United States
Environmental Protection
Agency

Air Pollution Training Institute
MD 20
Environmental Research Center
Research Triangle Park, NC 27711

EPA 450/2-81-081
December, 1981

Air

APTI
Correspondence Course 436
Site Selection for the Monitoring of SO_2 and TSP in Ambient Air

Guidebook

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Guidebook

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United States Environmental Protection Agency
Office of Air, Noise, and Radiation
Office of Air Quality Planning and Standards
Research Triangle Park, NC 27711

Notice

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Availability

This document is issued by the Manpower and Technical Information Branch, Control Programs Development Division, Office of Air Quality Planning and Standards, USEPA. It was developed for use in training courses presented by the EPA Air Pollution Training Institute and others receiving contractual or grant support from the Institute. Other organizations are welcome to use the document.

This publication is available, free of charge, to schools or governmental air pollution control agencies intending to conduct a training course on the subject covered. Submit a written request to the Air Pollution Training Institute, USEPA, MD 20, Research Triangle Park, NC 27711.

Others may obtain copies, for a fee, from the National Technical Information Service (NTIS), 5825 Port Royal Road, Springfield, VA 22161.

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Course Introduction

Overview of Course

Course Description

This training course is a 35-hour correspondence course dealing with the siting of ambient SO_2 and TSP monitors. The course presents general concepts of ambient monitor site selection and specific, detailed considerations and procedures for selecting SO_2 and TSP ambient monitoring sites. Course topics include the following:

- use of monitoring data and related monitor siting objectives
- special considerations associated with SO_2 and TSP monitoring
- procedures and criteria for site selection for SO_2 and TSP monitors
- rationale for SO_2 and TSP siting criteria
- network design and probe siting criteria for SO_2 and TSP SLAMS, NAMS, and PSD monitoring stations.

Course Goal

The goal of this course is to familiarize you with general concepts of ambient monitor site selection and with specific, detailed considerations and procedures for selecting SO_2 and TSP ambient monitor sites.

Course Objectives

Upon completion of this course, you should be able to:

1. describe general considerations for siting ambient air quality monitors.
2. select the optimum general siting area and probe location for SO_2 and TSP monitors for a given monitoring objective.
3. describe the logic of the SO_2 and TSP siting criteria.

Sequence, Lesson Titles, and Trainee Involvement Time

Lesson number	Lesson title	Trainee involvement time (hours)
1	Introduction to SO_2 Monitoring	4
2	Site Selection for General Level SO_2 Monitoring Stations	6
3	Locating Proximate Middle Scale SO_2 Monitoring Stations for Urban and Isolated Point Sources	7
4	Rationale for SO_2 Monitor Siting Criteria	6
5	Introduction to TSP Monitoring and Site Selection for Regional and Neighborhood TSP Monitoring Stations	4
6	Locating Middle Scale TSP Monitoring Stations and Rationale for TSP Siting Criteria	4
7	Monitoring Network Design and Probe Siting Criteria for TSP and SO_2 SLAMS, NAMS, and PSD Monitoring Stations	4

Requirements for Successful Completion of this Course

In order to receive 3.5 Continuing Education Units (CEUs) and a certificate of course completion you must:

- take two supervised quizzes and a supervised final examination.
- achieve a final course grade of at least 70% (out of 100%) determined as follows:
  - 20% from Quiz 1
  - 20% from Quiz 2
  - 60% from the final examination.

Use of Course Materials

Necessary Materials

- "APTI Correspondence Course 436 Site Selection for the Monitoring of SO_2 and TSP in Ambient Air: Guidebook"
- EPA-450/3-77-013 "Optimum Site Exposure Criteria for SO_2 Monitoring"
- EPA-450/3-77-018 "Selecting Sites for Monitoring Total Suspended Particulates"
- protractor
- ruler
- pencil or pen

Use of this Guidebook

Relationship Between Guidebook and Assigned Reading Materials

This guidebook directs your progress through the reference texts "Optimum Site Exposure Criteria for SO_2 Monitoring" and "Selecting Sites for Monitoring Total Suspended Particulates" and through the excerpts of 40 CFR 58 Appendices D and E and "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)", which are contained in the guidebook.

Description of Guidebook Sections

This guidebook contains seven reading assignment sections which correspond to the seven lessons of the course.

Each section contains the following:

- reading assignment
- reading assignment topics
- section's learning goal and objectives
- reading guidance
- review exercise

Instructions for Completing the Quizzes and the Final Examination

- You should have received, along with this guidebook, a separate ***sealed*** envelope containing two quizzes and a final examination.
- You must arrange to have someone serve as your test supervisor.
- You must give the ***sealed*** envelope containing the quizzes and final examination to your test supervisor.
- At designated times during the course, under the supervision of your test supervisor, complete the quizzes and the final exam.

- After you have completed each quiz or the exam, your test supervisor must sign a statement on the quiz/exam answer sheet certifying that the quiz/exam was administered in accordance with the specified test instructions.
- After signing the quiz/exam answer sheet, your test supervisor must mail the quiz/exam and its answer sheet to the following address:

  Air Pollution Training Institute
  Environmental Research Center
  MD-20
  Research Triangle Park, NC 27711
- After completing a quiz, continue with the course. Do ***not*** wait for quiz results.
- Quiz/exam and course grade results will be mailed to you.

If you have questions, contact:

Air Pollution Training Institute
Environmental Research Center
MD-20
Research Triangle Park, NC 27711

Telephone numbers:
Commercial: (919) 541-2401
FTS: 629-2401

Section 1

Introduction to SO_2 Monitoring

Reading Assignment

Pages 1-26 of EPA-450/3-77-013 "Optimum Site Exposure Criteria for SO_2 Monitoring".

Reading Assignment Topics

- General emission characteristics of SO_2 sources
- Characteristics of anthropogenic sources of SO_2
- Need for objective, uniform siting procedures
- Uses of SO_2 monitoring data
- Monitor siting objectives
- Spatial scales of representativeness
- General types of monitoring sites
- Correlation of general types of monitoring sites with siting objectives

Learning Goal and Objectives

Learning Goal

To familiarize you with the major sources of SO_2 emissions and the general types of monitoring sites used to measure ambient SO_2 concentrations.

Learning Objectives

At the end of this section, you should be able to:

1. describe contributions and effects of natural and anthropogenic sources of SO_2.
2. identify typical concentration patterns of SO_2 emissions from anthropogenic sources.
3. associate major anthropogenic SO_2 source categories with geographical areas of the United States.
4. describe contributions of urban and rural sources of SO_2 emissions.
5. differentiate between point and area sources of SO_2 emissions.
6. define spatial scale of representativeness.
7. associate typical spatial scales of representativeness with physical dimensions of siting areas.

8. associate typical spatial scales of representativeness with general land-use areas.
9. differentiate between proximate and general-level monitoring sites.
10. associate general types of monitoring sites with siting objectives.

Reading Guidance

- In addition to the regulatory concerns pertaining to ambient air monitoring that are described on page seven of the assigned reading material, the United States Environmental Protection Agency has also promulgated regulations specifying monitoring network design and monitor probe siting requirements for State Implementation Plan purposes. These regulations are found in Title 40, Part 58 of the Code of Federal Regulations (40 CFR 58) and are addressed in Section 7 of this guidebook.
- Refer often to Tables 3-1 and 3-2 of the assigned reading material as you progress through the assignment.
- When you have finished the reading assignment, complete the review exercise for Section 1. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), proceed to Section 2 of this guidebook.

Review Exercise

Now that you've completed the assignment for Section 1, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. Globally, about ___(?)___ percent of all SO_2 in the atmosphere comes from natural sources.
   a. 75
   b. 25
   c. 50
   d. 10
2. True or False? Intense concentrations of ambient SO_2 are usually found near anthropogenic SO_2 emission sources.

Match the geographical areas of the United States with their major anthropogenic SO_2 source categories. (Questions 3-5)

3. North	a. transportation/power plants/industrial processes
4. South	b. industrial processes/transportation
5. West	c. commercial and residential heating/power plants

6. About ___(?)___ percent of SO_2 emissions occur in urban areas.
   a. 65
   b. 50
   c. 25
   d. 90
7. Which of the following is an area source of SO_2 emissions?
   a. power plant
   b. smelter
   c. highway
   d. none of the above

Match the following spatial scales of representativeness with their corresponding dimensions. (Questions 8-12)

8. microscale	a. 0.1 to 0.5 kilometer
9. middle scale	b. greater than 50 kilometers
10. neighborhood scale	c. less than 0.1 kilometer
11. urban scale	d. 4 to 50 kilometers
12. regional scale	e. 0.5 to 4 kilometers

Match the following land use areas with the spatial scale of representativeness most likely to be represented by a single SO_2 measurement in each of them. (Questions 13-15)

13. urban
14. suburban
15. rural

a. middle scale
b. neighborhood scale
c. regional scale

16. True or False? Proximate sites are those associated with siting objectives that require information regarding impacts from a specific source or a group of specific sources.

17. True or False? General-level sites are those located in areas where information concerning the total air pollutant concentration is important but where information concerning contributions from individual sources to the total concentration is relatively unimportant.

Match the following SO_2 monitor siting objectives with their appropriate types of monitoring sites. (Questions 18-21)

18. determination of the peak concentration in an urban area
19. determination of the impact of an isolated point source
20. determination of the base concentration in areas of projected growth
21. assessment of background concentrations in rural areas

a. general-level regional scale
b. proximate micro/middle scale
c. general-level middle scale
d. general-level neighborhood scale

Review Exercise Answers

	Answer	Page of SO_2 Siting Manual
1.	c	1
2.	True	1
3.	c	4
4.	a	4
5.	b	4
6.	a	4
7.	c	5
8.	c	17
9.	a	17
10.	e	17
11.	d	18
12.	b	18
13.	a	19
14.	b	19
15.	c	19
16.	True	21
17.	True	21
18.	c	24
19.	b	24
20.	d	24
21.	a	24

Section 2

Site Selection for General-Level SO_2 Monitoring Stations

Reading Assignment

Pages 27-52 of EPA-450/3-77-013 "Optimum Site Exposure Criteria for SO_2 Monitoring".

Reading Assignment Topics

- Site selection aids and background material
- Locating general-level regional scale SO_2 monitoring stations
- Locating general-level neighborhood scale SO_2 monitoring stations
- Locating general-level middle scale SO_2 monitoring stations

Learning Goal and Objectives

Learning Goal

To familiarize you with the siting of regional, neighborhood, and general-level middle scale SO_2 monitoring stations.

Learning Objectives

At the end of this section, you should be able to:

1. recognize the appropriate SO_2 concentration gradient for regional scale SO_2 monitoring sites.
2. determine the number of SO_2 monitoring sites required to represent SO_2 concentrations over an area.
3. select the general siting area for regional mean SO_2 monitoring stations.
4. select the general siting area for SO_2 transport monitoring stations.
5. select the general siting area for SO_2 emergency monitoring stations.
6. select the general siting area for population exposure and projected growth neighborhood scale SO_2 monitoring stations.
7. select the general siting area for peak concentration general-level middle scale SO_2 monitoring stations.

Reading Guidance

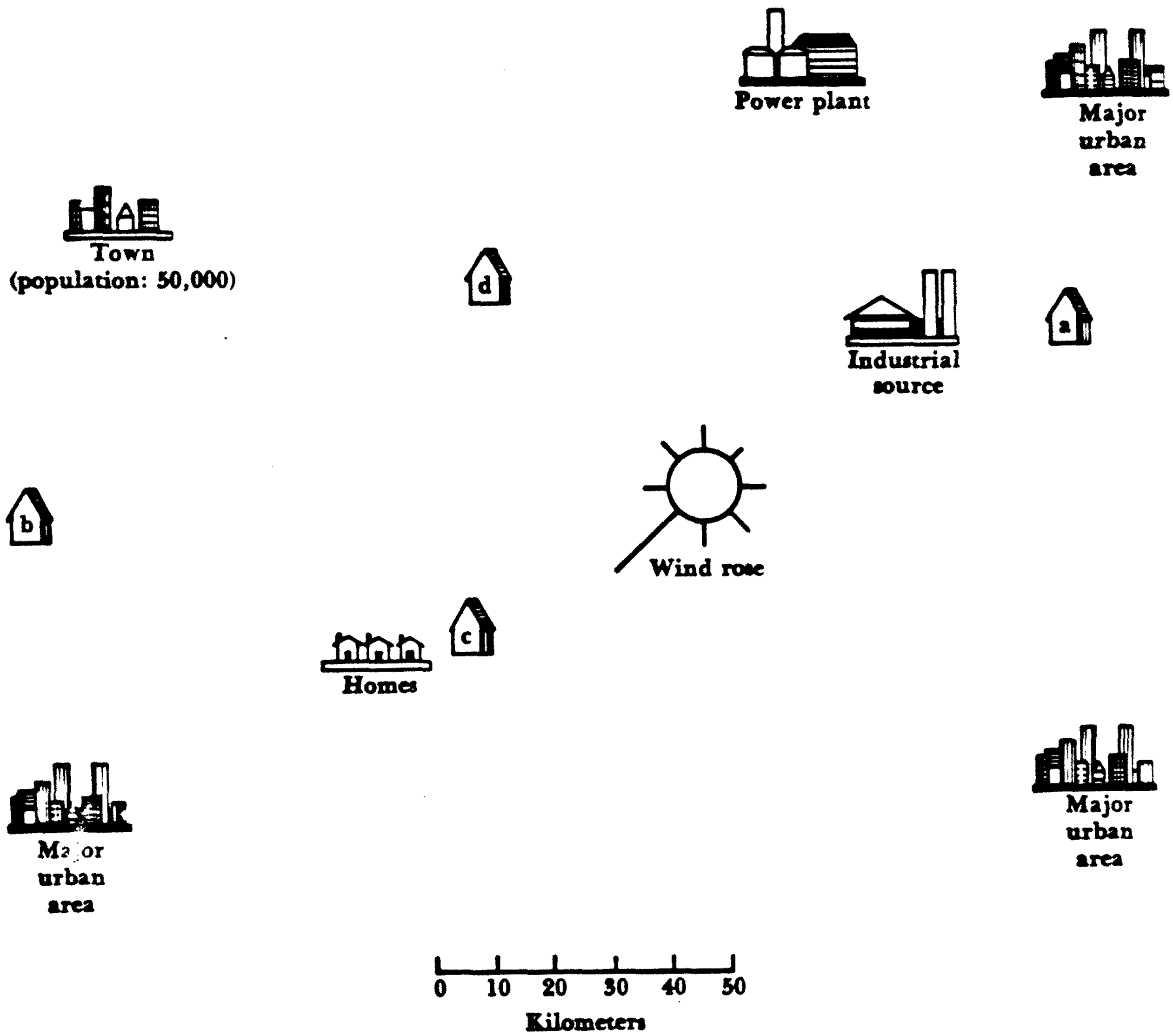
- Because "Optimum Site Exposure Criteria for SO_2 Monitoring" was published before the promulgation of 40 CFR 58, the monitor probe heights specified in the document do not agree with the required probe heights of 40 CFR 58. Probe heights specified in 40 CFR 58 are addressed in Section 7 of this guidebook.
- Wind roses are discussed in this reading assignment. A wind rose is a graphical representation of wind directional frequency. The farther that the bar extends from the circle, the more frequently the wind blows ***from*** that direction.
- In this reading assignment, the winter wind rose is recommended for use in selecting SO_2 monitoring sites. The basis for this recommendation is that for many areas, especially northern areas of the United States, winter is the season associated with maximum emissions of SO_2 because of space heating. However, you should determine the season associated with maximum SO_2 emissions for your specific monitor siting situation.
- Refer often to the flow charts and figures of the assigned reading material as you progress through the assignment.
- When you have finished the reading assignment, complete the review exercise for Section 2. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), take Quiz 1. Follow the directions listed in the Course Introduction section of this guidebook.
- After completing Quiz 1, proceed to Section 3 of this guidebook.

