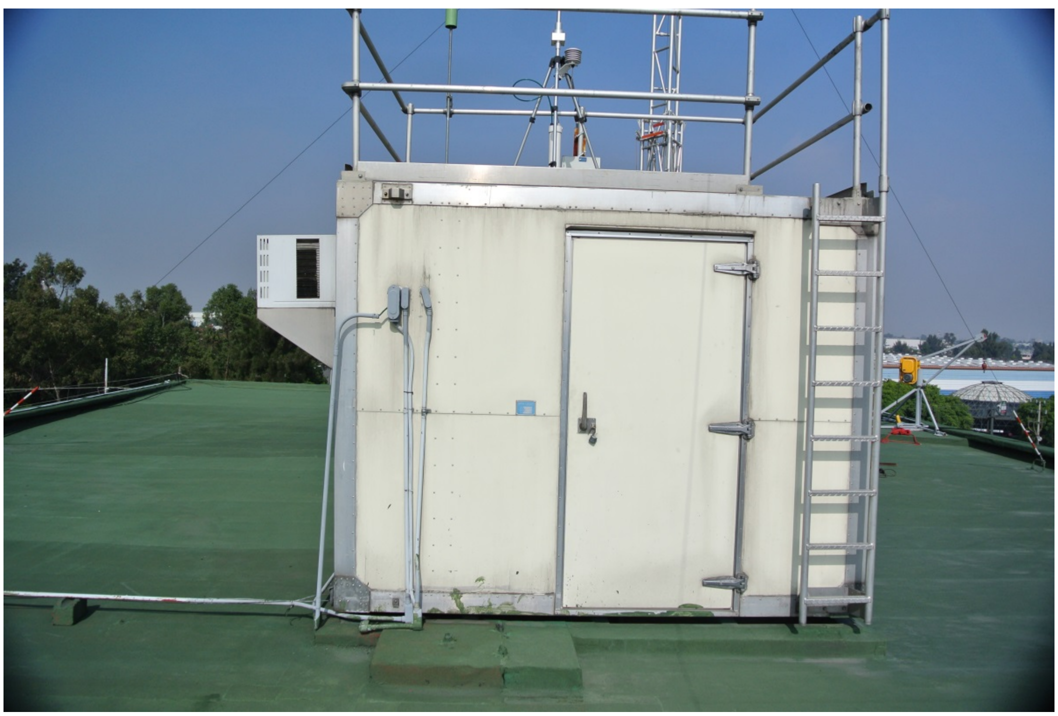


Figure 3-9. Front View of the UIZ Ekto Shelter

3.9 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 (3.1%), NO_x (4.0%), SO_2 (-4.7%), and CO (-1.8%)} were well within the audit objective of ± 15%. In addition, the GPT showed a NO_2 convertor efficiency of 101.1%. Audit results for each of the analyzers at this site are shown in Tables 3-41 to 3-47. Photos of the site are shown in Figures 3-10 and 3-11.

Table 3.41. 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	0.001	---	***Slope:***	0.97436
0.081	0.080	-1.1%	***Intercept:***	0.00087
0.201	0.198	-1.7%	***Correlation:***	0.99999
0.302	0.294	-2.6%		
0.400	0.391	-2.3%		

[1] **Objective ±15%**

Table 3.42. 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
0.0000	-0.0001	-0.0009	---	---	***Slope:***	1.05275	1.04470
0.0496	0.0506	0.0496	2.0%	0.0%	***Intercept:***	-0.00118	-0.00134
0.0996	0.1034	0.1034	3.8%	3.8%	***Correlation:***	0.99999	1.00000
0.1998	0.2080	0.2070	4.1%	3.6%			
0.2998	0.3150	0.3120	5.1%	4.1%			
0.4502	0.4730	0.4690	5.1%	4.2%			

[1] Objective ±15%

Table 3.43. 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	0.473	0.469	0.450	0.450	---
0.365	0.472	0.096	0.449	0.093	0.093
Off	0.315	0.312	0.300	0.300	---
0.200	0.316	0.106	0.301	0.103	0.103
Off	0.208	0.207	0.199	0.199	---
0.100	0.211	0.108	0.202	0.105	0.105

Table 3.44. 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:***	1.04875
0.094	0.103	9.6%	0.097	***Intercept:***	0.00255
0.197	0.210	6.6%	0.198	***Correlation:***	0.99995
0.357	0.376	5.3%	0.356	***Converter Efficiency[1]***	**101.1%**

