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Site Relocation and Parallel Monitoring Guidelines

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AMTAC understands this to be a working document and accepts revisions and recommendations at all times.

Parallel Monitoring Guidelines

I. INTRODUCTION

The purpose of this document is to assist agencies in determining whether parallel monitoring should be conducted when relocating an air monitoring station. There are many situations which can lead to the need to relocate an air monitoring station. During the relocation process parallel monitoring provides evidence for selecting the best replacement site(s) and for establishing relationships between concentrations of pollutants at an existing site and a replacement site(s). Although there is no statutory or regulatory requirement for parallel monitoring, there may be regulatory consequences when parallel monitoring is not conducted prior to relocation. Failure to demonstrate that concentrations of critical pollutants at the replacement site(s) are equal to or greater than at the old site may affect the current or future attainment status of an area. Also, parallel monitoring can help assure the validity of assessments of control program effectiveness when key trend sites must be relocated. In fact, when a site must be relocated, an analysis of parallel monitoring data is often the best way to determine if important monitoring objectives for the existing site will be satisfactorily continued at the replacement site. In addition to explaining when and how to conduct parallel monitoring, this document includes guidelines on the appropriate use of analytical techniques.

I.1. Definitions

<u>Parallel Monitoring</u>: Concurrent ambient air monitoring of one or more critical pollutants at an existing site and its potential replacement site(s).

<u>Critical Pollutant(s)</u>: Pollutants for which ambient air quality data are critical to meeting the overall goals and purposes of the monitoring network. Critical pollutants should be decided on a case-by-case basis in the context of current data needs and uses.

I.2. Purpose and Application of Parallel Monitoring

The purpose of parallel monitoring is to assemble evidence for determining whether a replacement site satisfactorily meets the monitoring objectives of a site that is to be relocated. This is done by establishing relationships between concentrations of pollutants at an existing site and a replacement site(s). The following questions arise when relocating a monitoring station: What are the key monitoring objectives served by the existing site? Is parallel monitoring necessary, that is, is it necessary to determine whether a replacement site adequately replaces an existing site, and is parallel monitoring the way to do this? What pollutants should be parallel monitored and for how long? What limitations of time and resources must constrain the parallel monitoring effort?

If there is a need to relocate an existing ambient air monitoring station, the need for parallel monitoring at the existing site and a replacement site should be evaluated on a case-by-case basis. In some cases, depending on the importance and uses of the data at the original site, parallel monitoring is necessary. The following are examples of monitoring situations where parallel monitoring would be necessary:

- Relocating a National Air Monitoring Station (NAMS) monitor. These monitors track national air quality trends. Parallel monitoring data will be needed to determine the adequacy of the replacement site and to substantiate any shifts in concentrations from the existing site to the proposed site. Usually the concentrations from a replacement trend site need to be of comparable magnitude to the concentrations at the existing trend site.

- Relocating monitors that track air quality trends. While NAMS track national air quality trends, other monitoring stations provide data for tracking long term trends on a regional scale. The data are used to evaluate progress in attaining the ambient air quality standards and document baseline conditions. Appropriate sites must be carefully chosen. Any shift in concentrations due to the site relocation needs to be accounted for when analyzing air quality trends in the area.

- Relocating a monitor that has been, or may reasonably be expected to become the determining site for area designations ("design" or high site). The pollutant concentrations at the replacement site should be equal to or greater than the pollutant concentrations observed at the existing site.

- Relocating a monitor that provided data for health advisories. Again, the pollutant concentrations at the replacement site should be equal to or greater than the pollutant concentrations observed at the existing site.

For all other monitoring situations, the need for parallel monitoring has to be evaluated on a case-by-case basis.

II. SCOPING OF PARALLEL MONITORING

The goal of "scoping" is to optimize the parallel monitoring process. The decision whether or not to conduct parallel monitoring should be made on a case-by case and pollutant-by-pollutant basis. The following factors should be considered when determining critical pollutants and evaluating the need for parallel monitoring:

- The importance and uses of the data (ie. monitoring objectives) for each monitor at the original site;
- Future data needs and uses;
- The existence of other monitoring stations in the area.

II.1. Data Considerations

When relocating an ambient air monitoring station, the importance and uses of the data for each monitor at the original site need to be assessed. This understanding is needed as the basis for determing whether replacement sites are needed and for selecting the location of replacement sites. It is important to note that the data needs may change with time as air quality programs change, and in response to changes in emissions, population, and ambient pollutant concentrations. So a recent evaluation of the monitoring objectives served by the existing site is advised. These data needs should be evaluated in the context of the overall goals and purposes of the monitoring network in order to determine if data from the existing site support any of the key uses described below:

- Evaluation of Ambient Air Quality

For the purpose of determining attainment of State or Federal ambient air quality standards, reasonable representation of ambient air quality throughout the area is needed. Area designations are determined based on the highest concentrations of air pollutants. Therefore, each designation area needs a monitoring site that is located to collect such data. The data are also used to demonstrate reasonable progress toward attainment for areas in violation of National Ambient Air Quality Standards (NAAQS) or California Ambient Air Quality Standards (CAAQS).

- Assessment of Population Exposure

The ultimate goal of air quality monitoring is to protect public health and welfare. The number and location of monitors in the network and their monitoring objectives arise from the need to adequately support and ensure public health and welfare. The Pollution Standards Index (PSI) is used to keep the public aware of current levels of air pollutants in a given location. It is further used to forecast health advisories to sensitive populations, the elderly, school children, etc.

Another important use of health oriented data is to evaluate population exposure. NAMS are located in the areas with high pollutant concentrations and high population exposure. Areas subject to episodes with extremely high concentrations use monitoring data to identify these episodes and develop emergency episode plans.

- Enforcement of Source Specific Regulations

The objective of source specific monitoring is to measure the impact of major air pollution sources on ambient air quality. The primary concern is to measure acute concentrations due to catastrophic releases, as well as chronic health impact due to average concentrations.

- Development and Evaluation of Control Plans

The monitoring data are used to demonstrate and characterize the need for controls. The California and the Federal Clean Air Acts require areas in violation of one or more air quality standards to develop a plan and a control program to attain the standards. Another example of using air quality data for developing and evaluating control plans is California's agricultural burning program in which the air quality data and meteorological data are used to forecast air quality and allocate acres for agricultural burning.

- Research

Monitoring data are needed to carry out research designed to improve the accuracy and interpretation of air quality data, and prediction of ambient air quality. Monitoring sites selected to support research may be unique for each project or may be satisfied by existing stations. The monitoring objective would depend on the research needs. For example, the impacts of pollutant transport are assessed based on high concentration events that occur in strategic transport corridors.

Table 1 summarizes important data uses.

TABLE 1. AMBIENT AIR QUALITY DATA USES

- Evaluation of Ambient Air Quality
  - -Judging Attainment of National Ambient Air Quality Standards (NAAQS) and California Ambient Air Quality Standards (CAAQS)
  - -Assessing Progress in Achieving/Maintaining NAAQS and CAAQS
  - -Tracking Long Term Trends

- Protection of Public Health
  - -Air Quality Indices
  - -Documentation of Population Exposure
  - -Developing an Air Pollution Emergency Episode Plan

- Enforcement of Source Specific Regulations
  - -Categorical Sources (Prevention of Significant Deterioration)
  - -Individual Sources
  - -Enforcement Actions

- Development and Evaluation of Control Plans
  - -SIP Provisions
  - -Local Control Strategies

- Research
  - -Effects on Humans, Plants, Animals, and Environment
  - -Characterization of Source, Transport, Transformation, and Fate
  - -Development and Testing of New Instruments
  - -Development and Testing of Models

II.2. Monitored Pollutants

Critical pollutants for parallel monitoring are decided on a case-by-case basis with reference to data needs and uses. The following questions will help to determine which pollutants are critical to meeting the overall goals and purposes of the monitoring network.