Review Exercise

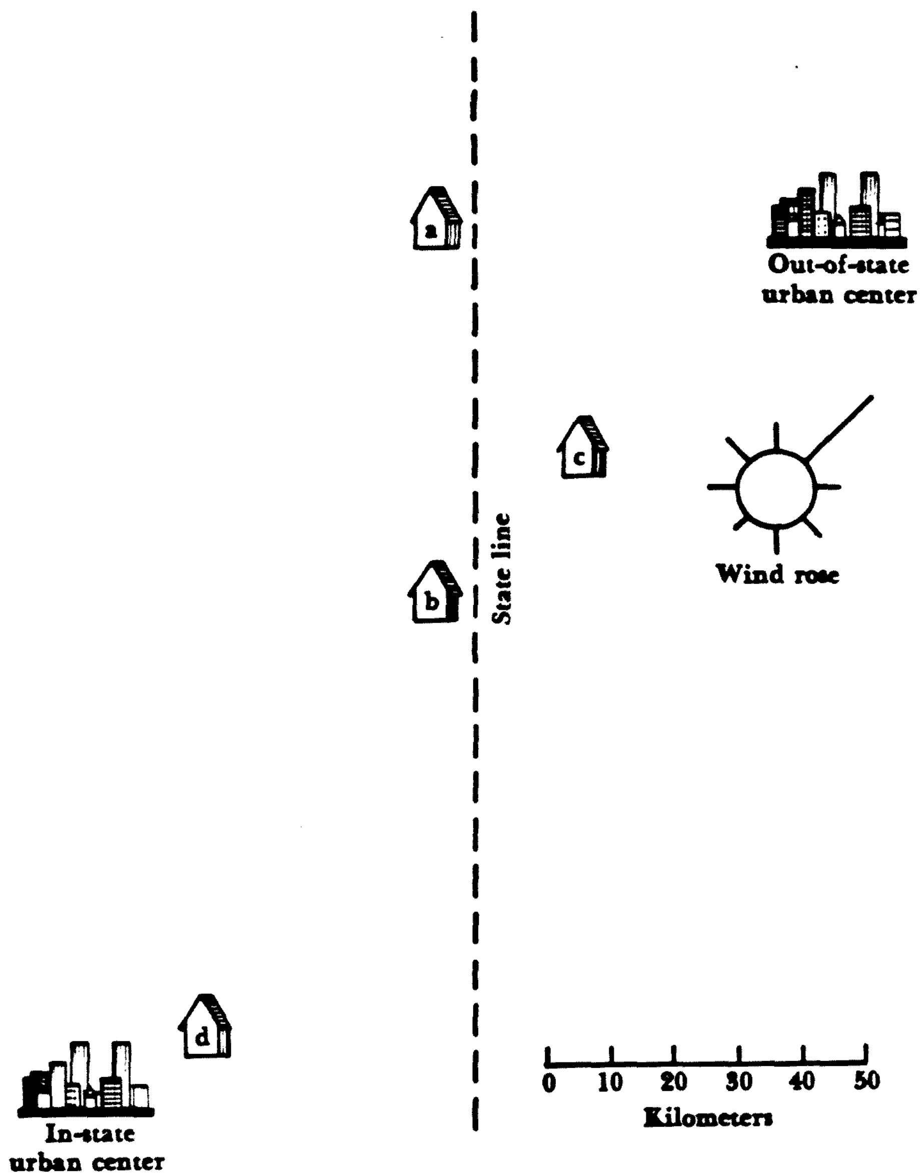
Now that you've completed the assignment for Section 2, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. The measurements from a single SO_2 monitoring site will represent concentrations over the regional spatial scale if the concentration gradient over the area of interest does not exceed about ___(?)___ $\mu g/m^3$ per kilometer.
   a. 0.5
   b. 0.1
   c. 1.0
   d. 3.0
2. If the SO_2 concentration extremes over the area of interest are not within about ___(?)___ percent of the average value, then more than one SO_2 monitoring site will be needed to represent SO_2 concentrations over the area.
   a. 5
   b. 10
   c. 25
   d. 50

3. Which of the four general siting areas, labeled a through d, is the best siting area for an SO_2 regional mean concentration monitoring station?

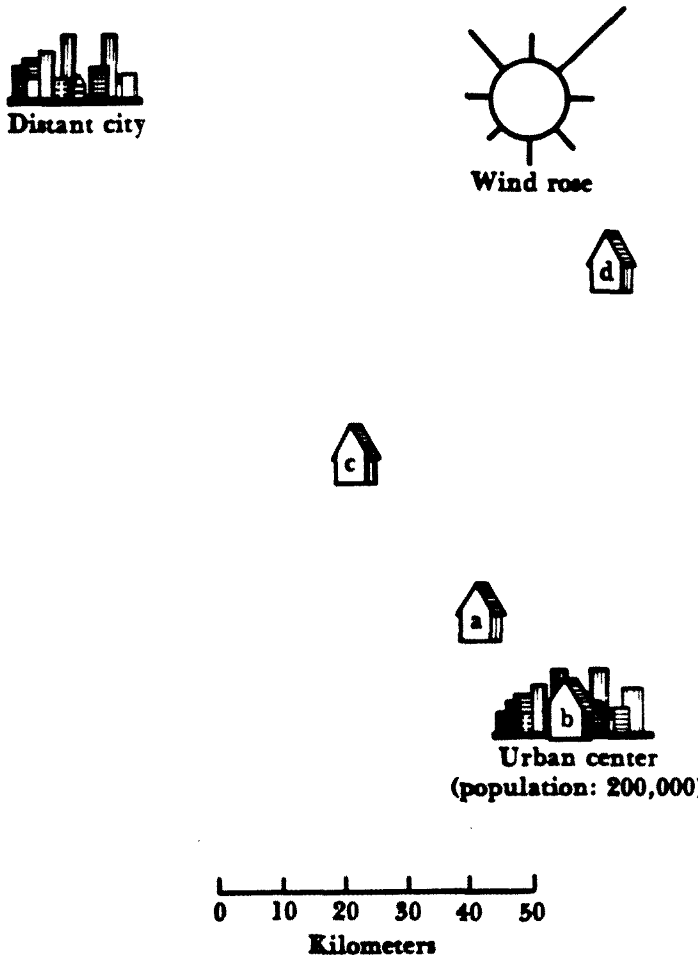


4. Which of the four general siting areas, labeled a through d, is the best siting area for measuring the ***maximum*** in-state SO_2 concentration resulting from the out-of-state urban center?

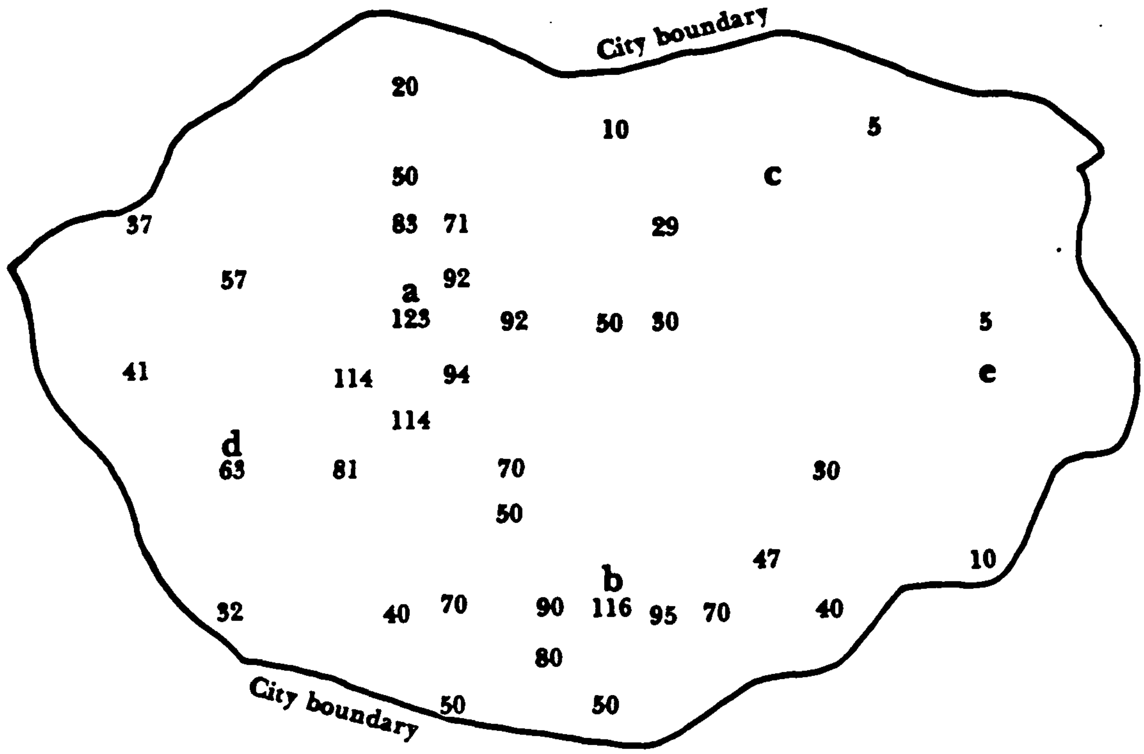


5. Which of the four general siting areas, labeled a through d in question four, is the best siting area for measuring the ***most frequent*** in-state SO_2 concentrations resulting from the out-of-state urban center?

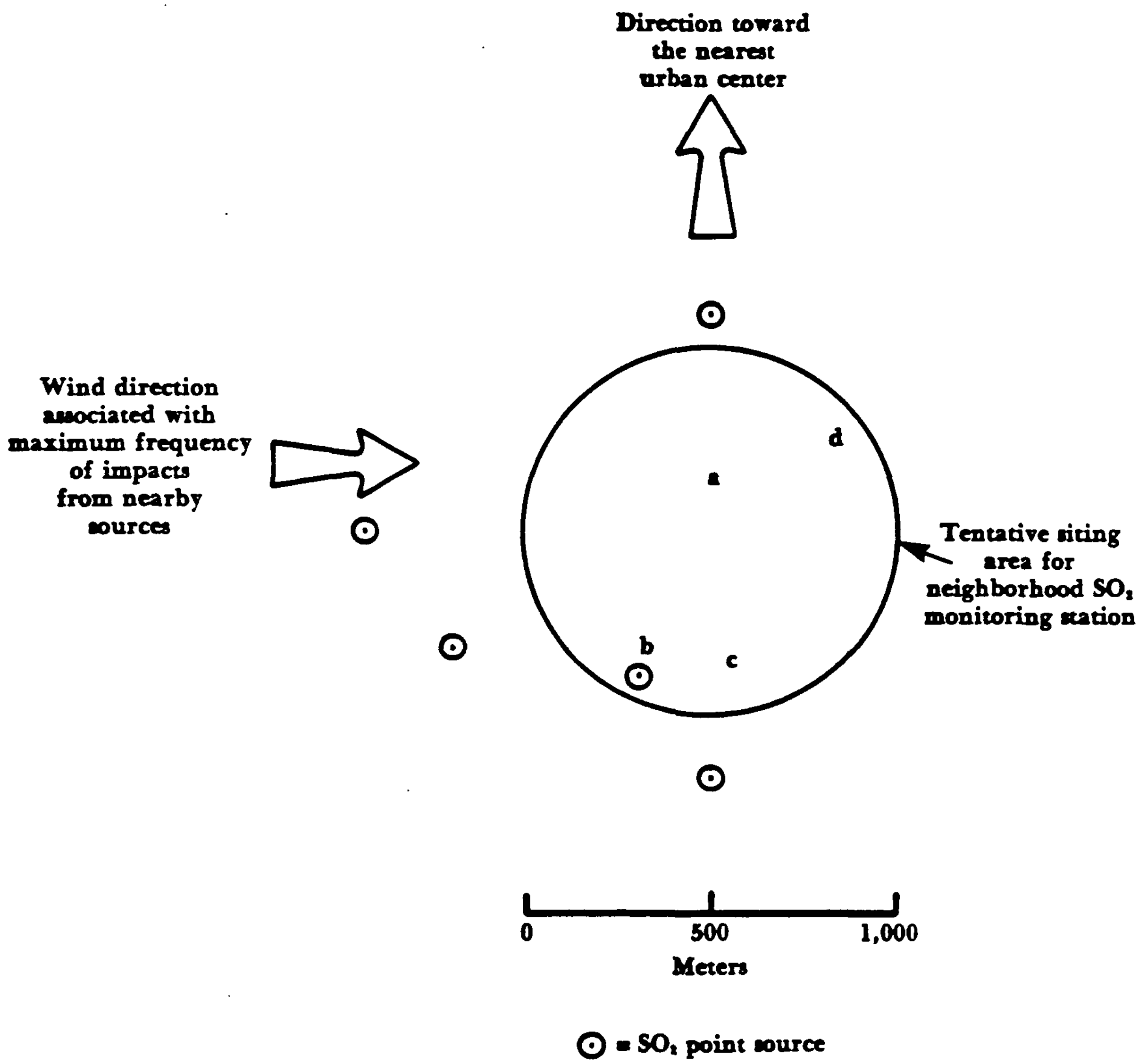
6. Which of the four general siting areas, labeled a through d, is the best siting area for assessing the transport of SO_2 from the distant city into the urban center?