[1] Acceptance Criteria >96%

Table 3.45. 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:***	0.98301
0.047	0.043	-8.7%	***Intercept:***	-0.00235
0.095	0.088	-6.8%	***Correlation:***	0.99992
0.190	0.183	-3.6%		
0.285	0.279	-2.0%		
0.427	0.418	-2.2%		

[1] Objective ±15%

Table 3.46. 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	0.04	---	***Slope:***	0.99336
4.73	4.52	-4.4%	***Intercept:***	-0.08921
9.51	9.23	-2.9%	***Correlation:***	0.99988
19.07	18.94	-0.7%		
28.62	28.50	-0.4%		
42.97	42.70	-0.6%		

[1] Objective ±15%

Figure 3-10. Front View of UAX Shelter

Figure 3-11. Side View of UAX Shelter

3.10 XALOSTOC (XAL) SITE

During the 2009 audit this station was in an industrial/commercial/residential area in a shed on the back lot of a car dealership. Prior to the 2012 audit this site was relocated to the top of the fourth floor of a Regional Hospital. The shelter was fairly old (same shelter as the 2009 audit) old and cramped but the equipment was well maintained. The audit results showed that all of the parameters {O_3 (0.3%), NO (-0.5%), NO_x (1.4%), SO_2 (-1.2%), CO (2.8%)} were well within the audit objective of ± 15%. The GPT showed a NO_2 convertor efficiency of 102.2%. Sample results for each of the analyzers at this site are shown in Tables 3-47 to 3-52. A photo of this site is shown in Figures 3-12.

Table 3.47. Summary of Ozone (O_3) Audit Results, XAL Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.001	---	***Slope:***	0.98282
0.080	0.083	3.1%	***Intercept:***	0.00265
0.201	0.201	0.0%	***Correlation:***	0.99998
0.302	0.300	-0.8%		
0.399	0.394	-1.2%		

[1] Objective ±15%

Table 3.48. Summary of Nitrogen Oxides (NO_x) Audit Results, XAL 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**	1.01543	1.01299
0.050	0.049	0.047	-2.1%	-4.9%	***Intercept:***	0.00074	-0.00112
0.100	0.105	0.099	5.1%	-0.6%	***Correlation:***	0.99991	0.99996
0.200	0.201	0.200	0.5%	0.3%			
0.300	0.305	0.304	1.8%	1.5%			
0.450	0.459	0.455	1.9%	1.0%			

[1] Objective ±15%

Table 3.49. Summary of Nitrogen Oxides (NO_x) Audit Results, XAL Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.459	0.455	0.451	0.450	---
0.365	0.457	0.109	0.449	0.109	0.109
Off	0.305	0.304	0.300	0.302	---
0.200	0.305	0.113	0.300	0.112	0.112
Off	0.201	0.200	0.197	0.199	---
0.100	0.207	0.115	0.203	0.115	0.115

Table 3.50. Summary of Nitrogen Oxides (NO_x) GPT Results, XAL 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:*	1.01060
0.084	0.092	9.3%	0.090	*Intercept:*	0.00302
0.190	0.192	1.2%	0.190	*Correlation:*	0.99980
0.341	0.348	2.1%	0.339	*Converter Efficiency*[1]	**102.2%**

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

Table 3.51. Summary of Sulphur Dioxide (SO_2) Audit Results, XAL Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.000	---	*Slope:*	1.02141
0.047	0.044	-6.8%	*Intercept:*	-0.00269
0.095	0.093	-2.1%	*Correlation:*	0.99995
0.190	0.190	0.2%		
0.285	0.288	1.3%		
0.427	0.435	1.7%		

[1] **Objective ±15%**

Table 3.52. Summary of Carbon Monoxide (CO) Audit Results, XAL Site

CO Input (ppm-v)	CO Response (ppm-v)	Percent Difference[1]	CO Analyzer Regression Data	
0.00	0.0	---	*Slope:*	1.03343
4.73	4.8	1.5%	*Intercept:*	-0.01794
9.50	9.9	4.2%	*Correlation:*	0.99998
19.06	19.6	2.8%		
28.63	29.6	3.4%		
42.96	43.9	2.2%		

[1] Objective ±15%

Figure 3-12. Rear View of XAL Shelter

3.11 LA PRESA (LPR) SITE

The LPR site is located on the grounds of a local small hospital/clinic. The site is situated in and are that abuts a large mountain range. This siting makes getting perfect sampling locations difficult due to the very steep rise in elevation around the site. While the site is not ideal from an exposure perspective, its' exposure is adequate to represent the ambient conditions in this mostly residential areas. The audit results showed that all of the parameters {O_3 (-3.0%), NO (-2.39%), NO_x (-1.6%), and SO_2 (1.6%)} were well within the audit objective of ± 15%. The GPT showed a NO_2 convertor efficiency of 100.3%. Sample results for each of the analyzers at this site are shown in Tables 3-53 to 3-57. Photos of this site are shown in Figures 3-13 and 3-14 below.

Table 3.53. Summary of Ozone (O_3) Audit Results, LPR Site

O_3 Input (ppm-v)	O_3 Response (ppm-v)	Percent Difference[1]	O_3 Analyzer Regression Data	
0.000	0.002	---	***Slope:***	0.96899
0.081	0.078	-3.7%	***Intercept:***	0.00092
0.203	0.197	-3.0%	***Correlation:***	0.99997
0.302	0.295	-2.3%		
0.401	0.389	-3.0%		

[1] **Objective ±15%**

Table 3.54. Summary of Nitrogen Oxides (NO_x) Audit Results, LPR 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**	0.98301	0.98161
0.050	0.049	0.048	-1.3%	-3.3%	***Intercept:***	0.00062	-0.00013
0.100	0.097	0.097	-2.7%	-2.7%	***Correlation:***	0.99998	0.99999
0.200	0.197	0.196	-1.4%	-1.9%			
0.300	0.296	0.294	-1.3%	-2.0%			
0.450	0.443	0.442	-1.6%	-1.8%			

[1] **Objective ±15%**

Table 3.55. Summary of Nitrogen Oxides (NO_x) Audit Results, LPR Site

Gas Phase Titration					
Ozone Setting	Response		Corrected		NO Corrected
	NO_X	NO	NO_X	NO	
Off	0.443	0.442	0.450	0.450	---
0.365	0.439	0.091	0.446	0.093	0.093
Off	0.296	0.294	0.300	0.300	---
0.200	0.299	0.100	0.304	0.102	0.102
Off	0.197	0.196	0.200	0.200	---
0.100	0.197	0.102	0.200	0.104	0.104

Table 3.56. Summary of Nitrogen Oxides (NO_x) GPT Results, LPR 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:***	0.97413
0.096	0.095	-1.0%	0.096	***Intercept:***	0.00221
0.198	0.199	0.5%	0.202	***Correlation:***	0.99984
0.357	0.348	-2.5%	0.353	***Converter Efficiency***[1]	100.3%

[1] Acceptance Criteria >96%

Table 3.57. Summary of Sulphur Dioxide (SO_2) Audit Results, LPR Site

SO_2 Input (ppm-v)	SO_2 Response (ppm-v)	Percent Difference [1]	SO_2 Analyzer Regression Data	
0.000	0.005	---	***Slope:***	0.99774
0.047	0.050	6.2%	***Intercept:***	0.00259
0.095	0.095	0.4%	***Correlation:***	0.99994
0.190	0.190	0.2%		
0.285	0.286	0.4%		
0.428	0.431	0.8%		

[1] Objective ±15%

Figure 3-13. LPR Site Front View

Figure 3-14. LPR Site Side View

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 2012 audit there were no primary concerns so no additional follow-up was required during this audit.

Table 4.1. Summary of Audit Observations and Concerns

Site	Description of Concern or Observation	Recommendation
Primary Concerns		
PED/UIZ	Syntech 955 GC plumbed using Teflon tubing	Make all connections from glass sample manifold to instrument with stainless steel tubing
All Auto-cal Sites	Automated sites using air sources and calibrators are configured to use zero/span ports for ALL calibrations. Performing calibrations through zero/span ports may result in lost data if sample valve develops leak (see section 3-1 for a more thorough explanation.	Configure systems to either automatically perform calibrations through sample ports or only perform calibrations manually.
Secondary Concerns		
All Sites	Issues with calibration gases and low Cylinder pressure (see Section 3-1 for more discussion)	Never use calibration cylinders below 100 psig and if cylinder contamination is suspected do not use below 400 psig if there appears to be calibration anomalies.