- What pollutants are monitored at the existing station?

- What key data uses described in section II.1 are supported by the existing station and for which pollutants?

- Are the monitoring data of value in representating the air quality in the area? Are the data unique or redundant with respect to nearby air quality stations?

- Would the monitoring role of the network be compromised without this monitor?

When relocating an air monitoring station, all of the pollutants for which air quality data have served high priority purposes in the monitoring network should be parallel monitored. Therefore, there could be more than one critical pollutant at the existing site. In addition, a critical pollutant may be deemed critical for more than one monitoring objective. Sometimes the replacement site may be optimal for one pollutant and/or monitoring objective but not for another. In that case, multiple replacement sites would be required to satisfy all of the critical pollutants and their monitoring objectives. For example, the existing site may measure high concentrations of PM10 in a highly-populated area. The data from this site could be used for judging attainment of air quality standards and assessing population exposure. It may be difficult to find a single replacement site that will be the highest site but still located in the highly populated area. In that case, two replacement sites may be necessary, one optimal for measuring highest concentration, and one optimal for measuring population exposure. If operational constraints force an agency to select a single compromise site, it should be biased towards conditions appropriate for the most critical pollutants, and/or monitoring objectives.

II.3. Duration of Parallel Monitoring

Ideally, the time period for conducting parallel monitoring is at least one year. A practical approach that considers resource constraints that might exist is to collect a sufficient number of data values that are sufficiently high in magnitude. At a minimum, parallel monitoring must be conducted during the season when maximum concentrations are expected. Historical data for the pollutant(s) of concern should be required to determine the typical peak season and the peak season should include at least three months of data. In the absence of sufficient data for an analysis of historical patterns, Table 2 suggests how long parallel monitoring should be conducted. For pollutants that do not show strong seasonality the necessary season for the parallel monitoring effort may include an entire year.

TABLE 2: Duration of Parallel Monitoring
(In absence of sufficient historical data)

Pollutant		Months
Ozone (O_3)		July through September
Carbon Monoxide (CO)		November through January
Nitroge Dioxide (NO_2)	CAAQS	October through January
	NAAQS	January through December
Sulfur Dioxide (SO_2)		September through December
Sulfates (SO_4)		June through January
Lead (Pb)		November through January
Other Pollutants		January through December

Again, the key for most situations in which parallel monitoring is required is to collect a sufficient number of high data values. A sufficient number of data values for continuously-monitored pollutants is at least 30, all of which are sufficiently high in magnitude. A sufficient number of data points for sampling done less frequently than once per day is at least 15 data values sufficiently high in magnitude. For hourly data, a high value is a value greater than 80% of the data for the previous three years for the original site. For daily data, a high value is a value greater than 75% of the data for the previous 3 years for the original site. The averaging times for the data values used in the comparison should be equivalent to the averaging times of the relevant air quality standard. Pollutant concentrations at parallel monitored sites can reveal the peak concentrations at different times. Averaging the data values would eliminate the impact of fluctuations in peak hours and make the analyses less complex. For most pollutants, daily maximum values should be used. For some pollutants, noon-to-noon maximum values should be recommended, e.g., an 8 hour CO maximum value may span midnight. Table 3 summarizes data values requirements.

TABLE 3: Parallel Monitoring Data Requirements

Sampling Schedule	Averaging time used in parallel data comparison	Required Data Values	
		Number	Threshold [1]
Continuous	Daily maximum for most pollutants Noon-to-noon maximum for some pollutants	>=30	> 80th percentile of the data for the original site
Less than daily	Daily averages	>=15	> 75th percentile of the data for the original site

Obtaining a sufficient number of parallel monitored samples for less than daily sampling programs, such as PM10, is a particular concern. If parallel monitoring cannot be carried out for a full year, an accelerated sampling schedule (e.g., every three days) should be used over the peak concentration season (as determined by the analysis of historic data).

II.4. Potential Problems and Constraints

Situations may prevent an agency from conducting parallel monitoring. Some of the common reasons are:

- Insufficient resources (equipment, personnel and costs).
- Insuffient time to find a new site and secure access to collect sufficient data to ascertain the relationship between concentrations at the two sites.

Often these reasons can be overcome or mininized. It may be possible to borrow or rent the necessary equipment or analyzers. While there are recommended minimums for monitoring any monitoring data is better than none, especially during the season of interest for the critical pollutant.

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[1] The percentile is determined using a recent three year period of data. Only one of the data values in each matched pair of values needs to be greater than the appropriate threshold.

III. SITE SELECTION

Once the decision is made to conduct parallel monitoring, the next step is to select a suitable parallel monitoring location. The general procedure for selecting candidate replacement sites is similar to that used for selecting any monitoring site. These guidelines presented here describe only the aspects of site selection that are unique to selecting a replacement site.

III.1. Evaluation of Monitoring Network

The location of a replacement site(s) should complement the existing monitoring network. As indicated in Section II.1, the adequacy of the monitoring network should be re-evaluated to determine if the replacement site should have the same monitoring objectives as the existing site and to ensure that critical uses of the monitoring data would be supported. When selecting a suitable replacement site(s), the location of the existing monitoring stations should be taken into account to avoid redundancy.

III.2. Evaluation of the Area

The site search process would typically focus on a sub-region or a neighborhood relatively close to the existing site in an attempt to achieve data continuity. An important step in selecting a replacement site is to identify the unique local influences affecting air quality. This is important when analyzing the spatial distribution of pollutant concentrations over the area of concern. Factors affecting pollutant concentrations at the existing site and the possible replacement site should be considered. These include:

- The location of emission sources, together with source strength, and operating characteristics;
- Meteorological conditions that can cause frequent air stagnation or frequent persistent wind conditions;
- Topographical features that can affect transport and diffusion of pollutants.

If available information is not sufficient to characterize pollutant levels within the area to be monitored, it may be beneficial to conduct a saturation (many monitor) study to determine a possible replacement site. The saturation study would then typically be followed by parallel monitoring to establish relationships between concentrations of pollutants at an existing site and a replacement site(s). This may seem time and resource intensive, however, there is a trade off in time and resources between doing a saturation study, and then parallel monitoring versus conducting parallel monitoring at a replacement site and then determining that parallel monitoring needs to be conducted at a different replacement site.

III.3. Siting Criteria

The monitoring site must meet the EPA siting requirements as stated by Code of Federal Regulations (CFR) 40 with respect to spacing from obstructions, spacing from roads, horizontal vertical placement, etc. Ambient air monitoring stations in California are part of the State and Local Air Monitoring Station (SLAMS) network, the NAMS network, the Photochemical Assessment Monitoring Station (PAMS) network, and Special Purpose Monitoring (SPM). The primary guidance documents for network design and station siting of SLAMS and NAMS are listed below:

40 CFR58, Appendix D, Network Design For SLAMS/NAMS.

40 CFR58, Appendix E, Probe Siting Criteria For Ambient Air Quality Monitoring.

EPA-600/4-77-027a. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol.II - Ambient Air Specific Methods, Section 2.0.1 - Sampling Network Design and Site Selection.

EPA-600/4-77-027a. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol.II - Ambient Air Specific Methods, Section 2.0.2 - Sampling Considerations.

EPA-600/4-90/003. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV - Meteorological Measurements, Section 4.0.4.3 - Siting and Mounting.

EPA-450/3-78-013. Site Selection for the Monitoring of Photochemical Air Pollutants.

EPA-450/4-91-033. Enhanced Ozone Monitoring Network Design and Siting Criteria Guidance Document.

EPA-450/3-75-077. Selecting Sites for Carbon Monoxide Monitoring.

EPA-450/4-87-009. Network Design and Optimum Site Exposure Criteria for Particulate Matter.

EPA-450/3-77-013. Optimum Site Exposure Criteria for SO2 monitoring.