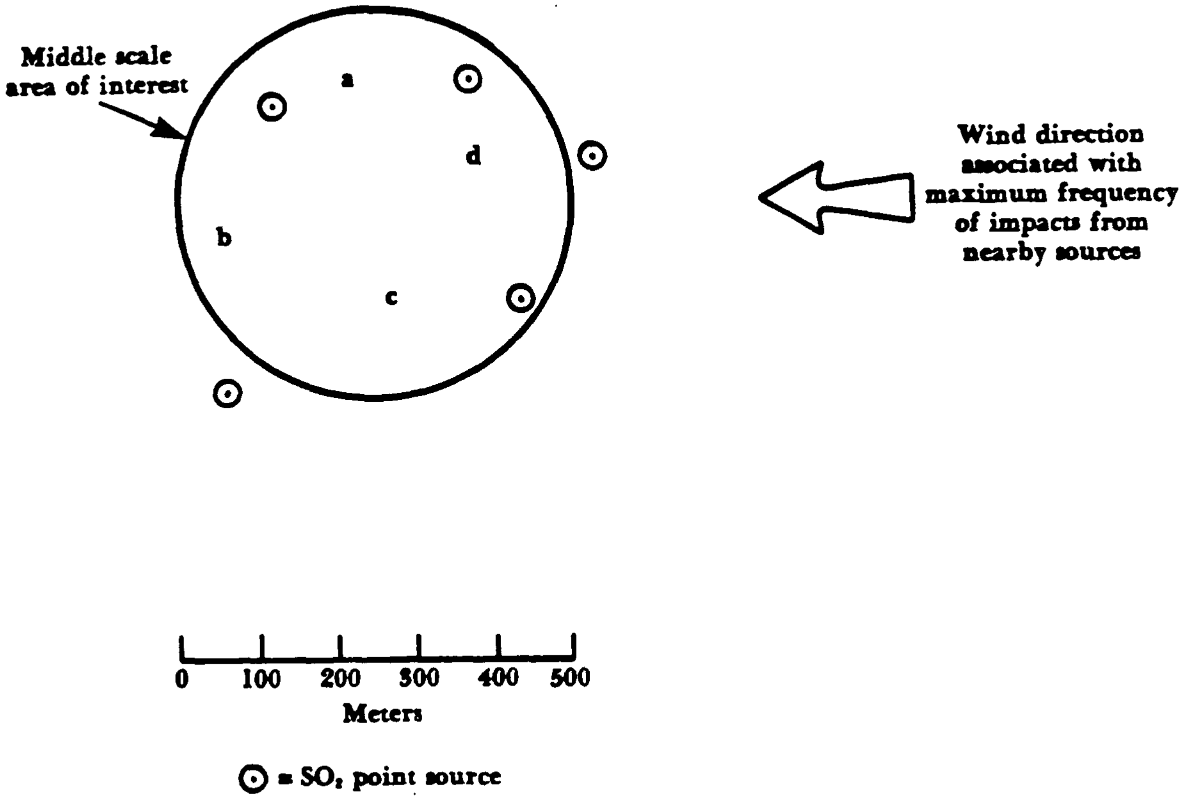
7. The figure below represents a city area with relative sulfur dioxide emission rates plotted. Which of the five general siting areas, labeled a through e, are the best ***two*** sites for SO_2 emergency episode monitoring?



8. Which of the four general siting areas, labeled a through d, is the best siting area for an ***urban*** population exposure/projected growth neighborhood scale SO_2 monitoring station?



9. Which of the four general siting areas, labeled a through d, is the best siting area for a general-level middle scale monitoring station for determining peak SO_2 concentrations?



Review Exercise Answers

	Page(s) of SO_2 Siting Manual
1. a	29
2. c	29
3. d	31
4. a	31
5. b	31
6. c	31
7. a and b	38
8. d	41-44
9. b	48-50

Section 3

Locating Proximate Middle Scale SO_2 Monitoring Stations for Urban and Isolated Point Sources

Reading Assignment

Pages 52-82 of EPA-450/3-77-013 "Optimum Site Exposure Criteria for SO_2 Monitoring".

Reading Assignment Topics

- Locating proximate middle scale SO_2 monitoring stations for urban point sources
- Locating proximate middle scale SO_2 monitoring stations for isolated point sources

Learning Goal and Objectives

Learning Goal

To familiarize you with the siting of proximate middle scale SO_2 monitoring stations for urban and isolated point sources.

Learning Objectives

At the end of this section, you should be able to:

1. select the general siting area for an SO_2 monitoring station for assessing the annual SO_2 impact from an urban point source.
2. recognize source characteristics which increase the probability of stack downwash.
3. define flat terrain.
4. select the general siting areas for an isolated point source's peak SO_2 concentration and for background stations in a flat terrain setting.
5. recognize the usefulness of mobile sampling for determining monitoring site locations.
6. define sea-breeze fumigation and recognize its cause.
7. recognize necessary information for determining a sea-breeze fumigation area.

8. describe the effect of terrain elevation on vertical mixing depth for a sea-breeze situation.
9. select the general siting areas for an isolated point source's peak SO_2 concentration and for background stations in a ridge/valley setting under various meteorological conditions.
10. describe the effects of moderately rough terrain on ambient SO_2 concentrations resulting from isolated point sources.
11. recognize general siting considerations for locating SO_2 monitoring stations for isolated point sources in extremely rough terrain.

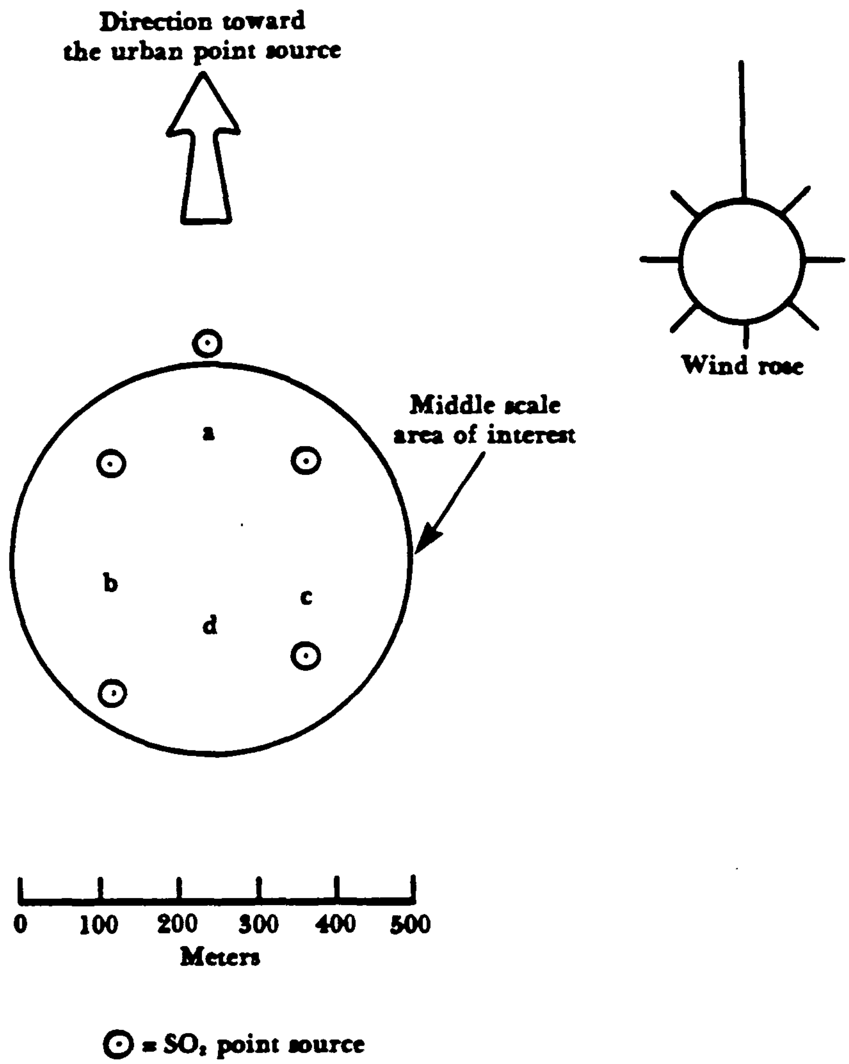
Reading Guidance

- Refer often to the flow chart and figures of the assigned reading material as you progress through the assignment.
- When you have finished the reading assignment, complete the review exercise for Section 3. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), proceed to Section 4 of this guidebook.

Review Exercise

Now that you've completed the assignment for Section 3, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. Which of the four general siting areas, labeled a through d, is the best siting area for a proximate middle scale monitoring station for determining the maximum annual SO_2 impact from the urban point source?

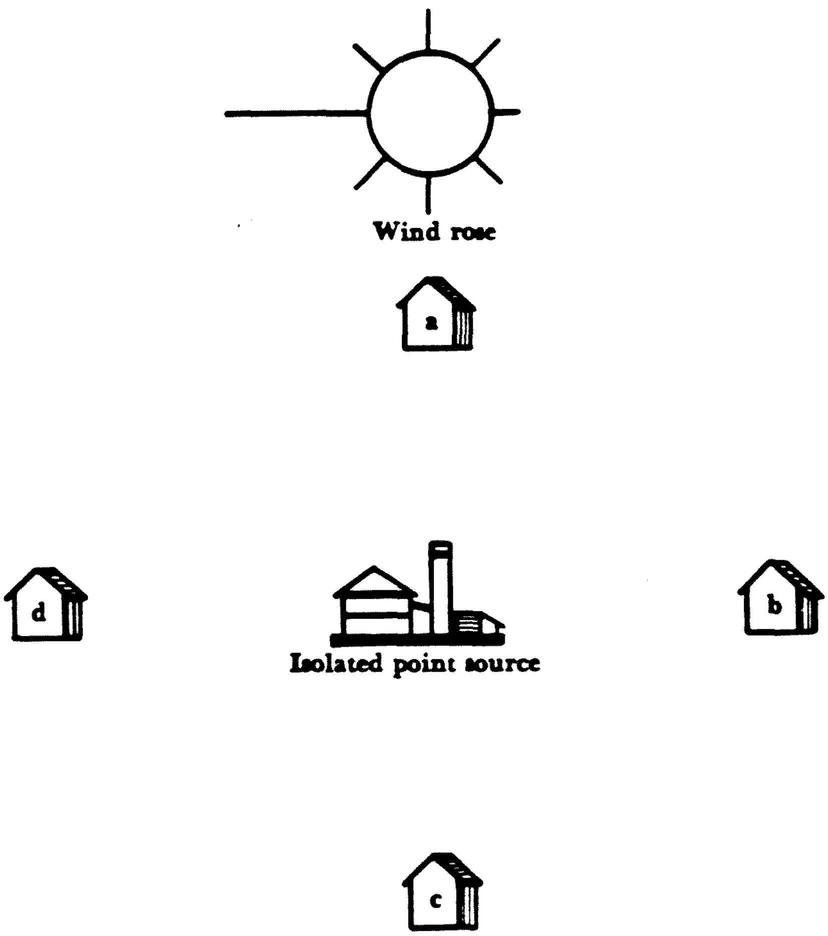


2. Stack downwash conditions may occur if the ratio between the stack gas velocity and the wind velocity is less than about ___(?)___.
   a. 15
   b. 10
   c. 5
   d. 1.5

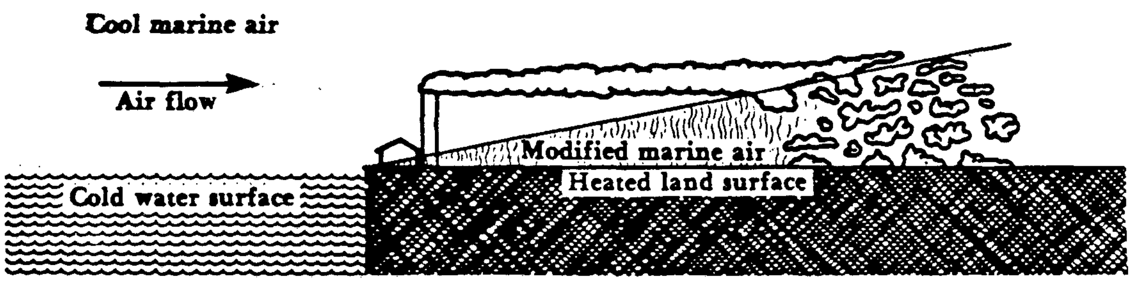
3. True or False? Stack downwash is likely to occur if the heights of any buildings and other obstructions that exist within a distance of 10 stack heights of the source exceed 2/5 of the height of the stack.

4. Terrain is deemed to be flat if terrain elevations greater than 2/5 the height of the stack do not exist within ___(?)___ kilometers of the source.
   a. 10
   b. 50
   c. 25
   d. 100

5. Which of the four general siting areas, labeled a through d, is the best siting area for a monitoring station for determining peak SO_2 concentrations resulting from the isolated point source?



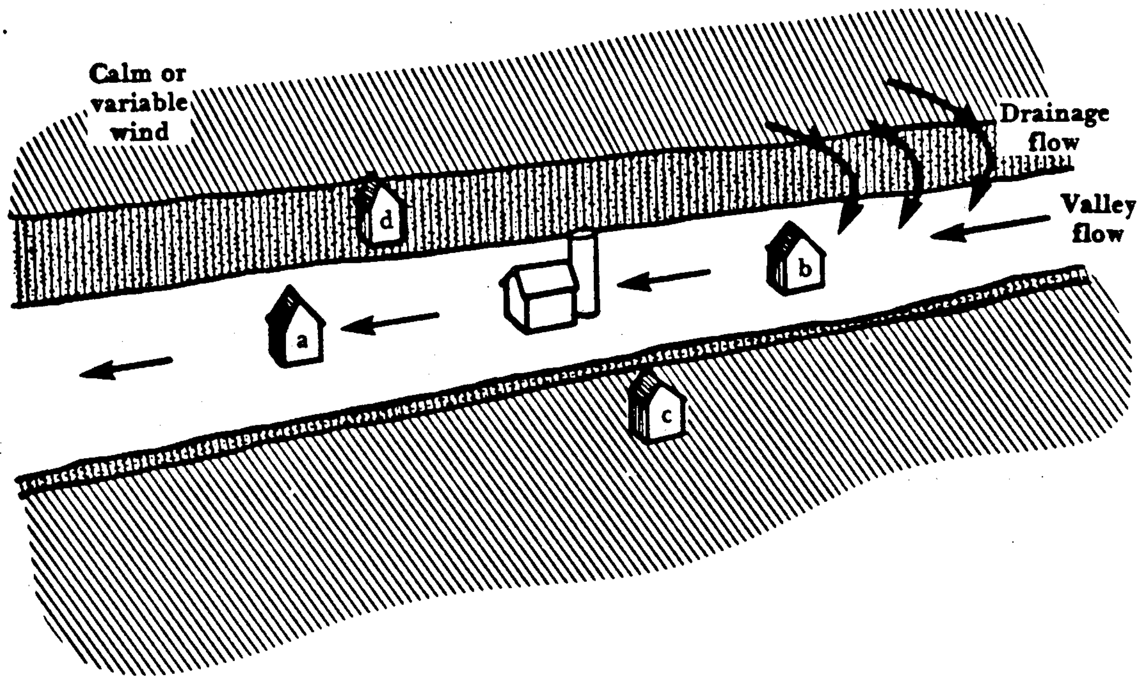
6. Which of the four general siting areas, labeled a through d in question 5, is the best siting area for an SO_2 background monitoring station?
7. True or False? Mobile sampling should be used in locating peak SO_2 concentration monitoring stations for determining the air quality impacts of isolated point sources.
8. The following figure depicts:
   a. plume lofting.
   b. plume fanning.
   c. sea-breeze fumigation.
   d. none of the above



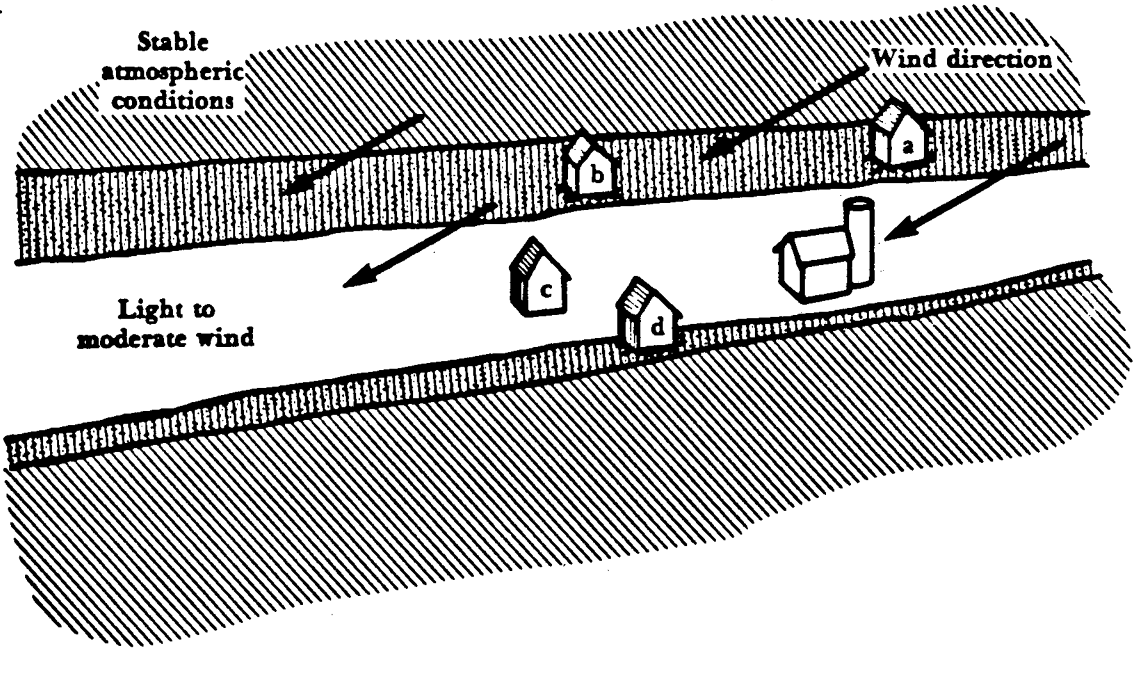
9. Which of the following is necessary for determining a sea-breeze fumigation area?
   a. the difference between the atmospheric temperature at plume height and the sea-surface temperature
   b. the mean wind speed of the marine air/plume layer
   c. the height of the plume
   d. all of the above
10. In a sea-breeze situation, vertical mixing depth ____(?)____ as the terrain slopes upward from flat.
   a. decreases
   b. increases
   c. remains the same
11. In a sea-breeze situation, vertical mixing depth ____(?)____ as the terrain slopes downward from flat.
   a. remains the same
   b. increases
   c. decreases

Which of the four general siting areas, labeled a through d, is the best siting area for a proximate middle scale monitoring station for determining peak SO_2 concentrations resulting from the point source for each of the following ridge/valley situations? (Questions 12-15)

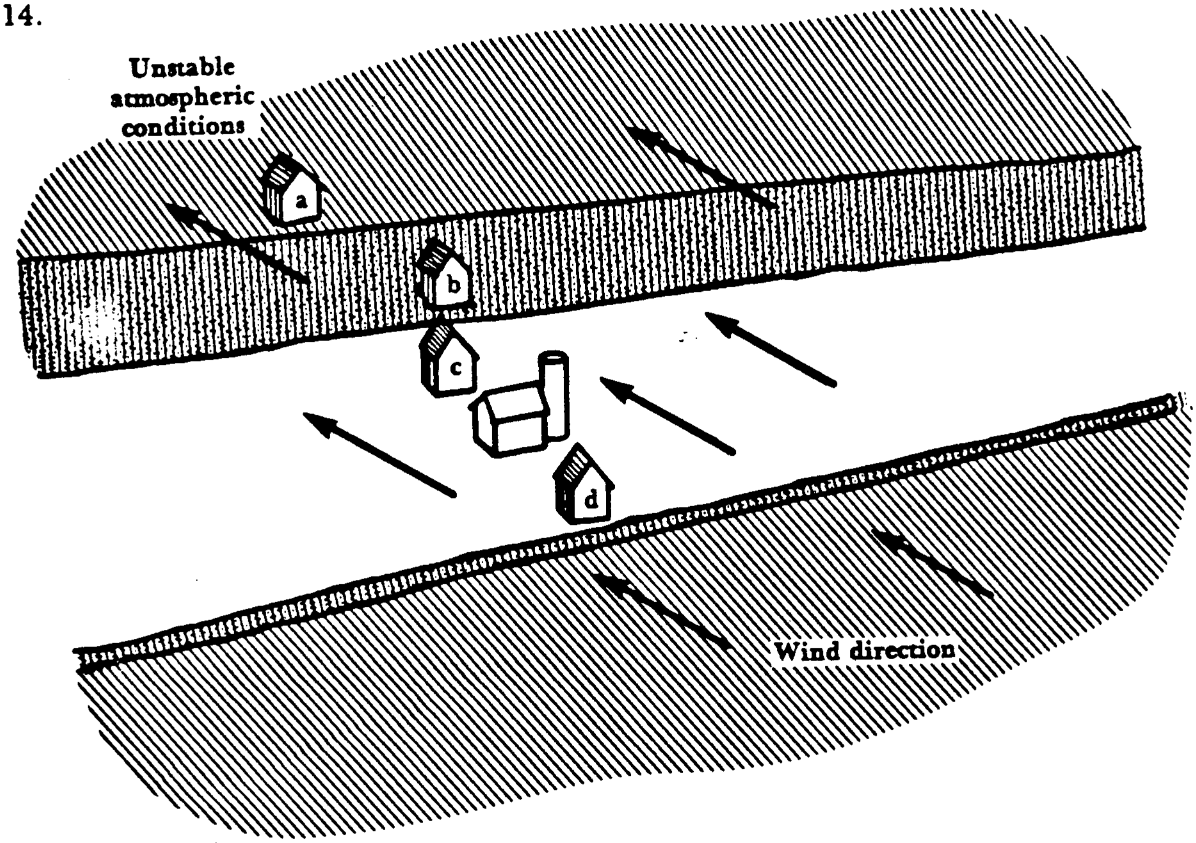
12.



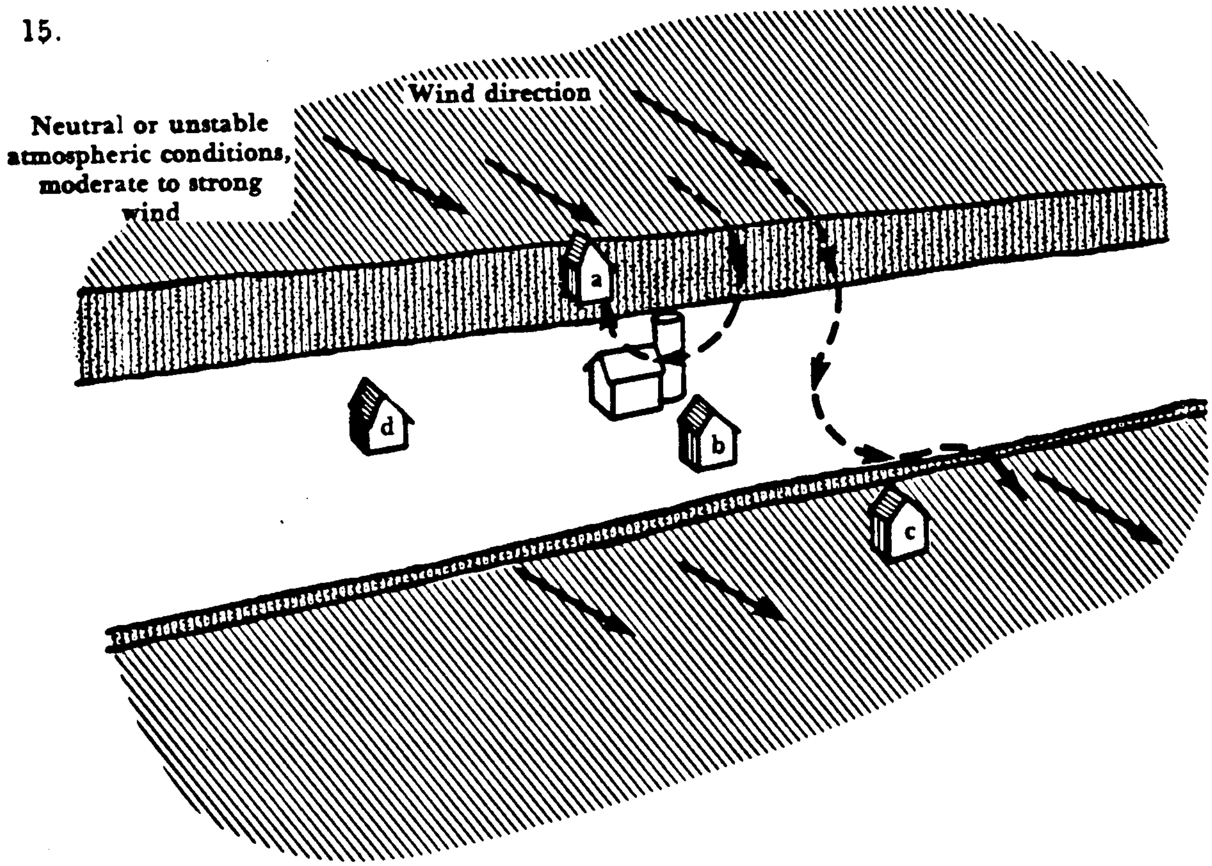
13.



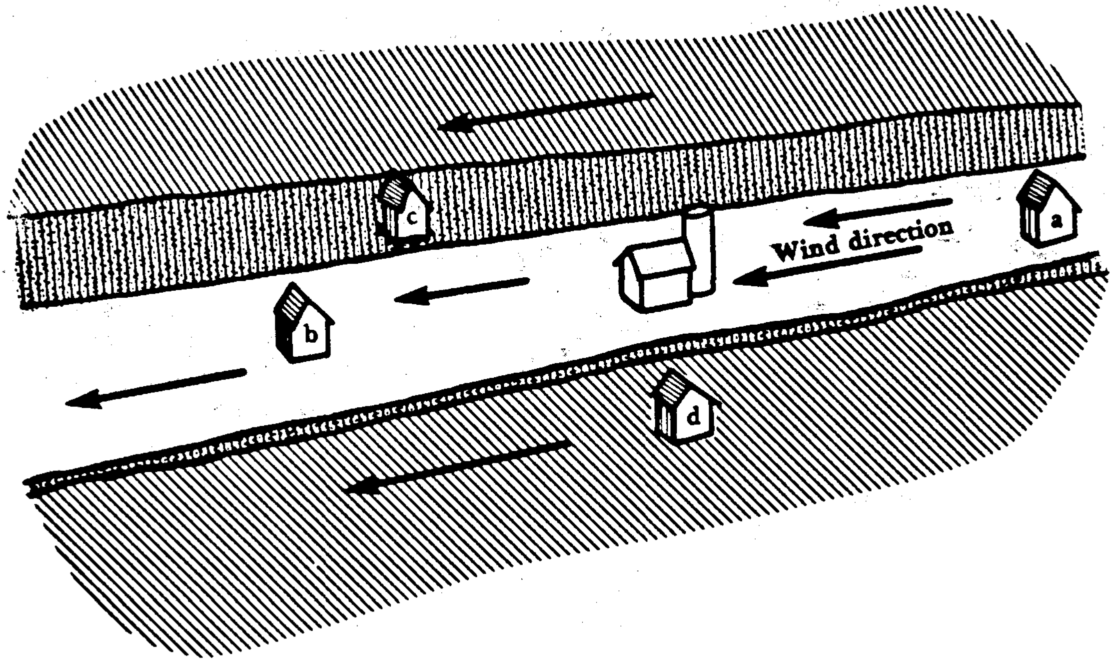
14.


Unstable atmospheric conditions
a
b
c
d
Wind direction

15.


Wind direction
Neutral or unstable atmospheric conditions, moderate to strong wind
a
b
c
d

16. Which of the four general siting areas, labeled a through d, is the best siting area for a background SO_2 monitoring station?



17. True or False? When monitoring SO_2 resulting from an isolated point source in a ridge/valley setting, one monitoring site should be established at a point nearest the source on the valley wall that is most frequently downwind of the source.

18. True or False? The major effect of moderately rough terrain on a plume is to decrease its rate of dispersal.

19. True or False? In a moderately rough terrain setting, SO_2 concentrations are always greater at the top of obstacles.

20. Monitoring stations should be established at which of the following locations when monitoring SO_2 impacts from an isolated point source that is located in extremely rough terrain?
   a. for regions subject to periods of low mixing depths, in basins having inlets for the point source's plume
   b. at ridge top locations in the general downwind directions from the point source
   c. both a and b, above
   d. none of the above

Review Exercise Answers

	Page(s) of SO_2 Siting Manual
1. d	54-56
2. d	61
3. True	61
4. a	60
5. b	62
6. d	62
7. True	63
8. c	64
9. d	65-66
10. b	66
11. a	66
12. a	71-72
13. d	72-73
14. a	72-73
15. b	74-75
16. a	74
17. True	74
18. False	77
19. False	77
20. c	80,82

Section 4

Rationale for SO_2 Monitor Siting Criteria

Reading Assignment

Pages 83-102 of EPA-450/3-77-013 "Optimum Site Exposure Criteria for SO_2 Monitoring".

Reading Assignment Topics

- Undue influence effects of nearby SO_2 sources
- Meteorological processes pertinent to monitor siting
- Effect of ambient temperature on SO_2 emission rates
- Chemical and physical interactions of SO_2 pertinent to monitor siting

Learning Goal and Objectives

Learning Goal

To familiarize you with the logic of the SO_2 monitor siting criteria.

Learning Objectives

At the end of this section, you should be able to:

1. associate assumed undue influence SO_2 concentration levels with the effects of SO_2 sources in rural, urban, and suburban areas.
2. describe assumptions for determining interference distances.
3. differentiate between the relative influences of a nearby SO_2 source on SO_2 monitoring stations within and outside the source's 10° plume sector.
4. recognize topographic effects on the shape of an air parcel and on wind speed.
5. define mechanical turbulence.
6. recognize the averaging effect of an air cavity on pollutant concentration.
7. describe the causes of upslope and downslope air flows.
8. recognize the effects of obstacles on air flows under stable and unstable atmospheric conditions.
9. recognize the effect of ambient temperature on SO_2 emission rates.
10. associate assumed SO_2 half-lives with areas having populations greater than and less than one million.

Reading Guidance

- Refer often to the figures of the assigned reading material as you progress through the assignment.
- Try to visualize how the siting criteria would be affected if the assumptions described in this reading assignment were altered.
- When you have finished the reading assignment, complete the review exercise for Section 4. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), take Quiz 2. Follow the directions listed in the Course Introduction section of this guidebook.
- After completing Quiz 2, proceed to Section 5 of this guidebook.

Review Exercise

Now that you've completed the assignment for Section 4, please answer the following questions. These will help you determine whether or not you are mastering the material.

Select the values that were assumed for each of the following parameters in determining the regional scale interference distance for a major urban area. (Questions 1-5)

1. Wind speed (m/s):
   a. 0.1
   b. 1
   c. 10
   d. 15
2. Half-life of SO_2 (hours):
   a. 6
   b. 12
   c. 24
   d. 3
3. Averaging interval of monitoring site SO_2 concentrations (hours):
   a. 1
   b. 3
   c. 24
   d. none of the above
4. SO_2 emission rate for a major urban area ($g/s/m^2$):
   a. 0.75×10^{-6}
   b. 0.63×10^{-4}
   c. 0.86×10^{-5}
   d. 0.72×10^{-3}
5. Undue influence SO_2 concentration level ($\mu g/m^3$):
   a. 0.1
   b. 2.6
   c. 25
   d. 50

Select the values that were assumed for each of the following parameters in determining the point source, minor source, and source interference distances (PSID, MSID, and SID, respectively). (Questions 6-10)

6. Effective SO_2 emission height (m):
   a. zero
   b. 10
   c. 15
   d. 25

7. Undue influence SO_2 concentration level ($\mu g/m^3$):
   a. 1
   b. 10
   c. 100
   d. 500
8. Wind speed (m/s):
   a. 0.1
   b. 1
   c. 10
   d. 15
9. Atmospheric stability class:
   a. A
   b. B
   c. C
   d. D
10. Averaging interval of monitoring site SO_2 concentrations (hours):
   a. 0.5
   b. 1
   c. 3
   d. 24
11. An SO_2 source has ___(?)___ influence on SO_2 concentrations measured at monitoring sites within its 10 degree plume sector than at sites outside its 10 degree plume sector.
   a. more
   b. less
   c. the same
12. As an air parcel passes between two obstructions, the parcel is squeezed ___(?)___ and its speed ___(?)___.
   a. vertically, increases
   b. vertically, decreases
   c. horizontally, increases
   d. horizontally, decreases
13. As an air parcel passes over a mountain, the parcel is squeezed ___(?)___ and its speed ___(?)___.
   a. vertically, increases
   b. vertically, decreases
   c. horizontally, increases
   d. horizontally, decreases
14. As an air parcel passes across a valley, the parcel expands ___(?)___ and its speed ___(?)___.
   a. vertically, increases
   b. vertically, decreases
   c. horizontally, increases
   d. horizontally, decreases

15. True or False? Mechanical turbulence is produced when air moves over a rough surface.

16. Which of the locations, labeled a through d, would be the most likely site of an air cavity wake?

17. An air cavity tends to ___(?)___ pollutant concentrations.
    a. average
    b. increase
    c. decrease

18. True or False? When the general wind direction is oblique to a ridge-valley axis, channeling of the wind often occurs.

19. Mountain passes ___(?)___ wind speeds.
    a. increase
    b. decrease
    c. have no effect on

20. At night, ___(?)___ air flows are caused by ___(?)___ of the air adjacent to the ground along a valley floor and slope.
    a. downslope, heating
    b. downslope, cooling
    c. upslope, heating
    d. upslope, cooling

21. In the daytime, ___(?)___ air flows are caused by ___(?)___ of the air adjacent to the ground along a valley floor and slope.
    a. downslope, heating
    b. downslope, cooling
    c. upslope, heating
    d. upslope, cooling

22. Under ____(?)____ atmospheric conditions, air parcels tend to move ____(?)____ obstacles.
   a. unstable, around
   b. stable, over
   c. unstable, over
   d. none of the above

23. Under ____(?)____ atmospheric conditions, air parcels tend to move ____(?)____ obstacles.
   a. stable, around
   b. unstable, around
   c. stable, over
   d. none of the above

24. True or False? The urban heat-island effect causes air to flow into urban centers at night.

25. True or False? The pollutant averaging effects of building wakes and air cavity flows cause the SO_2 concentration distribution of a city to be uniform up to at least the mean building height.

26. True or False? Ambient temperature may influence the rate of SO_2 emissions.

27. The SO_2 monitoring criteria are based on an assumed SO_2 half-life of ____(?)____ hour(s) for cities with populations greater than one million, and ____(?)____ hour(s) for cities with populations of one million or less.
   a. 1, 10
   b. 10, 1
   c. 1, 3
   d. 3, 10

Review Exercise Answers

	Page(s) of SO_2 Siting Manual
1. b	84
2. d	84
3. b	84
4. c	84
5. b	84
6. a	85
7. b	85
8. b	85
9. d	85
10. c	85
11. a	87
12. c	88
13. a	88
14. b	88
15. True	89
16. d	89
17. a	89
18. True	90
19. a	90
20. b	90
21. c	90
22. c	91
23. a	91
24. True	92
25. True	95-96
26. True	99
27. c	102

Section 5

Introduction to TSP Monitoring and Site Selection for Regional and Neighborhood TSP Monitoring Stations

Reading Assignment

Pages 1-49 of EPA-450/3-77-018 "Selecting Sites for Monitoring Total Suspended Particulates".

Reading Assignment Topics

- Need for careful selection of TSP monitoring sites
- General siting approach for TSP samplers
- Special characteristics of particulate matter
- Sources of particulate matter
- Classification of TSP monitoring sites
- Locating regional scale TSP monitoring stations
- Locating neighborhood scale TSP monitoring stations

Learning Goal and Objectives

Learning Goal

To familiarize you with general considerations for monitoring TSP matter and specific information for siting regional and neighborhood TSP monitoring stations.

Learning Objectives

At the end of this section, you should be able to:

1. explain the need for considering particle size in the selection of TSP monitoring sites.
2. describe the transport and removal mechanisms for large and small particles.
3. differentiate between the health and visibility effects of large and small particles.
4. describe contributions and impacts of natural and anthropogenic sources of TSP matter emissions.
5. define "particulate emissions from ground-level sources".
6. recognize the applicability of middle scale TSP monitoring sites for strip development, freeway corridors, and downtown street canyons.

7. differentiate between the location of the maximum annual TSP impact area and the location of the maximum 24-hour TSP impact area for a large, elevated TSP point source.
8. recognize the importance of monitoring TSP matter in high TSP concentration/high population areas for determining compliance with the TSP National Ambient Air Quality Standards.
9. select the general siting area for regional mean TSP monitoring stations.
10. select the general siting area for TSP transport monitoring stations.
11. select the general siting area for determining average neighborhood TSP concentrations.
12. select the general siting area for determining highest average neighborhood TSP concentrations.

Reading Guidance

- Because "Selecting Sites for Monitoring Total Suspended Particulates" was published before the promulgation of 40 CFR 58, the TSP sampler roadway set-back distances specified in the document do not agree with the required set-back distances of 40 CFR 58. Set-back distances specified in 40 CFR 58 are addressed in Section 7 of this guidebook.
- Natural dusts mentioned on page 10 of the reading assignment include an indeterminate amount of particulate emissions from anthropogenic sources.
- The titles for Figures 11 and 15 of the assigned reading material are reversed.
- Refer often to the flow charts and figures of the assigned reading material as you progress through the assignment.
- When you have finished the reading assignment, complete the review exercise for Section 5. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), proceed to Section 6 of this guidebook.

Review Exercise

Now that you've completed the assignment for Section 5, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. Which of the following is(are) an important reason(s) for considering particle size in the selection of TSP monitoring sites?
   a. Mass concentration varies with particle size.
   b. Particle removal processes depend on particle size.
   c. Health effects are influenced by particle size.
   d. all of the above
2. True or False? Small particles are likely to stay airborne longer and be transported farther than large particles.
3. True or False? Large particles are more subject to removal by impaction on obstacles to air flow than small particles.
4. True or False? Deposition in the lungs is a greater health hazard with large particles than with small particles.
5. True or False? The most important visibility-reducing particles are those below 10 μm in size.
6. In the United States, natural dusts constitute nearly ___(?)___ percent of the particulate emissions.
   a. 10
   b. 25
   c. 50
   d. 90
7. True or False? In general, high atmospheric concentrations of large particles are limited to areas near their sources.
8. In the United States, about ___(?)___ percent of the anthropogenic particulate emissions originate from stationary fuel combustion and industrial processes.
   a. 15
   b. 25
   c. 50
   d. 85
9. Particles which are blown at least ___(?)___ meter(s) from a ground-level source are considered particulate emissions of the source.
   a. 1
   b. 6
   c. 14
   d. 30

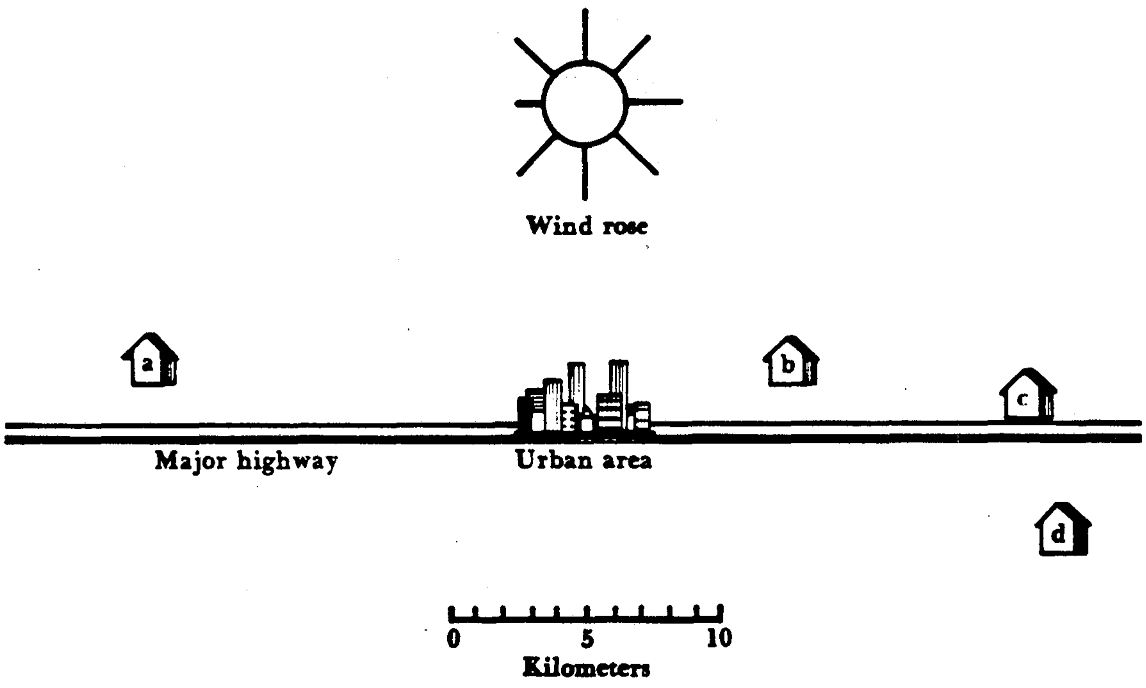
10. True or False? The middle spatial scale of representativeness may be appropriate when monitoring for TSP in strip developments, freeway corridors, or downtown street canyons.

11. True or False? In general, one TSP sampler is sufficient for determining the maximum annual and maximum 24-hour TSP impacts from a large, elevated source.

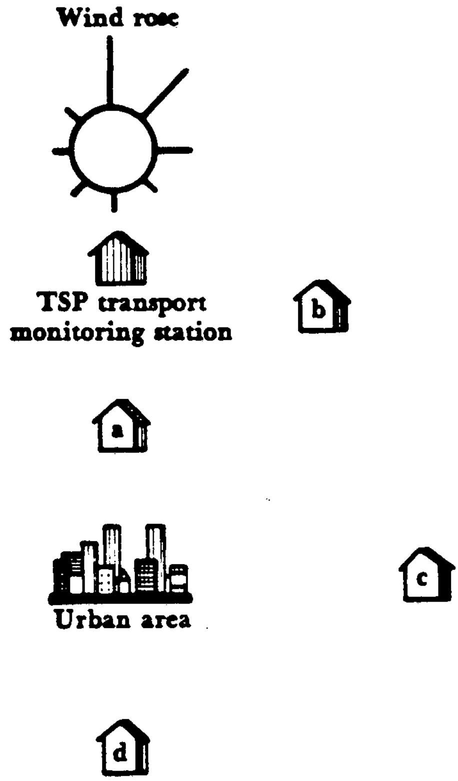
12. The most important locations for monitoring to determine compliance with the TSP National Ambient Air Quality Standards are in areas which have ___(?)___.

    a. high TSP concentrations.
    b. large populations.
    c. high TSP concentrations and large populations.
    d. none of the above

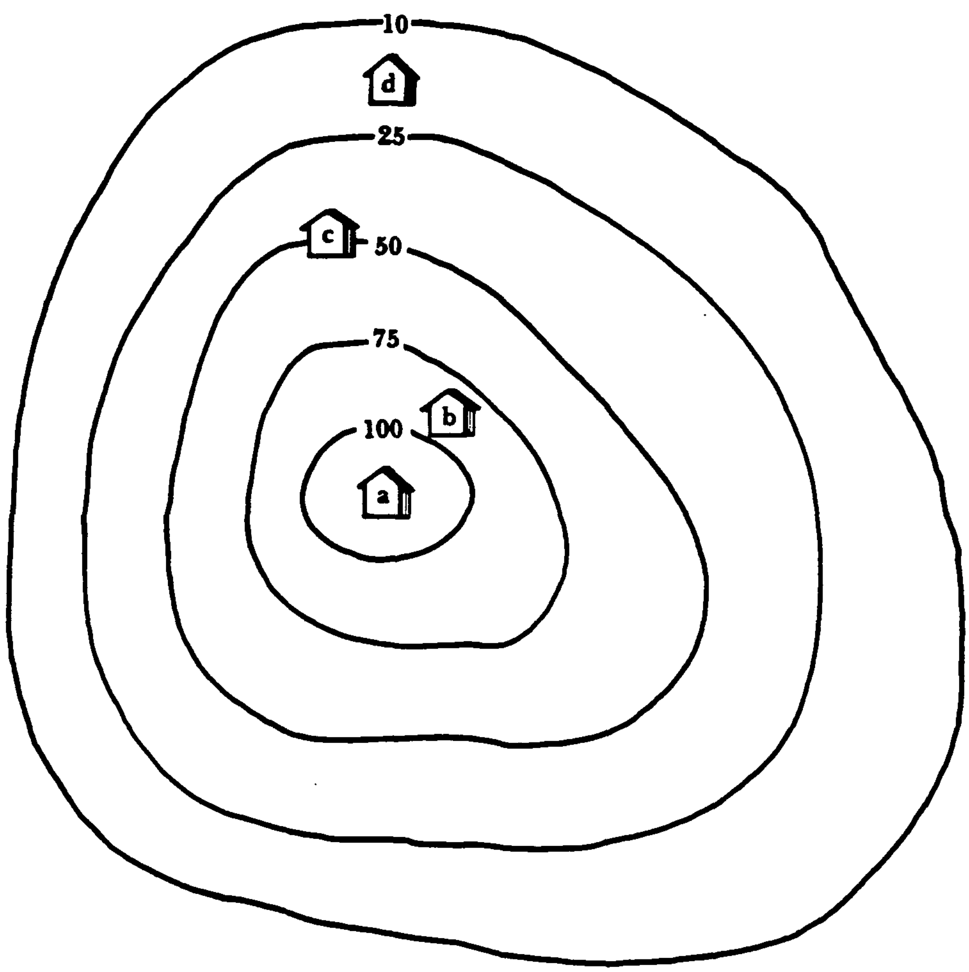
13. Which of the four general siting areas, labeled a through d, is the best siting area for a TSP regional mean concentration monitoring station?



14. Which of the four general siting areas, labeled a through d, is the best siting area for locating a ***second*** regional monitoring station for assessing the transport of TSP into the urban area?



15. The figure below represents an urban area with relative TSP concentrations plotted. Which of the four general siting areas, labeled a through d, is the best siting area for assessing TSP concentrations in neighborhoods which have average TSP concentrations in the urban area?



16. Which of the four general siting areas, labeled a through d in question 15, is the best siting area for assessing TSP concentrations in neighborhoods which have the highest TSP concentrations in the urban area?

Review Exercise Answers

		Page(s) of TSP Siting Manual
1.	d	2
2.	True	5
3.	True	5
4.	False	7
5.	True	7
6.	c	10
7.	True	10
8.	d	11
9.	b	12
10.	True	15
11.	False	18-19
12.	c	23
13.	d	30,33,36
14.	c	33,37
15.	c	39,45
16.	a	39,45

Section 6

Locating Middle Scale TSP Monitoring Stations and Rationale for TSP Siting Criteria

Reading Assignment

Pages 50-74 of EPA-450/3-77-018 "Selecting Sites for Monitoring Total Suspended Particulates".

Reading Assignment Topics

- Locating TSP monitoring stations for determining TSP impacts of elevated point sources
- Locating TSP monitoring stations in street canyons and near traffic corridors
- Roadway effects pertinent to TSP monitor siting
- Undue influence effects of urban areas on regional TSP monitoring
- Effects of obstructions pertinent to TSP monitor siting
- Undue influence effects of nearby TSP sources

Learning Goal and Objectives

Learning Goal

To familiarize you with the siting of middle scale TSP monitoring stations and the logic of the TSP siting criteria.

Learning Objectives

At the end of this section, you should be able to:

1. select general TSP monitor siting areas for determining the maximum annual and most frequent high short-term TSP impacts of an elevated point source.
2. select TSP monitor sites in street canyons and near roadways for determining worst-case and typical TSP concentrations.
3. describe the effects of horizontal and vertical placement of TSP samplers on obtaining a representative TSP concentration near a roadway.
4. describe the assumptions for determining the urban area interference distance for regional TSP monitoring sites.
5. recognize the effects of buildings on air flows.
6. describe the effects of nearby TSP area sources on TSP measurements.

Reading Guidance

- Refer often to the flow charts concerning the selection of source-oriented and middle scale TSP monitor sites as you progress through the assignment.
- Try to visualize how the siting criteria would be affected if the assumptions described in this reading assignment were altered.
- When you have finished the reading assignment, complete the review exercise for Section 6. It begins on the following page.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), proceed to Section 7 of this guidebook.

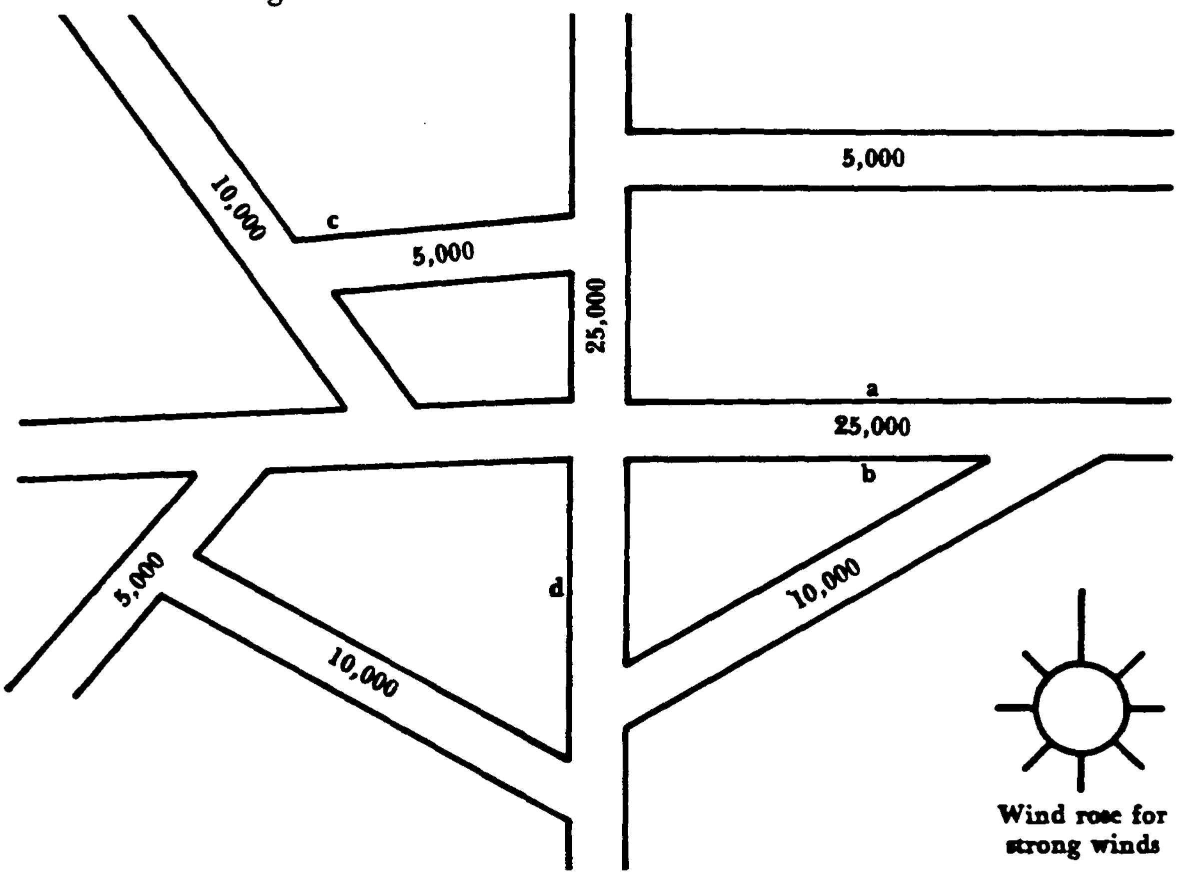
Review Exercise

Now that you've completed the assignment for Section 6, please answer the following questions. These will help you determine whether or not you are mastering the material.

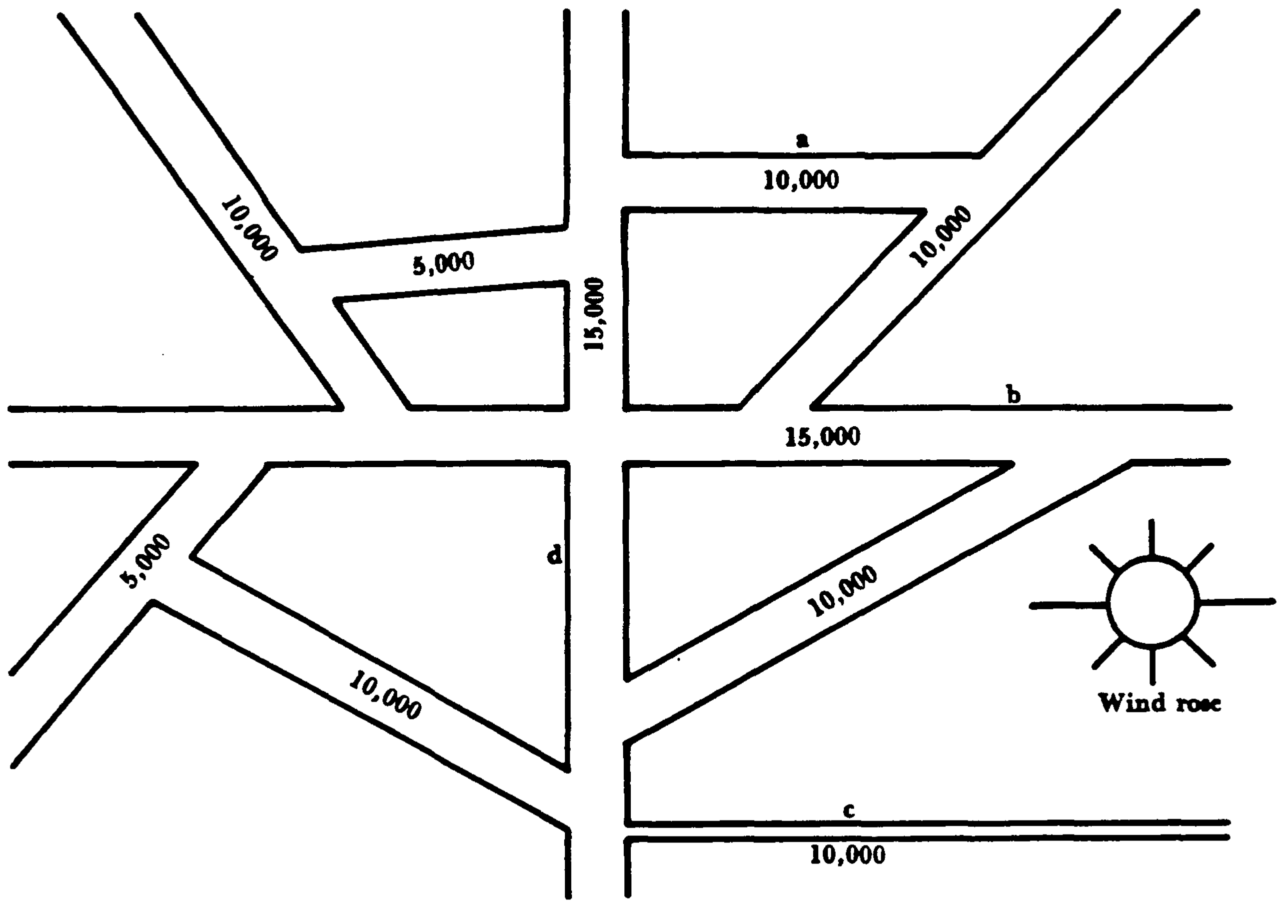
1. In general, areas of highest ___(?)___ average TSP concentrations resulting from an elevated point source are more likely to occur nearer the point source than are areas of highest ___(?)___ average TSP concentrations resulting from the point source.
   a. long-term, short-term
   b. short-term, long-term
   c. none of the above

2. True or False? When monitoring air quality impacts from an elevated TSP point source in an area which is influenced by additional sources of TSP, a TSP sampling station should be located in the direction that is least frequently downwind of the elevated point source.

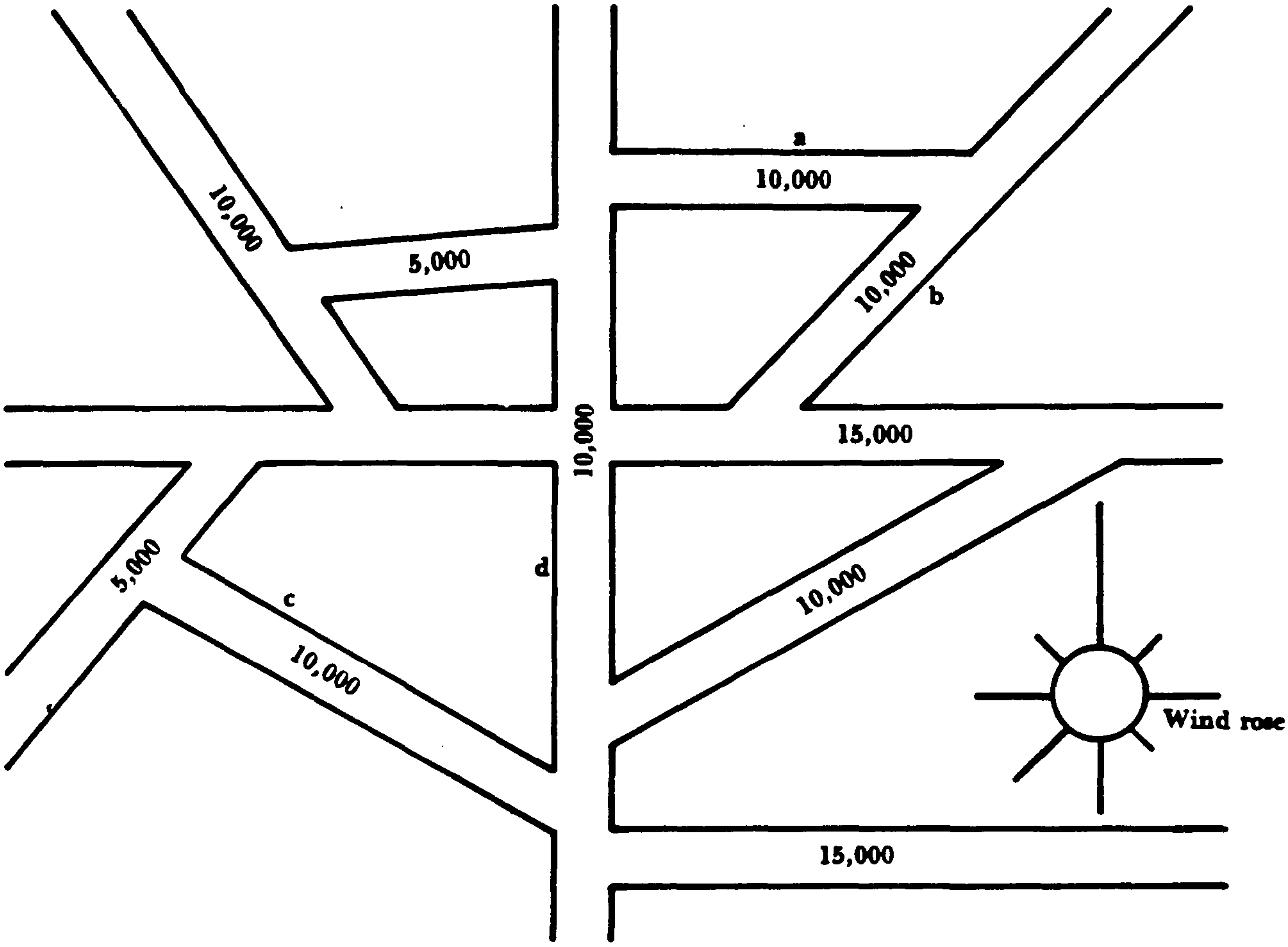
3. The figure below represents a downtown street canyon area with average daily traffic volumes for major streets indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a TSP sampler to monitor the highest concentrations in the downtown area?



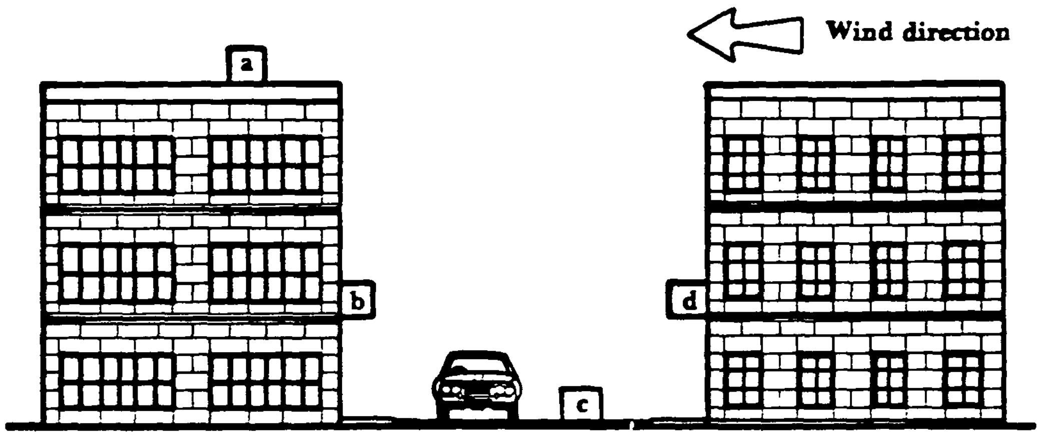
4. The figure below represents a downtown street canyon area with average daily traffic volumes indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a TSP sampler to monitor typical concentrations in the downtown area?



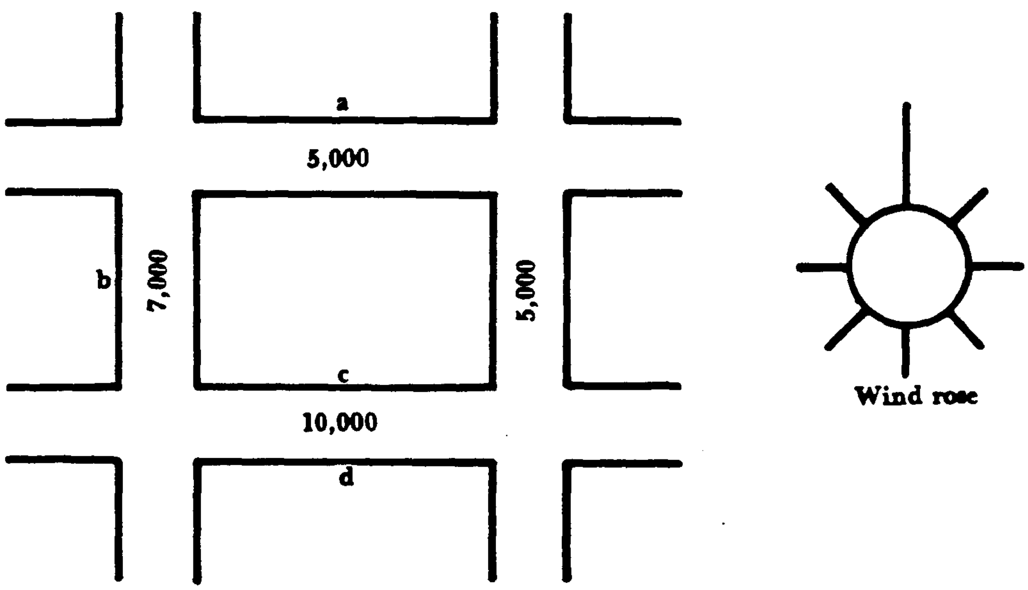
5. The figure below represents a downtown street canyon area with average daily traffic volumes indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a TSP sampler to monitor typical concentrations in the downtown area?



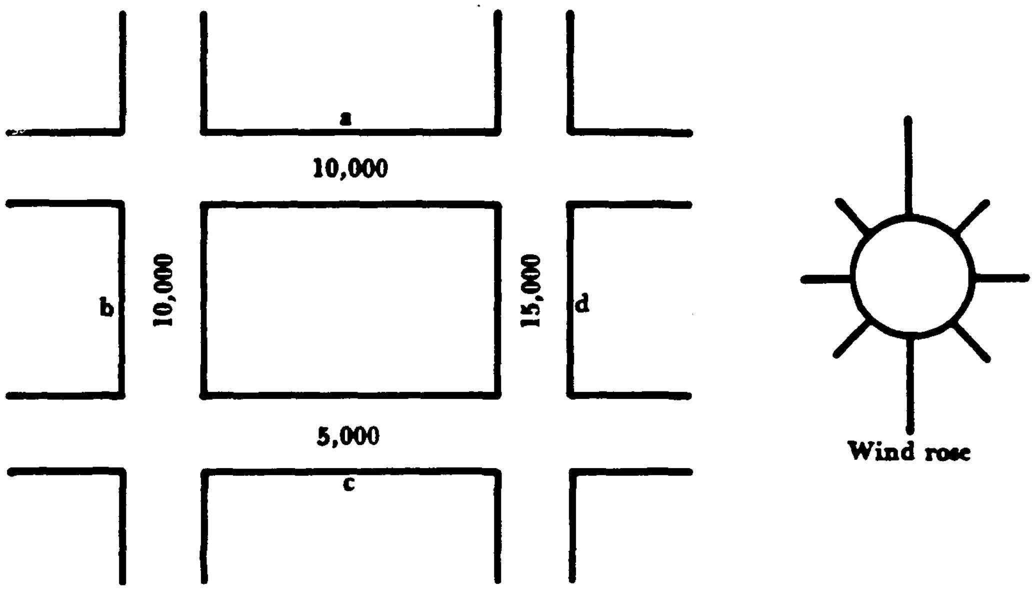
6. Which of the four general siting areas, labeled a through d, is the best siting area for locating a TSP sampler to monitor maximum concentrations in the street canyon?



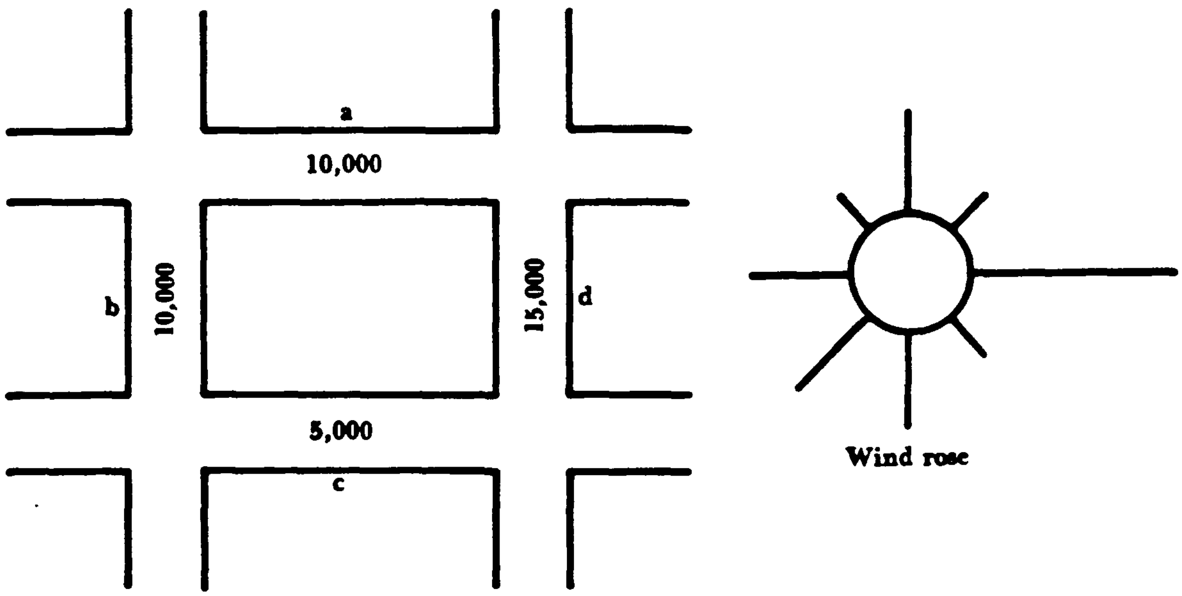
7. The figure below represents a roadway area with average daily traffic volumes indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a TSP sampler to monitor the highest concentrations in the roadway area?



8. The figure below represents a roadway area with average daily traffic volumes indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a TSP sampler to monitor typical concentrations in the roadway area?



9. The figure below represents a roadway area with average daily traffic volumes indicated. Which of the four general siting areas, labeled a through d, is the best siting area for locating a TSP sampler to monitor typical concentrations in the roadway area?



10. In proximity to a roadway, vertical TSP gradients resulting from the roadway ___(?)___ as the horizontal distance from the roadway ___(?)___.
    a. increase, decreases
    b. decrease, increases
    c. remain the same, decreases
    d. remain the same, increases

11. True or False? A regional TSP sampler should be sited so that it is not influenced by particulate matter resulting from unpaved roads.

Select the values that were assumed for each of the following parameters in determining the urban area interference distance for regional TSP monitoring sites. (Questions 12-15)

12. Undue influence TSP concentration level ($\mu g/m^3$):
    a. 0.6
    b. 6
    c. 26
    d. 50

13. Urban area TSP emission rate ($\mu g/m^2/s$):
    a. 1
    b. 4
    c. 12
    d. 25

14. Daily average minimum wind speed (m/s):
    a. 0.1
    b. 0.5
    c. 2
    d. 5

15. TSP concentration averaging interval at monitoring site (hours):
    a. 3
    b. 12
    c. 24
    d. 48

16. An air cavity extends downwind of a building about ___(?)___ heights of the building.
    a. 1.5
    b. 4.5
    c. 9
    d. 15

17. A TSP sampler should be located at least ___(?)___ meter(s) above a 2-meter high building in order for it to be reasonably well removed from the worst of the air turbulence caused by the building.
   a. 0.5
   b. 1.5
   c. 5.0
   d. 7.5

18. Emissions from ground-level area sources located within two kilometers of a TSP sampler account for more than half the TSP concentrations measured by the sampler about ___(?)___ percent of the time.
   a. 10 to 20
   b. 30 to 40
   c. 60 to 70
   d. 80 to 90

Review Exercise Answers

	Page(s) of TSP Siting Manual
1. b	50
2. True	53
3. a	56-57
4. a	56,58
5. d	58
6. d	57
7. d	59-60
8. b	59-60
9. a	59-60
10. b	66
11. False	67
12. b	68
13. b	68
14. c	68
15. c	68
16. a	70
17. b	70
18. b	73

Section 7

Monitoring Network Design and Probe Siting Criteria for TSP and SO_2 SLAMS, NAMS, and PSD Monitoring Stations

Reading Assignment

Pages 7-4 through 7-15 of this guidebook.

Reading Assignment Topics

- Excerpts of 40 CFR 58 Appendix D
  - SLAMS network design for TSP and SO_2 monitoring stations
  - NAMS network design for TSP and SO_2 monitoring stations
- Excerpts of 40 CFR 58 Appendix E
  - Probe siting criteria for TSP SLAMS and NAMS
  - Probe siting criteria for SO_2 SLAMS and NAMS
  - Materials of construction and maximum sample residence time for SO_2 probes
  - Waiver provisions for SLAMS and NAMS probe-siting criteria
- Excerpts of "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)" (EPA-450/4-80-012)
  - Network design for PSD monitoring stations
  - Probe-siting criteria for ground-level sources

Learning Goal and Objectives

Learning Goal

To familiarize you with regulations and guidelines concerning monitoring network design and probe-siting criteria for TSP and SO_2 SLAMS, NAMS, and PSD monitoring stations.

Learning Objectives

At the end of this section, you should be able to:

1. recognize the four basic monitoring objectives of SLAMS.
2. associate SLAMS monitoring objectives with spatial scales of representativeness.
3. recognize the primary monitoring objective of NAMS.
4. describe the two basic categories of NAMS.
5. recognize the two primary uses of NAMS data.
6. estimate the number of TSP and SO_2 NAMS required for a given monitoring area.
7. recognize the spatial scale of representativeness required for TSP and SO_2 NAMS.
8. select probe locations for TSP and SO_2 SLAMS, NAMS, and PSD monitoring stations.
9. select the appropriate materials of construction and the sample residence times for SO_2 probes.
10. describe waiver provisions for SLAMS and NAMS probe-siting criteria.
11. select general siting areas for PSD monitoring stations.
12. estimate the number of TSP and SO_2 monitoring stations needed for preconstruction and postconstruction PSD monitoring networks.
13. define ambient air.
14. recognize that PSD monitors should be located in ambient air areas.
15. select appropriate probe heights for TSP and SO_2 PSD monitors used to measure impacts of ground-level sources.

Reading Guidance

- SLAMS and NAMS are required for State Implementation Plan ambient air quality monitoring networks.
- The information concerning SLAMS and NAMS contained in the assigned reading material is stated as a regulation.
- PSD monitoring stations are used to determine the air quality impacts of existing or proposed sources that are located in areas meeting the National Ambient Air Quality Standards (NAAQS).
- The information concerning PSD monitoring stations contained in the assigned reading material is stated as a guideline.
- The probe-siting criteria for TSP and SO_2 PSD monitoring stations are identical to the probe-siting criteria for TSP and SO_2 SLAMS and NAMS except for the PSD monitoring of ground-level sources. Therefore, only ground-level source monitoring information is included in the PSD monitor-siting portion of the reading assignment.
- TSP sampler set-back distances described in the assigned reading materials apply only to ***paved*** roadways.

- Table 4 of the excerpts of 40 CFR 58 Appendix D is incorrectly titled as "Figure 5-2. Particulate field data". The correct title is "Summary of Spatial Scales for SLAMS and Required Scales for NAMS".
- The last reference found in the footnotes of the excerpts of 40 CFR 58 Appendix E should read 21-22, not 21-21.
- When you have finished the reading assignment, complete the review exercise for Section 7. It begins on page 7-16.
- After you have answered the review exercise questions, check your answers. The correct answers are listed on the page immediately following the review exercise.
- For any review exercise questions that you answered incorrectly, review the page(s) of the reading assignment indicated on the answers page.
- After you have reviewed your incorrect answers (if any), take the final examination for the course. Follow the directions listed in the Course Introduction section of this guidebook.
- Your course grade results will be mailed to you.

Excerpts of 40 CFR 58 Appendices D and E

APPENDIX D—NETWORK DESIGN FOR STATE AND LOCAL AIR MONITORING STATIONS (SLAMS) AND NATIONAL AIR MONITORING STATIONS (NAMS)

1. SLAMS Monitoring Objectives and Spatial Scales
2. SLAMS Network Design Procedures
2.1 Background Information for Establishing SLAMS
2.2 Total Suspended Particulates (TSP) Design Criteria for SLAMS
2.3 Sulfur Dioxide (SO_2) Design Criteria for SLAMS
2.4 Carbon Monoxide (CO) Design Criteria for SLAMS
2.5 Ozone (O_3) Design Criteria for SLAMS
2.6 Nitrogen Dioxide (NO_2) Design Criteria for SLAMS
3. Network Design for National Air Monitoring Stations (NAMS)
3.1 Total Suspended Particulates (TSP) Design Criteria for NAMS
3.2 Sulfur Dioxide (SO_2) Design Criteria for NAMS
3.3 Carbon Monoxide (CO) Design Criteria for NAMS
3.4 Ozone (O_3) Design Criteria for NAMS
3.5 Nitrogen Dioxide (NO_2) Design Criteria for NAMS
4. Summary
5. References

1. SLAMS MONITORING OBJECTIVES AND SPATIAL SCALES

The purpose of this appendix is to describe monitoring objectives and general criteria to be applied in establishing the State and Local Air Monitoring Stations (SLAMS) networks and for choosing general locations for new monitoring stations. It also describes criteria for determining the number and location of National Air Monitoring Stations (NAMS). These criteria will also be used by EPA in evaluating the adequacy of SLAMS/NAMS networks.

The network of stations which comprise SLAMS should be designed to meet a minimum of four basic monitoring objectives. These basic monitoring objectives are: (1) To determine highest concentrations expected to occur in the area covered by the network; (2) to determine representative concentrations in areas of high population density; (3) to determine the impact on ambient pollution levels of significant sources or source categories; and (4) to determine general background concentration levels.

To a large extent, the existing State Implementation Plan (SIP) monitoring networks have been designed with these four objectives in mind. Thus, they can serve as the logical starting point for establishing the SLAMS network. This will, however, require a careful review of each existing SIP ambient network to determine the principal objectives of each station and the extent to which the location criteria presented herein are being met. It should be noted that this appendix contains no criteria for determining the total number of stations in SLAMS networks. The optimum size of a particular SLAMS network involves trade offs among data needs and available resources which EPA believes can best be resolved during the network design process.

This appendix focuses on the relationship between monitoring objectives and the geographical location of monitoring stations. Included are a rationale and set of general criteria for identifying candidate station locations in terms of physical characteristics which most closely match a specific monitoring objective. The criteria for more specifically siting the monitoring station including spacing from roadways and vertical and horizontal probe placement, are described in Appendix E of this part.

To clarify the nature of the link between general monitoring objectives and the physical location of a particular monitoring station, the concept of spatial scale of representativeness of a monitoring station is defined. The goal in siting stations is to correctly match the spatial scale represented by the sample of monitored air with the spatial scale most appropriate for the monitoring objective of the station.

Thus, spatial scale of representativeness is described in terms of the physical dimensions of the air parcel nearest to a monitoring station throughout which actual pollutant concentrations are reasonably similar. The scale of representativeness of most interest for the monitoring objectives defined above are as follows:

- *Microscale*—defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters.
- *Middle Scale*—defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer.
- *Neighborhood Scale*—defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range.
- *Urban Scale*—defines the overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one site for definition.
- *Regional Scale*—defines usually a rural area of reasonably homogeneous geography and extends from tens to hundreds of kilometers.
- *National and Global Scales*—these measurement scales represent concentrations characterizing the nation and the globe as a whole.

Proper siting of a monitoring station requires precise specification of the monitoring objective which usually includes a desired spatial scale of representativeness. For example, consider the case where the objective is to determine maximum CO concentrations in areas where pedestrians may reasonably be exposed. Such areas would most likely be located within major street canyons of large urban areas and near traffic corridors. Stations located in these areas are most likely to have a microscale of representativeness since CO concentrations typically peak nearest roadways and decrease rapidly as the monitor is moved from the roadway. In this example, physical location was determined by consideration of CO emission patterns, pedestrian activity, and physical characteristics affecting pollutant dispersion. Thus, spatial scale of representativeness was not used in the selection process but was a *result* of station location.

In some cases, the physical location of a station is determined from joint consideration of both the basic monitoring objective, and a desired spatial scale of representativeness. For example, to determine CO concentrations which are typical over a reasonably broad geographic area having relatively high CO concentrations, a neighborhood scale station is more appropriate. Such a station would likely be located in a residential or commercial area having a high overall CO emission density but not in the immediate vicinity of any single roadway. Note that in this example, the desired scale of representativeness was an important factor in determining the physical location of the monitoring station.

In either case, classification of the station by its intended objective and spatial scale of representativeness is necessary and will aid in interpretation of the monitoring data.

Table 1 illustrates the relationship between the four basic monitoring objectives and the scales of representativeness that are generally most appropriate for that objective.

TABLE 1.—*Relationship among monitoring objectives and scale of representativeness*

Monitoring objective	Appropriate siting scales
Highest concentration	Micro, middle, neighborhood (sometimes urban)
Population	Neighborhood, urban
Source impact	Micro, middle, neighborhood
General/background	Neighborhood, regional

Subsequent sections of this appendix describe in greater detail the most appropriate scales of representativeness and general monitoring locations for each pollutant.

2. SLAMS NETWORK DESIGN PROCEDURES

The preceding section of this appendix has stressed the importance of defining the objectives for monitoring a particular pollutant. Since monitoring data are collected to "represent" the conditions in a section or subregion of a geographical area, the previous section included a discussion of the scale of representativeness of a monitoring station. The use of this physical basis for locating stations allows for an objective approach to network design.

The discussion of scales in Sections 2.2-2.6 does not include all of the possible scales for each pollutant. The scales which are discussed are those which are felt to be most pertinent for SLAMS network design.

In order to evaluate a monitoring network and to determine the adequacy of particular monitoring stations, it is necessary to examine each pollutant monitoring station individually by stating its monitoring objective and determining its spatial scale of representativeness. This will do more than insure compatibility among stations of the same type. It will also provide a physical basis for the interpretation and application of the data. This will help to prevent mismatches between what the data actually represent and what the data are interpreted to represent. It is important to note that SLAMS are not necessarily sufficient for completely describing air quality. In many situations, diffusion models must be applied to complement ambient monitoring, e.g., determining the impact of point sources or defining boundaries of nonattainment areas.

2.1 *Background Information for Establishing SLAMS*

Background information that must be considered in the process of selecting SLAMS from the existing network and in establishing new SLAMS includes emission inventories, climatological summaries, and local geographical characteristics. Such information is to be used as a basis for the judgmental decisions that are required during the station selection process. For new stations, the background information should be used to decide on the actual location considering the monitoring objective and spatial scale while following the detailed procedures in References 1 through 4.

Emission inventories are generally the most important type of background information needed to design the SLAMS network. The emission data provide valuable information concerning the size and distribution of large point sources. