CALIFORNIA
AIR RESOURCES BOARD

Performance Audit Procedures For Conducting a Site Survey

Volume V
Audit Procedures Manual for Air Quality Monitoring

QMB SOP Appendix AE
Revision 4

Quality Assurance Section
Quality Management Branch
Monitoring and Laboratory Division

Approval Signatures	Approval Date
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Disclaimer: Mention of any trade name or commercial product in this standard operating procedure does not constitute endorsement or recommendation of this product by the California Air Resources Board. Specific brand names and instrument descriptions listed in the standard operating procedure are for equipment used by the California Air Resources Board's Quality Assurance Section. Any functionally equivalent instrumentation is acceptable.

PERFORMANCE AUDIT PROCEDURES
FOR CONDUCTING A SITE SURVEY

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PERFORMANCE AUDIT PROCEDURES
FOR CONDUCTING A SITE SURVEY

FIGURES AND TABLES

ACRONYMS AND DEFINITIONS

Acronym	Definition
AIS	Audit Information System
AQS	Air Quality System (U.S. EPA database)
CAN	Corrective Action Notification
CARB	California Air Resources Board
LPM	Liters per minute
m	Meters
mm	Millimeters
m/s	Meters per second
NIST	National Institute of Standards and Technology
PM	Particulate Matter
QAS	Quality Assurance Section
QMB	Quality Management Branch
SI	International System of Units (metric system)
SIP	State Implementation Plan
SOP	Standard Operating Procedure
U.S. EPA	United States Environmental Protection Agency

AE.1.0 INTRODUCTION

Ambient air monitoring stations collecting pollutant data for comparison with national standards are independently assessed annually to verify compliance with state and federal mandates. The assessment includes a detailed analysis of siting conditions for determination of whether air monitoring stations are situated and configured in accordance with U.S. EPA's criteria. This is to ensure representative sampling with unobstructed air flow to the probes/inlets, reduced risk of scrubbing/scavenging, and a rapid delivery time to the analyzers.

In the AQS database, an AMP 380 site description report and AMP 390 monitor description report are created when an air monitoring station initially begins operating. With the passage of time, changes to the station need to be reflected in these reports. Stations that meet siting criteria at the time of initial setup may no longer conform due to updated regulations or changes in surrounding conditions and land use or modifications to station equipment. Many of the siting issues result from the growth of vegetation such as trees infringing on the minimum distance required from probe inlets and alterations to the sampling train.

Site surveys, completed as part of the annual performance evaluation at each station, consist of obtaining physical measurements and observations. These data are entered, confirmed, or updated in AIS. A site drawing and a calculation of residence time for gaseous samplers is done every two years unless there has been a change in the station configuration. In that case, a new drawing or calculation will be generated during the first audit following the change. The Site Survey Report is the final section of the performance audit report that is given or emailed to the site operator. The site drawing stays with the site folder that is stored in a filing cabinet.

It should be noted that the Site Survey Report is different from the site report that is maintained by the station operator. Auditors may ask the station operator for a copy of their site report.

AE.1.1 SUMMARY OF METHOD

During a site survey, the auditor inspects the immediate vicinity of the air monitoring station and takes note of any vegetation or other physical structures that might violate siting requirements. The auditor then

measures distances of inlets and probes from each other and from the potential obstacles in all directions. Additionally, inlet and probe heights are measured. If instruments are not at ground level then the roof or platform height is measured. A site drawing is composed so that a graphic representation captures the relative positions of all instruments and obstacles at the air monitoring station. Relevant measurements are recorded on a site drawing and entered into AIS.

At air monitoring stations operating gaseous analyzers, a residence time must be calculated. This is the time it takes an air sample extracted from the atmosphere to transit from the probe entry point, through the entire sample train, to a particular gaseous analyzer. The auditor verifies that the sample train is clean and consists of only acceptable materials. The lengths and inner diameters of the sample train sections are measured and recorded. Flow rates are obtained for each section of the sample train. This is done for each sampler. Based on this information, the residence time can be calculated and verified using Excel® worksheets and in AIS.

Other activities that are associated with siting include taking photographs, looking away and looking towards the inlet, and sighting of meteorological sensors/tower. Both are described in the CARB Audit Procedures Manual for Air Quality Monitoring Volume V, Appendices AK and S respectively.

AE.1.2 INTERFERENCES

Large nearby buildings and trees extending above the height of the monitor inlet may present barriers or deposition surfaces. Certain trees may also be sources of particulate matter (PM) in the form of detritus or pollen. The proximity of the observable footprint can adversely affect measurement, representativeness, and accuracy of the pollutant data. This can be mitigated by locating all inlets at least, if not beyond, the mandated distance from trees, buildings, or other physical structures.

The sample train for gaseous analyzers consists of a probe and sample line. Stations may also have a manifold to accommodate sampling by a suite of analyzers and some of these analyzers have filter holders. To ensure integrity of gaseous samples it is critical that they reach the analyzer as quick as possible after entrainment into the probe from the atmosphere. Additionally, all of the sample train components need to remain free of visible degradation and contaminants, which can include

insects and spider webs. Should these conditions not be verified, there is a strong likelihood that the pollutant measurements will be biased and inaccurate.

When obtaining measurements for the site drawing a tape measure is used and distances are recorded to the nearest 0.1 m. A rangefinder is used for measuring distances of obstacles that are inaccessible and further than 6m away from the inlet. The resolution of the rangefinder is 1m. Any obstacles that are inaccessible or unsafe to access, yet less than 6m away cannot be measured accurately. Nonetheless, these obstacles should be documented and an approximate distance should be recorded. If a particular distance is an estimate, it should be noted both on the site drawing and in the comments section in AIS.

AE.1.3 PERSONNEL QUALIFICATIONS

All new CARB auditors undertake a one-year training program that is documented and monitored by the QAS manager. The training includes in-office reading and coursework, hands-on field experience conducting audits, and shadowing an experienced auditor for one year along with several in-field evaluations by the QAS manager.

U.S. EPA reviews CARB's training program regularly for approval as equivalent to U.S. EPA's national certification and recertification courses. Auditors should be familiar with the regulations and guidance cited in the references section prior to conducting any audits without supervision. Each auditor is expected to have a minimum level of on the job training and familiarity with the audit equipment prior to conducting the audit.

NOTE: A station operator familiar with the equipment must be present during the entire audit.

AE.1.4 HEALTH, SAFETY, AND CAUTIONS

All personnel must follow all general health and safety guidelines as described by the facility where the audit is conducted. All audit equipment, should be used in the manner described in this SOP and in the appropriate operator's manual.

Falls from portable ladders are one of the leading causes of occupational fatalities and injuries. Appropriate safety precautions should be taken

and auditors should be familiar with, and trained on, proper ladder usage.

Care should be taken when accessing instrument probe and inlets, especially on station rooftops. All surrounding areas considered for inspection and measurements should be easily and safely accessible.

AE.1.5 EQUIPMENT AND MAINTENANCE

AE.1.5.1 GENERAL EQUIPMENT

The following equipment is considered general equipment for conducting a site survey and for determining residence time of gaseous analyzers:

- A 50m tape measure (Figure AE.1)
- A rangefinder (Figure AE.2)
- A clinometer with a compass (Figure AE.3)
- Digital calipers (Figure AE.4)
- Site folder
- Relevant worksheets
- Black and blue pens
- Clipboard
- Laptop computer with AIS

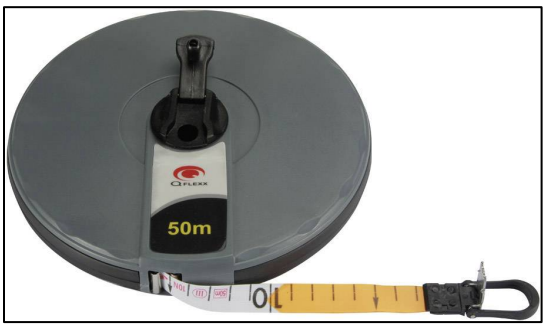


Figure AE.1 Example of a 50m tape measure

Figure AE.2 Example of a rangefinder

Figure AE.3 Example of a clinometer with a compass

Figure AE.4 Example of digital calipers

AE.1.6 MAINTENANCE AND CERTIFICATIONS

Prior to departure from the office, it is the responsibility of the auditors to complete a van checkout sheet. The auditors need to verify that they have the tape measure, the rangefinder, the clinometer/compass, and the digital calipers. It is important to verify that all pieces of equipment are in working order. None of these pieces of equipment requires laboratory calibration. The calipers should read 0.0 mm when closed. If they do not, a "zero" button that can be pressed at this time. If readings from the calipers appear to be incorrect, a crude verification can be made against a metric ruler or against the centimeter increments on the tape measure.

The rangefinder and digital calipers are battery operated. During the pre-audit van checkout, it is important to verify that the battery has sufficient voltage. It is highly recommended that a spare battery be onboard. Keep in mind these are non-standard batteries and not readily available.

AE.2.0 AUDIT PROCEDURES

AE.2.1 AUDIT PROCEDURE FOR DETERMINING OBSTACLES

When starting a site survey it is important to observe the immediate and neighboring land use to consider the measurements that should be recorded for scrutiny with potential for influencing the data generated at the monitoring station. Structures and vegetation at or above the probe or inlet height may influence the measurements because they can scavenge or scrub certain pollutants. Additionally, these obstacles can hinder or deflect representative samples from being gathered by altering the natural dispersion of pollutants in the atmosphere.

To aid in identifying obstacles that can result in siting violations it is necessary to have an understanding of three siting rules derived from 40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring. These are the Dripline Proximity Rule, the Two-To-One Rule, and the 270° Arc Rule. The order of application and interpretation of these three siting rules is not explicitly spelled out in the regulations. Discussions with U.S. EPA Region 9 have resulted in an agreed upon interpretation that the drip-line proximity rule takes precedent over the other two.

AE.2.1.1 DRIPLINE PROXIMITY RULE

The drip-line rule is most simply interpreted as follows: There shall be no vegetation such as branches or leaves within 10m of the probe/inlet at a height higher than the probe/inlet (Figure AE.5). This distance is confirmed with either the range-finder or, if safely accessible, the tape measure. Violation of the dripline rule results in a Corrective Action Notification, CAN unless the particular air monitoring station has a U.S. EPA waiver that addresses this violation. A 20m dripline is desirable and provides a buffer for vegetation to grow over the course of the year.

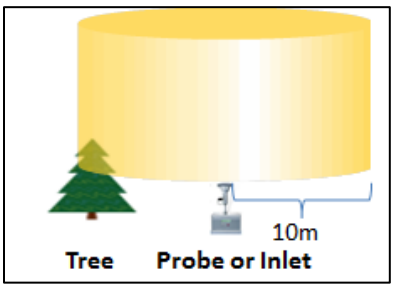


Figure AE.5 Drip-Line Proximity Rule

AE.2.1.2 TWO-TO-ONE RULE

The two-to-one rule identifies obstacles that need to be noted on the site drawing. Any tree or structure higher than half its distance from the probe/inlet qualifies as an obstacle (Figure AE.6). A clinometer and rangefinder are used to determine if the inlets or probes at the air monitoring station satisfy the two-to-one rule with respect to any surrounding trees or other obstacles. The Excel® worksheet, (Figure AE.7), requires the auditor to input several measurements if it is not possible to safely position their eye at the level of the inlet. If the auditor can safely place their eye at the level of the inlet then they can simply sight the top of the potential obstacle with a clinometer. This is done by keeping both eyes open with one eye looking through the clinometer and the other eye looking at the top of the potential obstacle. A reading is taken in either degrees incline or the percent slope. These appear in the viewfinder of the inclinometer (Figure AE.9). Degrees incline is on the left while percent grade is on the right. If the degrees incline is more than 26.6° or the percent slope is more than 50% then the two to one rule is exceeded and the obstacle has to be noted on the site drawing.

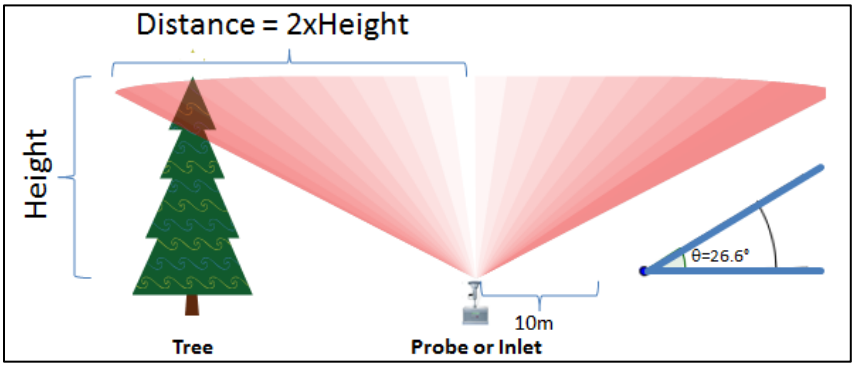
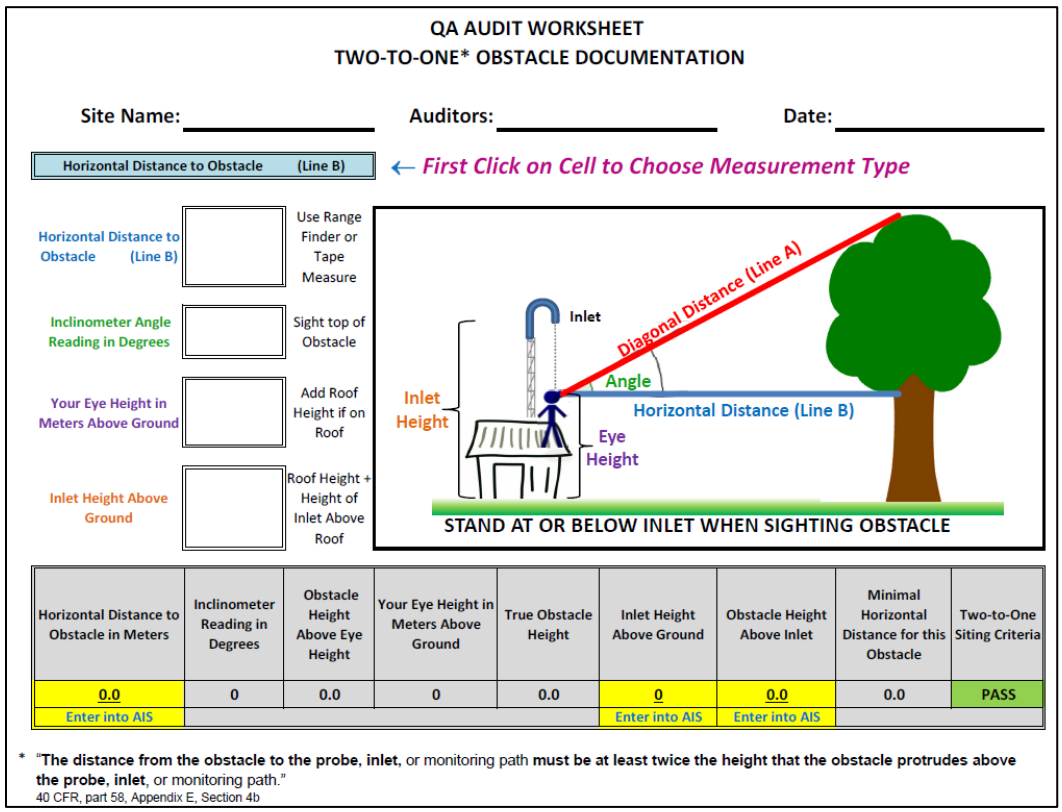


Figure AE.6 Two to One Rule



QA AUDIT WORKSHEET
TWO-TO-ONE* OBSTACLE DOCUMENTATION

Site Name: _____ Auditors: _____ Date: _____

Horizontal Distance to Obstacle (Line B) ← *First Click on Cell to Choose Measurement Type*

Horizontal Distance to Obstacle (Line B)		Use Range Finder or Tape Measure
Inclinometer Angle Reading in Degrees		Sight top of Obstacle
Your Eye Height in Meters Above Ground		Add Roof Height if on Roof
Inlet Height Above Ground		Roof Height + Height of Inlet Above Roof

Horizontal Distance to Obstacle in Meters	Inclinometer Reading in Degrees	Obstacle Height Above Eye Height	Your Eye Height in Meters Above Ground	True Obstacle Height	Inlet Height Above Ground	Obstacle Height Above Inlet	Minimal Horizontal Distance for this Obstacle	Two-to-One Siting Criteria
0.0	0	0.0	0	0.0	0	0.0	0.0	PASS
Enter into AIS					Enter into AIS	Enter into AIS		

* "**The distance from the obstacle to the probe, inlet**, or monitoring path **must be at least twice the height that the obstacle protrudes above the probe, inlet**, or monitoring path."
40 CFR, part 58, Appendix E, Section 4b

Figure AE.7 Two to One Rule Excel® Worksheet

AE.2.1.3 270° ARC RULE

Whether or not obstacles, found to violate the two-to-one rule, result in the issuance of a CAN depends on the third rule, the 270° arc rule. This rule states that there must be unrestricted airflow of 270° around the probe or sampler, or 180° if the probe is on the side of a building or a wall. The 270° arc rule can be interpreted in two ways, either continuous or cumulative (Figure AE.8). Nonetheless, an auditor needs to verify if trees and other obstacles exist upwind for the direction of the prevailing wind during the season when concentrations for a particular pollutant is high. The bottom dial of our clinometer is a compass and can be used to ascertain direction and to figure out how much of the flow arc is unobstructed (Figure AE.9). Additionally, our binoculars have a built in compass that can be used for this purpose.

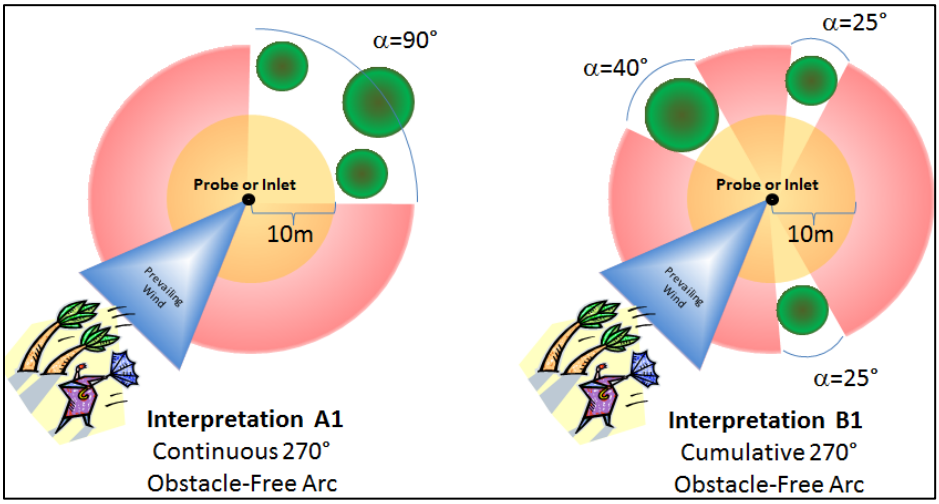


Figure AE.8 270° Arc Rule

Figure AE.9 Using a Clinometer

An informed station operator should be aware of the prevailing wind direction during various seasons. Keep in mind that wind is always given by the direction from which it arrives. A North wind blows from the

North to the South. Some operators will be able to provide a wind rose, (Figure AE.10).

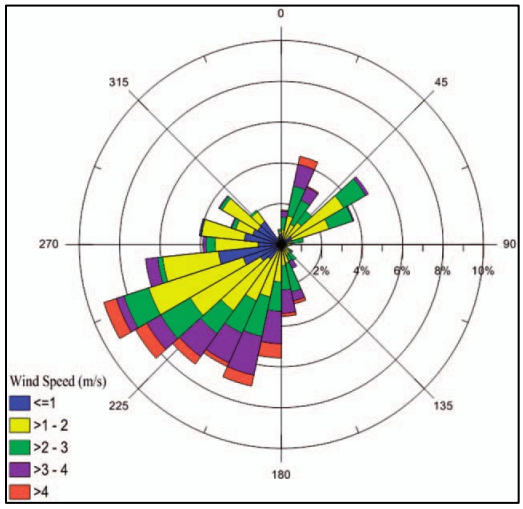


Figure AE.10 A Wind Rose Indicating Prevailing Southwesterly Wind

An auditor should be familiar with reading a wind rose. A wind rose is a graphic tool that gives a succinct view of how wind speed and direction are typically distributed at a particular location. In this figure, the prevailing wind is from the Southwest.

Figure AE.11 shows the prevailing wind patterns in the summer months in California. This is the high season for ozone. It is advised that auditors have some minimal knowledge of general prevailing wind directions throughout the state. For example, the southern San Joaquin Valley will have prevailing Northwesterly wind. If a Southeasterly wind is auto populating on the general site survey then this should be verified and corrected. However, local topography can modify the prevailing wind at a particular locale.

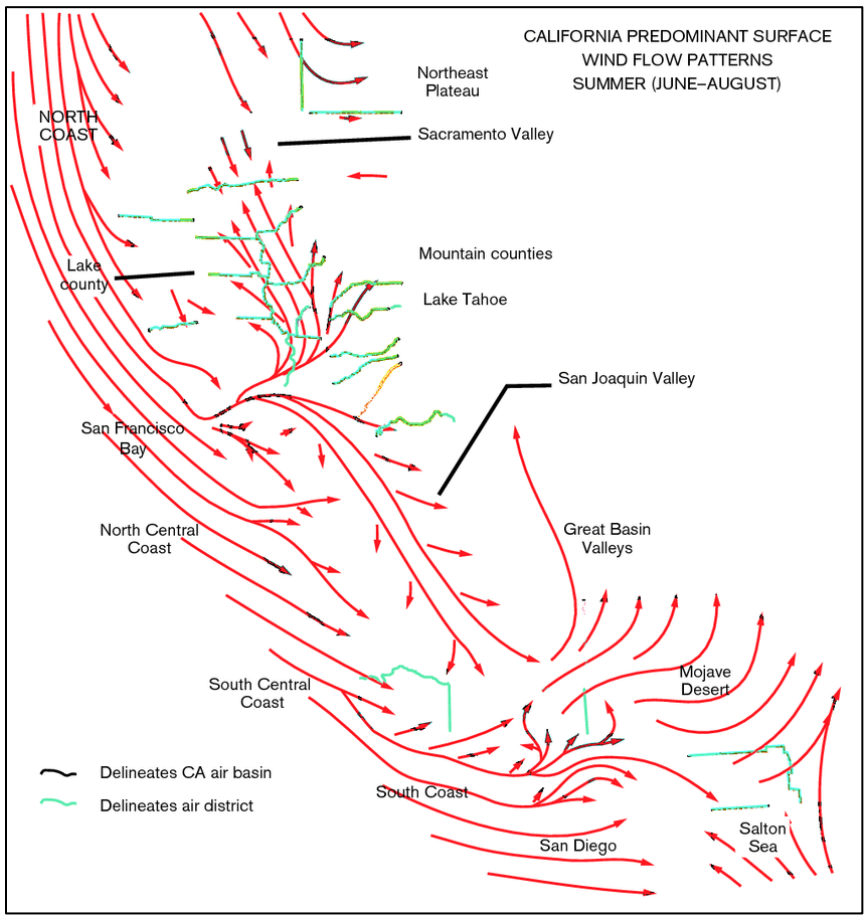


Figure AE.11 Predominant Summertime Surface Winds in California

The U.S. EPA can occasionally grant a siting exemption or waiver for an air monitoring station. This is a formal procedure pursued by the air monitoring agency. CARB QA section cannot grant this waiver. However, if a siting waiver exists then a CAN should not be issued for the particular siting violation. The general comments section in AIS needs to mention the existence of the particular siting waiver and a copy of the waiver should reside in the site folder.

AE.2.2 AUDIT PROCEDURES FOR SITE DRAWING

Other than trees, obstacles include walls, parapets, and large pieces of rooftop equipment such as air conditioners. These will need to be included in the site drawing along with any relevant trees or vegetation.

Figure AE.12 Measuring Distance between Inlets of Two Samplers

Figure AE.13 Measurement of Inlet Height above Roof or Platform

Once all obstacles and relevant pieces of vegetation have been identified, a site drawing is sketched out.

Despite a range of individual artistic skills, it is important that the site drawing be composed in a fashion so that another individual can make sense of it without struggle. The site drawing is a bird's eye view of the air monitoring station with North clearly noted by an arrow. It is good

practice but not obligatory to have north be the top of the page. The edges of the rooftop or platform should be evident.

Positions of all inlets, probes, instruments, met towers, obstacles, roads, and vegetation should be drawn in a way that is representative of their relative positions. In the AQS database, an AMP 380 site description report and AMP 390 monitor description report can be obtained for the site. For auditors that have AQS access these reports can be useful in verifying their site drawing and informing the site operator of any discrepancies.

A tape measure is used for all relevant heights and distances that can be taken without risk to the auditor. The height of the roof or platform can be obtained by carefully lowering the tape measure to the ground. On windy days, this might require the help of the second auditor or possibly the station operator. The heights of all inlets, probes, and meteorological equipment are measured (Figure AE.13) and recorded on the site drawing. The horizontal distances (Figure AE.12) between probes and inlets also need to be measured and recorded on the site drawing (Figure AE.15).

At air monitoring stations that contain a large number of samplers it is not necessary to record the horizontal distance from the center of each inlet to the center of every other inlet. This would be counter-productive, as the drawing would quickly become too busy and difficult to read. Nonetheless, it is important to verify that the center of each inlet is at least 1m away from the center of another inlet. Additionally, the distance to the closest inlet should be noted. High volume PM10 samplers should be 2m away from other probes/inlets. If there is an air conditioner on the roof then it needs to appear in the site drawing and the horizontal distance to the nearest probe/inlet needs to be measured and recorded on the site drawing.

Figure AE.14 Utilizing a Rangefinder to Measure Inaccessible Obstacles

All measurements are recorded on the site drawing worksheet (Figure AE.15) using International System of Units, SI, known as the metric system. These distances are recorded to the nearest 0.1m or 10cm. Distances greater than 6m that are not accessible can be measured remotely using a rangefinder (Figure AE.2 and Figure AE.14). The resolution on the rangefinder is 1m and the range is over 100m. The clinometer reads in degrees above horizontal and in percent incline.

During an annual station audit, a new site drawing is drawn up every two years. This site drawing is verified and updated during annual audits on alternate years. The original drawing and any subsequent minor updates should be done in pen. These minor updates or changes need to be dated and initialed by the auditor conducting the site survey. If major changes are noted then the site drawing will have to be redrawn.

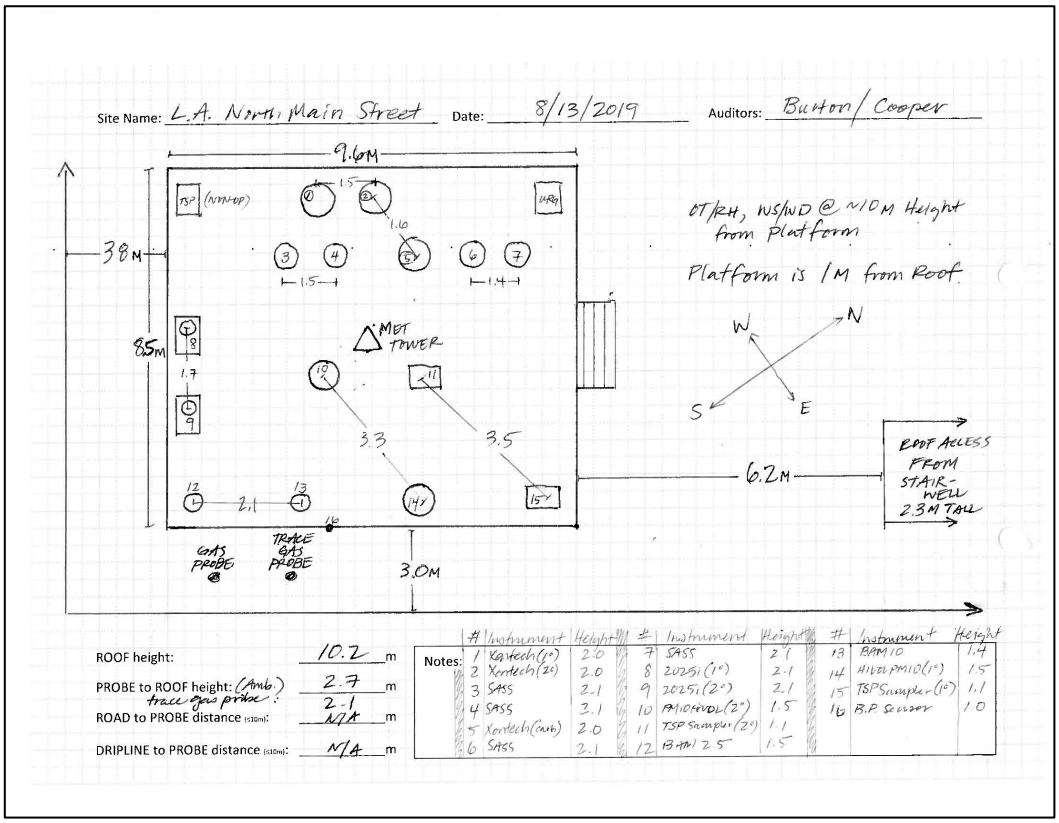


Figure AE.15 Example of a Completed Site Drawing Worksheet

The following is a checklist of everything that must be included on a site drawing:

- Birds eye view of station
- Arrow indicating North
- Relative placement of monitors or inlets even if not audited
- Location of air conditioners, parapets, walls, etc.
- Inlet heights for all audited monitors
- Distance to closest inlet for all audited monitors
- Roof or platform height
- Location and height of meteorological tower if present

- Distance to road
- Distance to dripline
- Location of trees or obstacles
- Any notes that might be relevant or helpful for other auditors

AE.2.3 AUDIT PROCEDURES FOR RESIDENCE TIME

In addition to a site drawing, the auditors calculate the residence time in the sample train for each of the gases that are sampled at the air monitoring station. Prior to taking any measurements an auditor needs to verify that the entire sample train is composed of only borosilicate glass, such as Pyrex®, and PFA or PTFE (Teflon®) tubing. Stainless steel or brass in the sample train will result in a CAN. Cleanliness of the sample train has to be evaluated during a full audit (Figure AE.16). This is a visual inspection for deposits of dirt, ash, insect, and other debris along the length of the sample train. This inspection can be conducted at the same time measurements are made for residence time. Dirty portions of the sample train should be photographed and noted in the site survey.

Figure AE.16 An Example of a Dirty Probe and a Sample Line with Spider Webs

Calculation of residence time is done by first measuring the lengths of the constituent sections of the sample train using the tape measure (Figure AE.17). The inner diameter of each section is measured using the digital calipers (Figure AE.18). Lengths of Teflon tubing are noted in

meters to the closest 0.1m. Lengths of Pyrex manifolds and other Pyrex tubes are noted to the closest 0.01m. Inner diameters are noted in millimeters to the closest 0.1mm. Auditors should not disconnect tubing or other coupling on the sample train. It is common that the operator has a spare piece of tubing at the station. If this is the same type of tubing then it can be used to verify the inner diameter.

The measurements are recorded on a residence time worksheet (Figure AE.19). In addition to these measurements, sampling flow rates, in liter per minute, have to be recorded for each gaseous sampler. For example, a typical flow rate for an ozone sampler would be 0.650 to 0.750 LPM. The actual flow rate is taken off the analyzer. If the station has a booster pump which pulls off the manifold, then the flow rate of this booster pump is noted as well. If the booster pump does not have an inline rotameter or other flow indicator then the auditor can use their rotameter at the booster pump exhaust to determine the flow rate. All measurements and flow rate data are noted on a residence time worksheet and then transcribed into an Excel® version of the worksheet that calculates residence time for all gases sampled at the site. A passing residence time is 20 seconds or less. Exceedances result in a CAN.

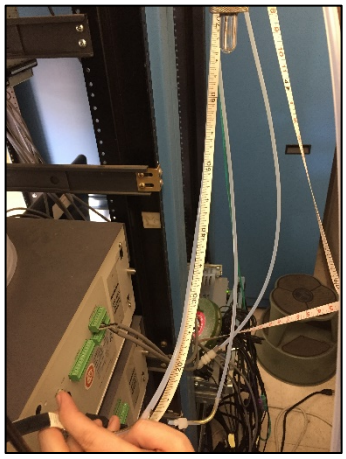


Figure AE.17 Measuring the Length of a Teflon Sample Line

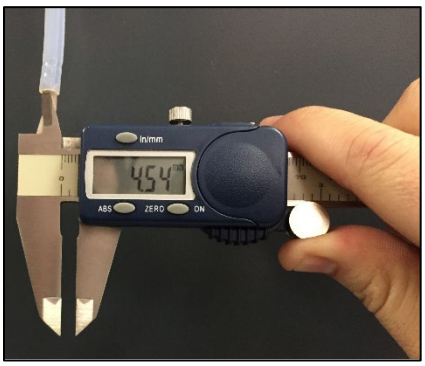


Figure AE.18 Measuring the Inner Diameter of a Teflon Sample Line

WORKSHEET - PROBE RESIDENCE TIME - Multiple Diameters

Site Name: _____ Operator / Auditors: _____ (circle as appropriate) Date: _____

Booster pump flow = LPM **Pollutant**

	Cane	Probe	Manifold	Manifold to Instrument	Manifold to Instrument	Manifold to Instrument	Manifold to Instrument	Manifold to Instrument	Manifold to Instrument
Material	Glass	Teflon	Glass	Teflon	Teflon	Teflon	Teflon	Teflon	Teflon
				T1 T2 T3					
ID (mm)				*	*	*	*	*	*
Length (m)				*	*	*	*	*	*
Flow (lpm)									
Time				*	*	*	*	*	*
Total Residence Time =									

Residence Time Calculation = $\frac{3.14(ID^2) \times LENGTH \times 0.015}{FLOW} = \frac{3.14 * radius^2\ (mm) * LENGTH\ (m) * 60\ (sec/min)}{FLOW\ (lpm) * 1000}$

Multiple Tubing Diameters Calculation*
**only used for entry into the Audit Information System (AIS), where different diameters of tubing are present*

$= ((tubing\_2\ I.D./tubing\_1\ I.D.)^2 * tubing\_2\ length) + ((tubing\_3\ I.D./tubing\_1\ I.D.)^2 * tubing\_3\ length) + tubing\_1\ length$

Common Sample Line Diameters

Outside Diameter (in.)	1/8"	3/16"	1/4"	1/4"	5/16"	5/16"	3/8"	3/8"	1/2"	1/2"
Wall Thickness (in.) *	.030"	.030"	.030"	.062"	.030"	.062"	.030"	.062"	.030"	.062"
Inside Diameter (mm)	1.6	3.2	4.8	3.2	6.4	4.8	7.9	6.4	11.1	9.5

* "thin wall" is typically = 0.030", while "thick wall" is typically = 0.062"

Manifolds

O.D. (in.)	1.25"	2.0"
W.T. (in.)	.25"	.25"
I.D. (mm)	25.4	44.5
Length (m)	0.25	0.30

Recorded by / Date: _____ _____ Verified by / Date: _____ _____

California Air Resources Board MLD/QAS-034b (Rev. 5/20/16)

Figure AE.19 Residence Time Worksheet

AE.3.0 DATA MANAGEMENT AND RECORDS

Site drawings and residence time worksheets must be signed by the auditor who created them. Corrections or updates should be initialed and dated. Both sheets stay on page five of the site folder that is stored in the filing cabinet.

AE.3.1 AUDIT INFORMATION SYSTEM

Once the site drawing is complete, measurements can be entered into AIS. In the instrument survey for each sampler, the following measurements are entered:

- Distance to Collocated Monitor (If Applicable)
- Inlet Height above Ground
- Inlet Height above Structure
- Distance from Obstructions on Roof (Horizontal)
- Height above Inlet for Obstructions on Roof
- Distance from Obstructions Not on Roof (Horizontal)
- Height above Inlet for Obstructions Not on Roof
- Distance from Trees (Dripline)
- Distance to Furnace, Flue, or A/C

Additionally, the following information is entered into the general site survey in AIS:

- Distance to Nearest Roadway (If less than or equal to10m)
- Unrestricted Airflow (Should be at least 270°, maximum is 360°)
- Prevailing Wind Direction (The direction from which the wind blows)

For each gaseous sampler it is necessary to enter the following into AIS:

- Flow rate for each section of the sample train (Change if auto-populated)
- Width of each of three component sections (mm)
- Length of each of three component sections (m)

AE.3.2 AUDIT DATA CALCULATIONS

AIS calculates residence time for each gaseous sampler in a similar manner as the Excel® residence time worksheet. These are basic calculations that calculate the volume of a long thin cylinder corresponding to each section of the sample train. When divided by a flow rate (volume per unit time) for that section of sample train, the volumes cancel and the result is the time that the sample resided in that portion of the sample train as it transited through it. This is referred to as the residence time.

Volume / Flow Rate = Residence Time

The pronounced difference between the Excel® spread sheet and AIS is that AIS does not allow for entry of more than three components of the sample train. These are the probe, the manifold, and the manifold to instrument. If the "manifold-to–instrument" section of the sample train contains a filter holder, the multiple diameters excel spreadsheet must be used. This version of the excel sheet calculates a new effective tube length. It can be thought of as compressing the short and wide filter holder to a long and narrow tube. This effective tube length has the same volume as the filter holder but an inner diameter that is the same as the rest of the Teflon tube on that manifold-to-instrument portion of the sample train.

AE.3.3 SITING CRITERIA

Table AE.1 summarizes the siting criteria.

Siting Criteria Distances

Instrument	Height above ground Micro	Height above ground Other	Spacing between samplers	Height above obstructions	Distance from obstacles	Distance from tree dripline	Distance from walls, parapets, etc.	Airflow arc
PM10, Nephelometer	2-7m	2-15m	2m-4m		2 times height of obstacle above inlet	should be 20m, must be 10m if considered an obstruction	2m	270
Dichot, TEOM, PM2.5	2-7m	2-15m	1m-4m		2 times height of obstacle above inlet	should be 20m, must be 10m if considered an obstruction	2m	270
Lead, TSP	2-7m	2-15m	2m-4m		2 times height of obstacle above inlet	micro and middle: no trees between sampler and source, neighborhood: should be 20m, must be 10m if considered an obstruction	2m	270
O3	3-15m	3-15m		1m	2 times height of obstacle above inlet	should be 20m, must be 10m if considered an obstruction	1m	270, or on side of building 180
CO	2 1/2 - 3 1/2m	3-15m		1m	2 times height of obstacle above inlet	micro: must be no trees between sampler and road, others: must be 10m if trees 5m above sampler.	1m	270, or on side of building 180
NO2	3-15m	3-15m		1m	2 times height of obstacle above inlet	should be 20m, if individual tree >5m above probe, must be 10m from dripline	1m	270, or on side of building 180
SO2	3-15m	3-15m		1m	2 times height of obstacle above inlet	should be 20m, must be 10m if considered an obstruction	1m	270, or on side of building 180
H2S	3-15m	3-15m		1m	2 times height of obstacle above inlet	should be 20m, must be 10m if considered an obstruction	1m	270,or on side of building 180
CH4, THC, NMHC, PAMS	3-15m	3-15m		1m	2 times height of obstacle above inlet	should be 20m, must be 10m in direction of urban core	1m	270, or on side of building 180
Toxics Gaseous 910, 910A, 920	3-15m	3-15m		2m	2 times height of obstacle above inlet			
Temperature and Relative Humidity	1.25-2m	1.25-2m			4 times height of obstacle above sensor	1 tower width from tower side	4.5m	
Wind Speed and Direction					1.5 times height of obstacle above sensor	2 tower widths from tower side, 1 tower width from tower top		

Table AE.1 Summary Table of Audit Criteria

The siting criteria for each pollutant vary depending on the pollutant's properties and the requirements addressed in the guideline documents. The Siting Criteria Distances table (Table AE.1), provides a concise summary of criteria. Note that height of instruments above ground is based on the scale that the station is designated to represent. This scale can be found in the dossier for a particular station. Stations designated for micro scale will have lower maximum height requirements for particulate and CO samplers. All other scales will fall into a category where the maximum height of these samplers can reach 15m above ground.

Collocated monitors have to be specifically designated. One is designated as the primary and the other is designated as the secondary. Collocation should not be assumed just because a station has two of the same type of monitor. Collocated monitors must be within 4 meters of each other and at least 2 meters apart for flow rates greater than 200 liters/min or at least 1 meter apart for samplers having flow rates less than 200 liters/min to preclude airflow interference, unless a waiver is in place. In practice, the only samplers that we encounter on audits that exceed the 200 liters/min flow rate are the high volume PM10 samplers.

AE.3.4 CORRECTIVE ACTIONS

Deviation from siting criteria or exceedance of residence time will result in the issuance of a CAN. The one exception is if the air monitoring station has been granted a waiver for a particular siting violation from the U.S. EPA. The audit team must inform the site operator, prior to the end of the audit, if a CAN will be issued. Refer to the SOP for Corrective Action Notifications (Volume V, Appendix AN) for guidance.

AE.3.4.1 WAIVER OPTIONS

A waiver of 40 CFR 58, Appendix E criteria may be requested from U.S. EPA, Region IX by the monitoring organization; however, U.S. EPA will not always grant waivers. Requests for a waiver must be very well documented. They must emphasize why the criteria cannot be met and demonstrate that the data are representative of monitoring objectives. Cost benefits, historical trends, etc., can be weighed as factors, but cannot be the sole reason for the waiver. U.S. EPA evaluates each request, taking into account the effect the deviation will have on the data, especially to the pollutants of primary concern at a monitoring site. For example, if a siting factor for PM is not met, but the primary purpose of the site is to monitor SO2 concentrations, U.S. EPA will be more amenable to a waiver of the PM siting criterion. U.S. EPA will also consider the impact of wind direction on pollutant concentrations when considering a waiver. A site must be free of impairments in the windward direction of pollutant sources.

AE.3.5 RESULTS AND REPORTING

AE.3.5.1 COMPILING PRELIMINARY AUDIT RESULTS

1. Review site drawing and residence time sheet for completeness and accuracy, sign.

2. Input relevant data from the worksheets into AIS to generate preliminary results and report. The second auditor should review and verify that the worksheet and AIS entries match.

3. Notify the operator of preliminary audit results and necessary follow up actions. Exceedances of established audit criteria or deviation from operational standards may result in corrective action. Vegetation that is close to becoming an obstacle should be noted in the comments section and discussed with the operator before concluding the audit.

4. Forward a copy of the preliminary report to the operator upon return from the field.

AE.4.0 REFERENCES

40 CFR Appendix A to Part 58 - Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards
https://www.law.cornell.edu/cfr/text/40/appendix-A_to_part_58

40 CFR Appendix D to Part 58 - Network Design Criteria for Ambient Air Quality Monitoring
https://www.law.cornell.edu/cfr/text/40/appendix-D_to_part_58

40 CFR Appendix E to Part 58 - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring
https://www.law.cornell.edu/cfr/text/40/appendix-E_to_part_58

CARB Audit Procedures Manual for Air Quality Monitoring
https://ww2.arb.ca.gov/our-work/programs/quality-assurance/quality-assurance-manual

Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements Version 2.0
https://www3.epa.gov/ttn/amtic/files/ambient/met/Volume_IV_Meteorological_Measurements.pdf

U.S. Environmental Protection Agency, Quality Assurance Handbook, Volume II (January 2017)
https://www3.epa.gov/ttnamti1/files/ambient/pm25/qa/Final%20Handbook%20Document%201_17.pdf

CARB Air Monitoring Quality Assurance Manual-Volume V: Audit Procedures for Air Quality Monitoring, "Appendix AN: Corrective Action Notification (CAN)", Revision 5 (May 2020):
https://ww3.arb.ca.gov/aaqm/qa/pqao/can/can_sop_rev5.pdf?_ga=2.170080296.901577441.1592238058-1267094091.1586795859

AE.5.0 REVISION HISTORY

Subject	Revision 2 (2020)
New or Revised Sections	The whole SOP has been revised.
Calibration and Audit Criteria	Hierarchy of siting rules is clarified.
Audit Procedures	Current procedures are described