EPA-450/4-80-011. Guidance Document for Collection of Ambient Non Methane Organic Compound data for use in 1983 Ozone SIP Development and Network Design Siting Criteria for NMOC and NOX Monitors.

III.4. Practical Considerations

There are many situations, which create the need to relocate an air monitoring station. Some of these situations are: loss of lease or permission to occupy an existing space, an unsafe work environment such as a high crime area, inadequate space due to growing monitoring requirements, natural disasters, changes in population or emissions patterns, changes in surrounding environment (e.g., trees, freeway, new buildings, etc.); and changes in monitoring objectives for one of the ambient air monitoring station's criteria pollutants. Once the decision is made that an air monitoring station relocation is necessary, there are several issues that require attention.

Special consideration and evaluation needs to be given when replacing an air monitoring site. If achieving data equivalency is the desired outcome for relocating an existing air monitoring station, choose a new site that is in the same part of the airshed as the old site. Look for a site that has the same scale classifications (ie. micro, neighborhood, regional) for all of the criteria pollutants. It may be preferable to choose a new site that is in the center of the down-wind plume of sources for as many criteria pollutants as possible. In some cases the site will be up wind from as many criteria pollutants as possible (depending on the objective of the air monitoring station). Where scaling conflicts occur, a site location should be decided by the critical pollutant.

Any relocation effort must consider the concentrations and locations of local air pollution sources and their impacts on ambient concentrations. An example is the sources of oxides of nitrogen, the sources of hydrocarbons, and the prevailing winds for a site that monitors for ozone. Emission inventories and meteorological information could be verified by contacting ARB staff in the Technical Support Division (TSD), the Monitoring and Laboratory Division (MLD), and staff at the appropriate air pollution control district (APCD).

It is important to conduct a map-study comparing the existing site to the new site(s). The new site should be located in the same geographical area as the old air monitoring station. If possible, locate and evaluate traffic maps, topographical maps, aerial photographs, local demographic maps, and other information that would be available on a Global Information System (GIS) or the Internet. Evaluate the topography, elevation, wind patterns, traffic, emission inventories, forests, bodies of water, population centers, commercial areas, etc., to get a consensus on the adequacy of the potential site(s).

There is no written rule on the minimum distance that a station must move before parallel monitoring is required. If a replacement site is within one city block, a case may be made to relocate without parallel monitoring. A monitoring requirement depends on the specific pollutant and spatial scale for which the monitoring is being conducted. For example, relocating a site from one side of a building to the other generally would not require parallel monitoring if the proximity to local traffic remains within the limits of its current scale classification.

Considering the above relocation concerns, the search process evolves into matters of practicality. Staff will "hit the streets" to do the necessary footwork and research to find a suitable new monitoring site. For example: 1) Where is a topographically suitable site, with an open airshed exposure, and adequate interior and exterior space available? 2) Where might there be a realistic chance of working out a lease or rental agreement with the building and/or land owner? 3) Is there enough power? 4) Will this power be free of surges, and other electromagnetic interferences? Is there a good ground? 5) Is adequate phone service available? 6) Are the heating/air conditioning systems adequate? 7) Is there safe access to the roof? 8) Is roof top sampling feasible for all of the required samplers? 9) Can meteorological equipment be installed that complies with siting requirements? 10) Is the security adequate in the new location? 11) Is an air monitoring trailer the best solution?

Air monitoring stations may create noise within a building, and in an area around the building. For example, pump noise, within air monitoring instruments, may cause an undue disturbance to the building's occupants. Roof top samplers may cause unwelcome noise to a neighborhood in general. One way to minimize this potential problem would be to consider locating in a light industrial or commercial area. Another way is to use a trailer or a prefab mobile shelter as the air monitoring station, then finding an adequate space to park the unit on a semi-permanent or permanent basis.

Once a potential site(s) is selected, it is prudent to discuss the selection(s) with the stakeholders. This includes, other staff, management, interested District personnel, ARB's TSD and MLD staff, landlord, neighbors, and the contracts personnel that will negotiate the air monitoring station lease.

Refer to Appendix A for a Relocation Checklist and Appendix B for New or Modified Site Check-Off Sheets as necessary. In summary, relocating an air monitoring station is not a simple matter. The more care, planning, public relations and budgeting that goes into relocating a site, the better.

IV. QUALITY ASSURANCE AND QUALITY CONTROL

IV.1 Calibration of Analytical Equipment

Once a parallel monitoring site has been approved, the next step is to initiate the monitoring. Parallel monitoring must be conducted following federal EPA reference or equivalent methods. The instrumentation's reference or equivalent method numbers should be included in the final report document. All test measurements or test samples must be collected in accordance with the sample manifold specifications as specified in CFR 40, the ARB's Air Monitoring Quality Assurance Manual, Volume II, or the APCD's Quality Control Procedures. Whichever set of guidelines is used, the sample collection systems must be as identical as practical at the old and new sites.

The following procedures will require that quality control statistics be performed on two levels. The first level of quality control will provide documentation that the analyzers at each site were calibrated and operated within control limits during the test period. The second set of statistics will demonstrate how well the "in control" analyzers at the old air monitoring site and the new air monitoring site compare with each other.

Instruments used to collect ambient air quality data for gaseous criteria air pollutants must be operated between 20 degrees and 30 degrees Centigrade, unless the instrument has obtained federal equivalency with a wider temperature range. In an ambient air monitoring station temperature control is provided by heating and air conditioning units. To verify that the temperature of the stations are within the limits stated above, a calibrated temperature thermometer must be used.

If possible, the temperature data should be sent to a data recording device such as linear or circular chart recorder, and/or a datalogger. If a "min-max" thermometer is used, the data should be recorded on a control chart. If the temperature of an air monitoring station falls outside of the range specified above, the data must be invalidated, and cannot be used to generate the mathematical equivalency relationships described below for parallel monitoring.

All analyzers should be operated for an adequate length of time before calibration. The regular and parallel monitoring samplers are to be setup and operated in strict accordance with the manufacturer's manual. All required maintenance must be performed at the frequencies described in the manufacturer's manual or the agency's standard operating procedures. Maintenance check sheets must be filled out, and submitted with the data during the data review process. All calibration data, test results, maintenance records, control charts, and instrument logs shall be signed, dated, stored for a seven year period in a secured environment.

IV.2 Operational Accuracy

Pre and post instrument calibrations. The CFR recommends an audit by an independent agency or, an entity within an organization, to test the accuracy of ambient air analyzers. Therefore, if possible it is recommended that an independent audit of an analyzer's accuracy be performed during the parallel monitoring period.

The attribute of an instrument's accuracy is added at the time it is calibrated. All instruments are non-linear to some extent, so their accuracy varies with concentration. Therefore, an instrument should have multipoint calibrations to determine accuracy throughout its operating range. Since all instruments drift over time, a post-test calibration is require to "back-validate" previously acquired data. Calibrations are performed using standards that are traceable to the National Institute of Standards and Technology (NIST). The ozone transfer standards must be certified on a quarterly basis using a national reference ozone photometer. Flow transfer standards used for flow measurements and dilution systems, must be certified with an NIST traceable flow standard on a quarterly basis. Bi-annually, the calibration gas standards for NO, CO, CH_4, SO_2, hydrogen sulfide H_2S, and propane must have their concentrations traceable to the NIST.

The points of the multipoint calibration should range between 10 percent and 80 percent of the Upper Range Limit (URL) of the analyzer. If the majority of the data that is collected will be below the 10 percent range limit, the instrument may need to be calibrated at the 5 percent level. Multipoint calibrations must include at least 4 different levels of gas standard concentrations plus a pre and post zero reading. Data collected for the accuracy determination must be collected from the "data for record" device such as the data acquisition system (DAS), also referred to as the datalogger, or a stripchart recorder. To increase the accuracy of the data being reported by the datalogger, the slope and intercept generated by the instrument calibration may be used. To calculate the instrument's Percent Accuracy (PA) use the following equation:

$$PA = \left[\frac{S2 - S1}{S1}\right] \times 100$$

where,

PA = Percent Accuracy, for a particular analyzer.
S2 = the summation of the net DAS readings (DAS reading minus average blank value) from 10 percent of the URL to 80 percent of the URL.
S1 = the summation of the concentrations of gases added to the analyzer, based on the NIST traceable gas concentrations and the NIST traceable flows in the dilution system and/or ozone photometer.

The equation presented above provides the percent accuracy measurement of the analyzer throughout its operating range, at the start of the parallel monitoring study. Since all instruments drift over time, the accuracy of the instrument drifts over time as well. To account for this inherent property of analytical instruments, a post calibration is performed at the end of the test period, and, again the accuracy of the analyzer is empirically derived for each concurrently operating ambient air analyzer. To determine the Average Percent Accuracy (APA) of an analyzer throughout the entire test period, perform the following computation:

$$APA = \frac{A1 + A2}{2}$$

where,

APA = Average Percent Accuracy throughout the parallel monitoring test period.
A1 = the percent average accuracy from the pre-calibration.
A2 = the percent average accuracy from the post-calibration.

Perform the immediately preceding equation for both the ambient air analyzers at the old site, and at the new site. The percentage generated by this equation is the best measure of accuracy for the ambient air analyzers throughout the entire concurrent monitoring test period. It is strongly recommended that the average percent accuracy for both sites be within +5 percent of each other.

The Percent Accuracy Change (PAC) calculated for the post-calibrations for both the old site, and the new site must not have varied by +15 percent. If either ambient air monitor drifted by more than +15 percent the agency is not allowed to perform the parallel monitoring statistics at the next level. To determine the Percent Accuracy Change of an analyzer throughout the entire test period, perform the following computation:

$$PAC = \frac{(T1 - T2)}{T2} \times 100$$

where,

PAC = Percent Accuracy Change, for a particular analyzer, for the time between the pre and post analyzer calibrations.
T2 = the summation of the net DAS readings (DAS reading minus average blank value) from 10 percent of the URL to 80 percent of the URL for the pre calibration.
T1 = the summation of the net DAS readings (DAS reading minus average blank value) from 10 percent of the URL to 80 percent of the URL for the post calibration.

IV.3 Operational Precision

The EPA requires precision response data from ambient monitors to be collected at least twice a month. It is preferable and technically possible to collection precision data on a daily basis. This process is accomplished with a certified gas cylinder containing known concentrations of the pollutants of interest, a zero air supply, a gas dilution system that delivers its output to the station probe inlet, a datalogger interfaced with computers via modems, and software to generate the control charts. The precision test must include a zero point. Daily control charts for the entire parallel monitoring test period can be collected. This information ensures confidence in the data collected during the parallel monitoring test period, and is invaluable when making a decision on whether or not to eliminate data points that might be considered "outliers".

Precision checks should be conducted during normally low ambient concentrations. The ARB performs its precision checks at 3:50 am (PSD) which is a non-eventful air monitoring sampling hour. If possible, the same level of pollutant should be used for the precision test throughout the test period. The precision checks on the regular and parallel sampler should also be conducted at the same concentration, and preferably at the levels prescribed in 40 CFR 58. If precision checks cannot be performed by an automatic gas dilution system, then precision checks on the regular and parallel sampler should be done manually on the same day, as frequently as possible. (It is recommended that the precision test be performed at least bi-weekly).

There are several ways to demonstrate instrument precision. At the ARB, the values for the precision test, are generated by comparing the instrument's digital output, minus the blank, to the true value determined during the analyzer's pre-calibration. Data acquisition software computes the ARB's precision control charts by the following method:

$$\text{precision} = \frac{(Y - X)}{X} \times 100$$

where,

Y = actual span value - blank value.
X = expected value determined by pre-calibration

Control charts can be automatically calculated by the existing air quality data acquisition system (AQDAS) software, and printed out on a monthly basis. Control charts can be plotted by hand if automatic computer generated control charts are not available. For the ARB, a precision control chart of +/-10 percent from true is considered the upper and lower warning limit, and a precision control chart of +/-15 percent from true is considered the upper and lower control limit. If an instrument drifts more than 10 percent away from true, then the instrument needs to be recalibrated.

An analyzer's precision can be calculated by using the Relative Standard Deviation (RSD) equation presented below. It is based on an instruments ability to reproduce the same value. The mean value starts out at the value determined during the pre calibration, as time goes on, this mean value can be replaced by the mean value collected during the test period. The warning limits for this control chart are +/- 2 RSD. The control limits for this control chart are +/- 3 RSD.

$$RSD = 100 \times \left(\frac{s}{X}\right)$$

where,

RSD = Relative Standard Deviation
s = standard deviation
X = mean of the replicate values

If any ambient air analyzer is out of control, greater than plus or minus 15 percent or greater than plus or minus 3 relative standard deviations, the data will not be used to compare with the concurrently monitoring sampler for equivalency determination purposes.

IV.4 Data Validation

If, (1) the concurrently monitoring instruments have been operated in accordance with the equivalency or reference method guidelines as stated in the manufacturer's manual, (2) the analyzers have been pre- and post-calibrated, and the calibration reports signed, verified and dated, (3) the maintenance check sheets have been filled out, signed, dated, and verified throughout the entire test period, (4) the ambient air analyzers and samplers have been operated for the time period(s) specified in Section III.3, (5) the monitors have operated within the temperature parameters of Section IV.1, and (6) the ambient air analyzers and sampler have been operated within the control limits stated in Sections IV.1 and IV.2, then it will be time to analyze the data for the second level of quality control statistics and equivalency.

For continuous monitoring data, the analyst must carefully "cross-check" the DAS data with the concurrent strip chart record. Verify that the instrument's zeros stayed within acceptable limits throughout the test period. Control charts will demonstrate that the instruments have been properly spanned throughout the test period. If applicable, verify that the data trends follow the usual diurnal or seasonal patterns. Ensure that power outages have not changed the time of the strip chart data record. Check unusually high values. Ensure that the high values appear on both the strip chart recorder and the datalogger printout. Verify that the high values are real, and not instrument checks, calibrations, or other instrumental artifacts.

V. DATA ANALYSIS

As part of evaluating the relationships between pollutant concentrations at an existing site and a replacement site, appropriate analyses comparing the parallel data should be conducted . For continuously monitored pollutants, the daily maximum value at each site for each day of parallel monitoring is used to generate a matching (same day) pair of data. Since many important air quality programs use high values exclusively, the data analyses would typically be performed on high values. For hourly data, a high value is taken to be a value greater than 80 percent of the data for the previous 3 years for the original site. For daily data, a high value is a value greater than 75 percent of the data for the previous 3 years for the original site. Only one of the data values in each matched pair of values need to be greater than the appropriate threshold. Table 3 in Section II.3 summarizes these parallel monitoring data requirements. A supplemental data analysis should be performed on all matched pairs of data values, not only the high values.

The initial preparation of the data to be used in a comparison as described above involves the following steps:

- Data validation as described in Section IV,
- Averaging of data values if needed (averaging times for the data values used in the comparison should be equivalent to the averaging times of the relevant air quality standards),
- Separating data into two sets of matching pairs: one set would include high values (**High Values** set) that meet the threshold

requirements, the other set would contain all matching pairs of data values (**All Values** set), and

- Evaluating whether the number of matching pairs in a **High Value** set is sufficient for data analysis. The fewer the high data values available, the less conclusive the analytical results will be.

The data analyses techniques described in these guidelines can prove valuable for establishing relationships between the data from two sites. The techniques include: a confidence interval test for the mean difference, linear regression analysis, and relative percent difference comparisons. Both data sets, **High Values** and **All Values**, should be analyzed using these techniques. The results of the data analyses along with graphical representations of the data must be evaluated in order to determine whether a replacement site satisfactorily meets the monitoring objectives of a site that is to be relocated. There are no standard performance criteria for establishing relationships between pollutant concentrations at two sites. The recommended criteria presented in the following sections of these guidelines should be considered as guidelines rather than pass/fail criteria. Data equivalency is not always the only desired outcome. For most of the monitoring objectives, a replacement site with higher concentrations of pollutants than at the existing site would be satisfactory. Also, in some cases it might be sufficient to show that the data from two sites are comparable instead of being equivalent. It might then be the case that a looser test of comparability is met when a more stringent test of equivalency is not.

Other factors, beside data analysis, should also be evaluated to determine the adequacy of a replacement site. These include the following:

- Differences in emission source impacts between the old site and a replacement site;
- Meteorological conditions during the study period as compared to typical peak season conditions; and
- Statewide monitor variations.

Different relationships to emission sources and varying meteorological conditions may need to be considered in evaluating the relationships between the two sites. They can not only affect pollutant concentrations, but also cause a "time shift." For example, one site may reach peak concentrations at a different time than the other site. For continuously monitored pollutants, this will probably not be a problem because the daily maximum values will be analyzed (for most pollutants).

For daily, one in every six day sampling, a large enough set of parallel monitoring data may tend to mitigate potential biases.

Statewide monitor variations can result from the normal drift in the response of monitoring instruments over long periods of time and this needs to be considered. The zero baseline of a monitor can be affected by line voltage, temperature, and surrounding vibration. The zero/baseline drift of monitors <u>statewide</u> for the pollutant(s) of concern should be determined by averaging the upper and lower drift limits at the 95% probability limits. This information is available from the ARB's Monitoring and Laboratory Division, Quality Assurance Section. For example, if the upper limit is for CO monitors throughout the state is +6% and the lower limit is -4%, the range is 10% and 1/2 the range is 5%. This provides an indication of a typical variation that may be present between the two (or more) monitors for a pollutant that are involved in the parallel monitoring study. This information, along with recent quality assurance audit results (if available), is further evidence to consider in interpreting whether an adequate replacement site has been found.

Making the determination as to whether a replacement site satisfactorily meets the monitoring objectives of a site to be relocated requires making a judgment regarding the results of data analyses in the light of such other factors.

V.1. Preparing the Data

- Average the data values to correspond to averaging times of the revelant standards
    - O3, NO2, SO2, hydrogen sulfide: the daily maximum values
    - CO: maximum 8-hour average for each day
    - PM10, sulfates: 24-hour average
- Make a set of **All Values** by looking through the data on a day by day basis and excluding any points for which either data for the existing site or the replacement site is missing.
- Make a set of **High Values**
    - Hourly Data (O3, NO2, SO2, CO)
      Step 1. Get the past 3-years worth of data points for the existing site averaged to the appropriate standard.

Step 2. Sort the data points in order from the highest concentration to the lowest.
Step 3. COUNT the number of data points.
Step 4. Determine which point represents the first point in the top 20% of all data points.

Example:	Suppose there are 1092 data points. We want to find the first point in the highest 20% of all the points. This will be point number: $$\frac{(1092)(20)}{100} = 218$$ In general, the first point in the highest 20% of all the data points will be point number: $$\frac{(\text{total \# of points})\ (20)}{100} = \text{first point in highest 20\% of all data points}$$

Step 5. FIND THE VALUE associated with the point we have found above. This is called the **Threshold Point.**
Step 6. Look at the set of **All Values** as found above, and make a set of those pairs in which at least one of the values (for the existing site or a replacement site or both) is greater than the Threshold Point. This is the set of **High Values** (for hourly data).
Step 7. In order for a proper data analysis to be conducted, this set should have at least 30 matching pairs. The fewer the high data values available, the less conclusive the analytical results will be.

▪ Daily Data (PM10, sulfates)
Step 1. Get the past 3-years worth of data points for the existing site averaged to the appropriate standard.
Step 2. Sort the data points in order from the highest concentration to the lowest.
Step 3. COUNT the number of data points.
Step 4. Determine which point represents the first point in the top 25% of all data points.

Example:	Suppose there are 183 data points. We want to find the first point in the highest 25% of all the points. This will be point number: $\frac{(183)(25)}{100} = 45$ In general, the first point in the highest 25% of all the data points will be point number: $\frac{(\text{total \# of points})(25)}{100} = \text{first point in highest 25\% of all data points}$

Step 5. FIND THE VALUE associated with the point we have found above. This is called the **Threshold Point.**

Step 6. Look at the set of **All Values** as found above, and make a set of those pairs in which at least one of the values (for the existing site or a replacement site or both) is greater than the Threshold Point. This is the set of **High Values** (for daily data).

Step 7. For conducting a proper data analysis, this set should have at least 15 matching pairs. The fewer the high data values available, the less conclusive the analytical results will be.

In our examples, we will use the set of **High Values** of PM_{10} data presented in Table 6. Based on the past 3-years of PM_{10} data for the existing site, we have found that the Threshold Point is 55.0 ug/m³. The set found in Table 6 includes matching pairs that meet the threshold requirement for the **High Values** (at least one of the values in the matching pair is greater than 55.0 ug/m³).

Table 6
PM_{10} concentrations in (ug/m^3)
at the existing site and the replacement site

Date	x-site (existing)	y-site (replacement)
5/23/89	57	67
5/25/89	62	61
5/28/89	72	75
6/4/89	65	68
6/6/89	56	58
6/8/89	63	65
6/11/89	55	59
6/13/89	70	75
6/15/89	77	78
6/18/89	55	54
6/22/89	66	71
6/29/89	62	66
7/2/89	73	75
7/4/89	58	62
7/6/89	56	57

V.2. Confidence Interval Test

As a background for understanding the confidence interval test, we first explain some concepts to help clarify what is meant by a confidence interval. While the confidence interval test is probably the most difficult to understand and apply of the three tests that should be applied, it can provide the most meaningful results for evaluating the parallel monitors.

The data that are collected by the monitors is a *sample* of information, not all of the values that could ever be collected. The sample is used to estimate what the complete set of values (called the "population") would be if we could sample exhaustively. Because we can not know the true characteristics of the population, we want to know how close our sample of data is to the population. One way to estimate how well it represents the population is to estimate how well the average, or mean, of the sample represents the mean of the population.

When we compare the concentrations of pollutants from parallel monitors using this test, we are interested in the mean of the differences between the two monitors. From the data that we have, we calculate the confidence interval, which is a range of values that contain the true mean difference between the two populations with a known degree of certainty or confidence. A 95% confidence interval, calculated according to the following procedure, will contain the true mean difference 95 times out of 100. Therefore, we have 95% certainty that our confidence interval contains the true mean difference. The 95% confidence "interval" contains the true mean difference with 95% certainty and is defined by a lower and an upper limit given in concentration units. We calculate the lower and upper limits as follows:

The formula for the Lower Limit of the Confidence Interval is:

$$L = \bar{d} - \left[t_{\alpha/2,df} * \frac{s}{\sqrt{n}} \right]$$

The formula for the Upper Limit of the Confidence Interval is:

$$U = \bar{d} + \left[t_{\alpha/2,df} * \frac{s}{\sqrt{n}} \right]$$

Where:	$\bar{d}$	is the mean of the set of differences
	s	is the standard deviation of the set of differences
	n	is the sample size (number of matching pairs)
	α	is equal to 1 minus the Confidence Level
	df	is one less than the number of matching pairs
	t	is found in the "t-distribution" table (Appendix C)

Example:

Matching Pair Number	x-site (existing)	y-site (replacement)	Paired Difference (Y - X)
1	55	54	-1
2	55	57	2
3	55	58	3
4	57	57	0
5	55	59	4
6	58	62	4
7	62	61	-1
8	63	65	2
9	62	66	4
10	65	68	3
11	66	71	5
12	70	75	5
13	72	75	3
14	73	75	2
15	77	78	1
n=15	$\bar{X}$=63	$\bar{Y}$=65.4	$\bar{d}$=2.4 s=1.96

Having found n, $\bar{d}$ and s, we must now determine the values for df , α, and finally t.

df is simply the number of matching pairs less one, or 15 - 1 = 14.

In most cases, a Confidence Interval of 0.95 or greater is used. In this example, we will use 0.95. Therefore, α = 1-0.95 = 0.05 and $\alpha/2$=0.025.

Looking at the t-Distribution Table in Appendix C, we find the value of $t_{0.025,14}$=2.145.

Plugging these values into the formula above,

$$L = 2.4 - \left[2.145 * \frac{1.96}{\sqrt{15}}\right] = 2.4 - \left[2.145 * \frac{1.96}{3.87}\right]$$
$$= 2.4 - [2.145 * 0.51] = 2.4 - 1.09 = 1.31$$

$$U = 2.4 + \left[2.145 * \frac{1.96}{\sqrt{15}}\right] = 2.4 + \left[2.145 * \frac{1.96}{3.87}\right]$$
$$= 2.4 + [2.145 * 0.51] = 2.4 + 1.09 = 3.49$$

The mean difference between the two monitors in our example was 2.4ug/m3. The values of the lower and upper limits above indicate that if we have high confidence (95% certainty) that the interval contains the true mean difference between the two monitors.

There are no standard performance criteria for the number corresponding to the lower and upper limits. It is recommended that for the key high sites that play a critical role in the monitoring network, the number corresponding to the lower Confidence Limit (L) should be no lower than 0% of the average concentrations at the parallel monitors. In other words,

as a guideline, $\frac{L}{(\overline{X}+\overline{Y})/2} * 100\% \geq 0\%$ for critical sites.

In most cases, higher concentrations of pollutants at the replacement site are satisfactory. However if the number corresponding to the upper Confidence Limit constitutes a large percentage of the mean concentration at the parallel monitors, we should evaluate the possible causes, especially the location of both sites, existing and replacement, in relation to major sources of pollutants.

To determine the relationship between the number corresponding to the lower Confidence Limit (L) for the mean difference and the mean concentration $(\overline{X}+\overline{Y})/2$, and

the relationship between the number corresponding to the upper Confidence Limit (U) for the mean difference and the mean concentration $(\overline{X}+\overline{Y})/2$ we want to calculate:

$$\frac{L}{(\overline{X}+\overline{Y})/2}*100\% \quad \text{and} \quad \frac{U}{(\overline{X}+\overline{Y})/2}*100\%$$

In our example, the lower and upper numbers are:

$$\frac{1.31}{(63+65.4)/2}*100\% = 2.04\% \qquad \text{and} \qquad \frac{3.49}{(63+65.4)/2}*100\% = 5.44\%$$

The results of our calculation imply 95% certainty that the true mean difference is at least 2.04% and at most 5.44% of the mean of both monitors. Since both values are positive, they indicate 95% certainty that the concentration of pollutants at the replacement site would be higher than at the existing site.

V.3. Relative Percent Difference (RPD)

For a replacement site to serve as a good substitute for an existing site, the matching pairs of data should exhibit the following characteristics:

- The distribution of concentrations of pollutants at the replacement site should be similar to the distribution for the existing site. However, higher concentrations at the replacement site are not a problem in most cases.

To determine if these characteristics are present, we look at the relative percent difference (RPD) between the existing site and replacement site values.

- Finding the RPD (of the replacement site versus the average of the 2 sites)
  Step 1. For each matching pair, find the RPD as follows:

Step 1. For each matching pair, find the RPD as follows:

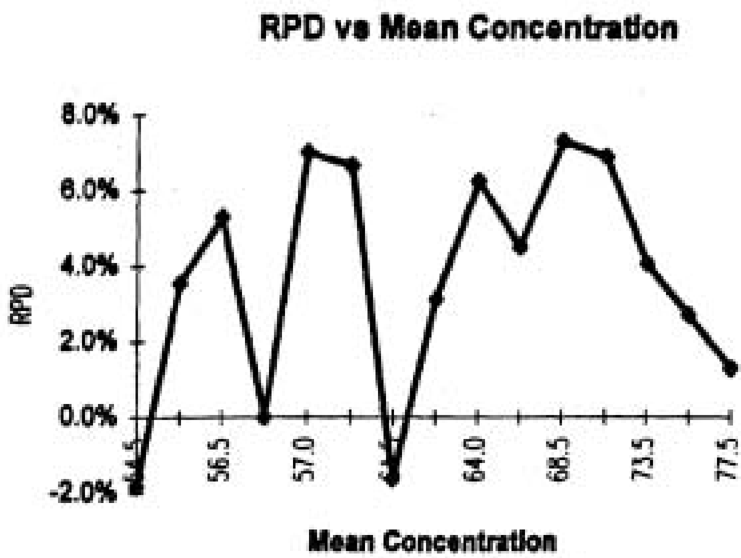
$$RPD = 100\% * \frac{Y - X}{(X + Y)/2}$$

Where: X = The concentration of pollutant at the existing site
Y = The concentration of pollutant at the replacement site

Example of Relative Percent Difference Using PM_{10} Concentrations (ug/m³)

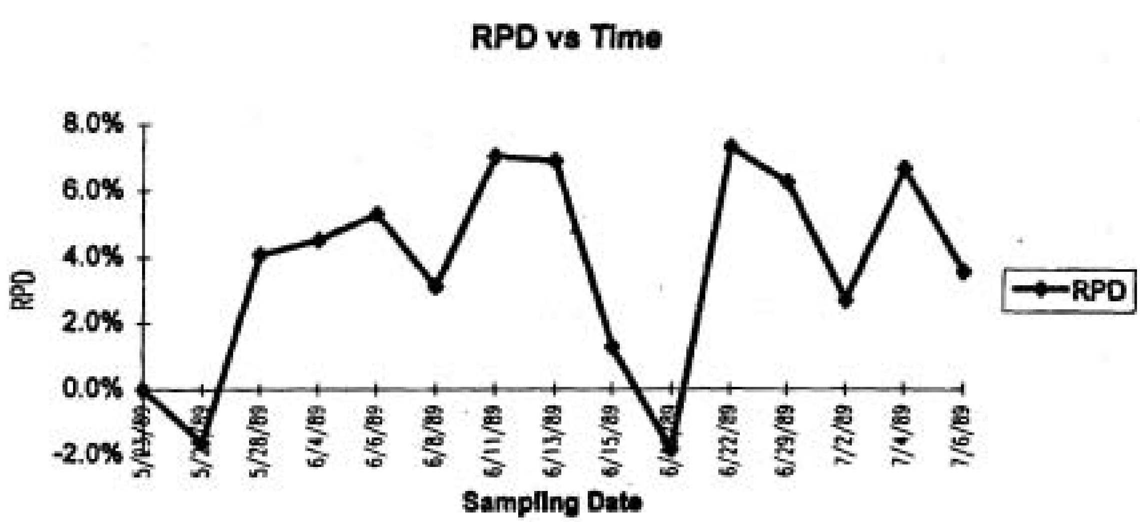
Date	X-Site (Existing)	Y-Site (Replacement)	Paired Difference (Y-X)	Mean Concentration (X+Y)/2	RPD
5/23/89	57	57	0	57.0	0.0%
5/25/89	62	61	-1	61.5	-1.6%
5/28/89	72	75	3	73.5	4.1%
6/4/89	65	68	3	66.5	4.5%
6/6/89	55	58	3	56.5	5.3%
6/8/89	63	65	2	64.0	3.1%
6/11/89	55	59	4	57.0	7.0%
6/13/89	70	75	5	72.5	6.9%
6/15/89	77	78	1	77.5	1.3%
6/18/89	55	54	-1	54.5	-1.8%
6/22/89	66	71	5	68.5	7.3%
6/29/89	62	66	4	64.0	6.3%
7/2/89	73	75	2	74.0	2.7%
7/4/89	58	62	4	60.0	6.7%
7/6/89	55	57	2	56.0	3.6%

Step 2. Plot the RPD for each pair on a graph against the mean concentration ((X+Y)/2), as is illustrated below:



In this example, note that most of the RPD values are greater than 0. This indicates that the concentrations at the replacement site are greater than those at the existing site. Please note that this is also the case at the higher concentrations.

Step3. Plot the RPD for each pair on the graph against time (date).



V.4. Linear Regression

The purpose of the Linear Regression Analysis is to explore the relationship between corresponding measurements at the parallel sites across a range of concentrations. The regression procedure determines the "best" available straight line for describing this relationship.

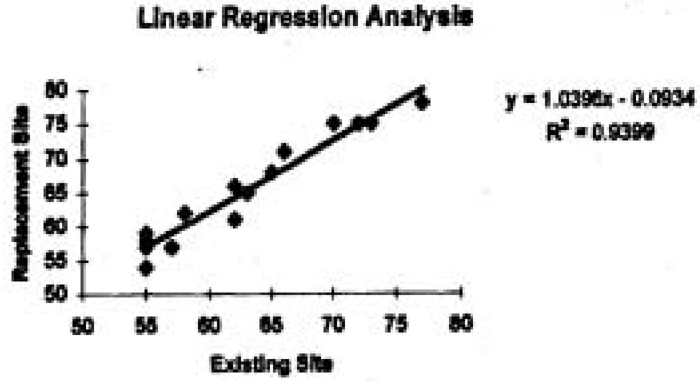
$$y = mx + b$$

Where:

x = The concentration of pollutant at the existing site
y = The concentration of pollutant at the replacement site
m = the slope of the line, and
b = the intercept of the line at the Y axis

The regression procedure yields values for m and b that determine the best fitting straight line. Common "spreadsheet" programs, statistical analysis programs, and modern hand-held calculators contain convenient tools for carrying out the regression calculations.

An integral part of the regression analysis is an X,Y plot of the data that also displays the regression line superimposed on the data points. Such a graph can reveal valuable information for interpreting the data that may not be evident from the regression analysis alone. For example, the graph may show that the line fits the data well except for the highest or lowest concentrations. The graph found below displays data point from our example with the regression line.



In our example the slope equals 1.0396, the intercept is 0.0934, and the squared correlation (R^2) which represents the fit of the curve is 0.9399.

Different parallel monitoring situations will vary in the distribution of the data concentrations collected and in how well the relationship between the two sites can be described as linear. Because of such variations, two studies with identical calculated regression values - slope, intercept , and the squared correlation R^2 - may come to different conclusions regarding relationships between the concentrations of pollutants at an existing site and a replacement site(s). In general, the slope (m) should be close to or greater than 1, the intercept (b) should be close to 0, and the points should fit closely to the line. The squared correlation which represents the fit of the curve should be close to 1, since 1 corresponds to a perfect fit. The intercept should be close to 0 because both instruments have been calibrated to a zero point.

VI. FINAL REPORT

A final report must be compiled to document the findings of the parallel monitoring effort. The final report should contain a narrative description to answer the question; why is parallel monitoring necessary? Describe the advantages and disadvantages at each site, such as, better temperature control, provides compliance with meteorological citing requirements, lower crime area, fewer trees, higher rent, more representative, etc.

Maps must be included in the final report that show the location of each site on a local and regional scale. A legend indicating direction, scale, and evaluation must accompany the maps. If available, wind roses for the area are a useful graphical tool to express the patterns of the local meteorology. For some pollutants, it would be appropriate to have maps to establish the relationships between the wind patterns, sources of pollution, and the new and old air monitoring sites.

Describe the instrument operation phase of the project. Did either or any instrument go out-of-control at any time? Were there power or instrument failures? Did the temperature control system operate within range at both sites for the entire test period? In a narrative, tabular, graphic, or any combination of formats, describe the accuracy and precision for both sites for each criteria pollutant, or at least the critical pollutant. Essentially, there is a need to establish that each analyzer was "in control" during the test period.

Once each analyzer has demonstrated to work properly, comparisons between the data sets at each site is possible. In a narrative, tabular, graphic, or combination of formats, describe the data between air monitoring sites for each criteria pollutant. For each pollutant, describe the dates of collection, the number of valid samples, the percent of data capture, the rational for why some data was used or not used in the comparison analysis. Describe the relative percent difference, the slope, the intercept, the correlation, and the equivalency determination results. A copy of the report should be sent to the ARB's MLD and TSD for comment and for the record. Other factors, besides data analysis, should also be evaluated. These include differences in the emissions source impact between the old site and a proposed site, meteorological conditions during the study period, statewide monitor variations, etc.

Attachments to the final report should include: 1) signed, dated and reviewed pre-and post-calibration reports. 2) signed, dated and reviewed copies of the instruments quality control charts. 3) signed, dated and reviewed copies of the instrument maintenance check sheets. 4) copies of meteorological data from both sites. 5) copies of the raw data from both sites for all parallel monitored pollutants. 6) either copies of the site reports from both sites, or copies of the forms from Appendices A and B. 7) references, and 8) a conclusion indicating the relationship of the two sites and whether or not the site is an adequate replacement site.

APPENDIX A
General Site Locator Checksheet

_____ Parallel monitoring necessary? Yes: _____ No: _____

_____ Able to work out necessary agreements, leases, etc.

_____ Adequate space availability (interior)

_____ Adequate space availability (exterior)

_____ Space/layout planning complete

_____ Security

_____ Technical specifications complete (e.g. for trailer, enclosure, or contract job)

_____ Site improvements:

- ___ Building or room revisions
- ___ Power (new service, metering, contract work, electricity (usually 100 or more amps needed). Electrical needs for interior and exterior instruments must be considered. Most stations require at least 4 separate 20 amp circuits.
- ___ Phone (including telemetry if needed, new cabling, pole, contract work, etc.)
- ___ Air conditioning/heating. Separate Air Conditioning System to keep station between 20 and 30 degrees Celsius. Necessary to insure data validity.
- ___ Fencing
- ___ Asphalt/concrete work
- ___ Carpentry (PM10/Met. platforms, ladders, steps, cabinets, etc.)
- ___ Miscellaneous (any needed landscaping, plumbing, etc.)
- ___ Permits for any of the above
- ___ Purchase orders/requests for any of the above
- ___ Notifications to ARB/EPA
- ___ New ARB Site Reports/EPA Hardcopy Information Reports
- ___ Closure ARB Site Reports/EPA Hardcopy Information Reports
- ___ Safety and Handicap facilities

(AQS 6/97)

APPENDIX B-1

NEW OR MODIFIED SITE CHECK-OFF SHEET

For more details refer to 40CFR Pt 58, Appendix D & E regarding Network Design and Citing Criteria.

POLLUTANT OZONE (O3)

Monitoring Network (SLAMS, NAMS, PAMS, SPM) ___________

Spatial Scale (Middle, Neighborhood, Urban, Regional)______

Vertical Probe (3-15 meters) _______________________

Horizontal Probe (>1 meter) _______________________

Length of Probe (meters)________Probe Inside Diameter______

Approximate Flow Rate___________Approx. Residence Time _____
Height of Nearby Obstacles above Probe _______________
Distance from Nearby Obstacles
(> Twice Height Obstacle above Probe) ___________

Predominate Wind Direction _________

Obstructions within 270 Arc of Predominate Wind Direction __
Name of Nearest Road(s) _______________________

Distance to Nearest Road(s) _______________________

Road Material (Dirt, Pavement Gravel, Concrete) __________

Average Daily Traffic (vehicles/day) on Nearest Road(s) ___

Minimum Acceptable Distance to Nearest Road(s) __________
Spacing from Trees (>20 meters from dripline) ___________
Spacing from Trees Upwind from Predominate Summer Day-time Wind Direction (>10 meters from dripline) ____________

List Nearby Possible Emission Sources _______________
List Emission Sources on Roof ____________________
Inside Temperature Recorded and Controlled between 25°C +/- 5°C
____

Reviewer's Signature __________________ Date ____________
Manager's Signature __________________ Date ____________

(AQS 6/97)

APPENDIX B-2

POLLUTANT NITROGEN DIOXIDE (NO_2)

Monitoring Network (SLAMS, NAMS, PAMS, SPM) ____________

Spatial Scale (Middle, Neighborhood, Urban) ____________

Vertical Probe (3-15 meters) ________________________

Horizontal Probe (>1 meter) ________________________

Length of Probe (meters) ______Approx. Residence Time _____

Approximate Flow Rate ______________

Height of Nearby Obstacles above Probe ______________

Distance from Nearby Obstacles (> Twice Height Obstacle above Probe) ____________________

Predominate Wind Direction _________

Obstructions within 270 Arc of Predominate Wind Direction__

Name of Nearest Road(s) ______________________________

Distance to Nearest Road(s)

Road Material (Dirt, Pavement Gravel, Concrete) _________

Average Daily Traffic (vehicles/day) on Nearest Road(s) ___

Minimum Acceptable Distance to Nearest Road(s) _________

Spacing from Trees (>20 meters from dripline) __________

Spacing from Trees that Protrude Height of Probe by 5 meters (>10 meters from dripline) __________

List Nearby Possible Emission Sources ________________

List Emission Sources on Roof ________________________

Inside Temperature Recorded and Controlled between 25°C +/- 5°C_________

Reviewer's Signature ____________________ Date __________

Manager's Signature ____________________ Date __________

(AQS 6/97)

APPENDIX B-3
POLLUTANT CARBON MONOXIDE (CO)

Monitoring Network (SLAMS, NAMS, SPM) ________________

Spatial Scale (Micro, Middle, Neighborhood) ____________

Vertical Probe (microscale = 3 +/- 1/2 meters)
(Middle, Neighborhood = 3 to 15 meters) ________________

Horizontal Probe (>1 meter) ____________________________

Length of Probe (meters)_____ Approx. Residence Time _____

Approximate Flow Rate ______________

Predominate Wind Direction _________

Obstructions within 270° Arc of Predominate Wind Direction ____________

Name of Nearest Road(s)_________________________________

Distance to Nearest Road(s) ____________

Road Material (Dirt, Pavement Gravel, Concrete) _________

Average Daily Traffic (vehicles/day) on Nearest Road(s) ____

Minimum Acceptable Distance to Nearest Road(s) __________
(Microscale = 2 to 10 meters)

Distance to Nearest Intersection (Microscale>10 meters)____

Spacing from Trees (>20 meters from dripline) ____________

Spacing from Trees that Protrude Height of Probe by 5 meters (>10 meters from dripline) ___________
List Nearby Possible Emission Sources ________________

List Emission Sources on Roof ___________________________

Inside Temperature Recorded and Controlled between 25°C +/- 5°C _____
Reviewer's Signature ____________________ Date ___________
Manager's Signature ____________________ Date ___________
(AQS 6/97)

APPENDIX B-4

POLLUTANT SULFUR DIOXIDE (SO_2)

Monitoring Network (SLAMS, NAMS, SPM) ____________________

Spatial Scale (Middle, Neighborhood, Urban, Regional) ______

Vertical Probe (3-15 meters) ____________________________

Horizontal Probe (>1 meter) ____________________________

Length of Probe (meters)________ Approx. Residence Time ____

Approximate Flow Rate ________________

Height of Nearby Obstacles above Probe __________________

Distance from Nearby Obstacles (> Twice Height Obstacle above Probe) _______________________

Predominate Wind Direction __________

Obstructions within 270° Arc of Predominate Wind Direction_

Name of Nearest Road(s)____________________________________

Distance to Nearest Road(s) _____________

Road Material (Dirt, Pavement Gravel, Concrete) __________

Road Material (Dirt, Pavement Gravel, Concrete) __________

Average Daily Traffic (vehicles/day) on Nearest Road(s) ____

Minimum Acceptable Distance to Nearest Road(s) ___________

List Nearby Possible Emission Sources ____________________

List Emission Sources on Roof ____________________________

Reviewer's Signature ______________________ Date _____________

Manager's Signature ______________________ Date _____________

(AQS 6/97)

APPENDIX B-5

POLLUTANT PARTICULATE MATTER (PM10)

Monitoring Network (SLAMS, NAMS, SPM) ____________________

Spatial Scale (Micro, Middle, Neighborhood, Urban, Regional) __________

Vertical Placement (Microscale 2-7 Meters) (Middle, Neighborhood, Urban, Regional 2-15 meters) ______________

Height of Nearby Obstacles above Sampler _________________

Distance from Nearby Obstacles (> Twice Height Obstacle above Sampler) ______________________

Predominate Wind Direction __________

Obstructions within 270° Arc of Predominate Wind Direction ____________

Name of Nearest Road(s) __________________________________

Distance to Nearest Road(s) _____________

Road Material (Dirt, Pavement Gravel, Concrete) __________

Average Daily Traffic (vehicles/day) on Nearest Road(s) ____________

Minimum Acceptable Distance to Nearest Road(s) __________
(Microscale 5-15 meters from Road)
(Middle, Neighborhood, Urban use Figure 2 or 40CFR pt58, page 178)

List Nearby Possible Emission Sources _____________________

List Emission Sources on Roof _____________________________

Reviewer's Signature ______________________ Date ____________

Manager's Signature _______________________ Date ____________

(AQS 6/97)

Appendix C

t Scores

(For Checking Both Upper and Lower Limits)

Degrees of Freedom (df)	80%	90%	95%	99%	99.9%
	Level of Certainty				
1	3.078	6.314	12.706	63.657	636.619
2	1.886	2.920	4.303	9.925	31.598
3	1.638	2.353	3.182	5.841	12.941
4	1.533	2.132	2.776	4.604	8.610
5	1.476	2.015	2.571	4.032	6.859
6	1.440	1.943	2.447	3.707	5.959
7	1.415	1.895	2.365	3.499	5.405
8	1.397	1.860	2.306	3.355	5.041
9	1.383	1.833	2.262	3.250	4.781
10	1.372	1.812	2.228	3.169	4.587
11	1.363	1.796	2.201	3.106	4.437
12	1.356	1.782	2.179	3.055	4.318
13	1.350	1.771	2.160	3.012	4.221
14	1.345	1.761	2.145	2.977	4.140
15	1.341	1.753	2.131	2.947	4.073
16	1.337	1.746	2.120	2.921	4.015
17	1.333	1.740	2.110	2.898	3.965
18	1.330	1.734	2.101	2.878	3.922
19	1.328	1.729	2.093	2.861	3.883
20	1.325	1.725	2.086	2.845	3.850
21	1.323	1.721	2.080	2.831	3.819
22	1.321	1.717	2.074	2.819	3.792
23	1.319	1.714	2.069	2.807	3.767
24	1.318	1.711	2.064	2.797	3.745
25	1.316	1.708	2.060	2.787	3.725
26	1.315	1.706	2.056	2.779	3.707
27	1.314	1.703	2.052	2.771	3.690
28	1.313	1.701	2.048	2.763	3.674
29	1.311	1.699	2.045	2.756	3.659
30	1.310	1.697	2.042	2.750	3.646
40	1.303	1.684	2.021	2.704	3.551
60	1.296	1.671	2.000	2.660	3.460
120	1.289	1.658	1.980	2.617	3.373
∞	1.282	1.645	1.960	2.576	3.291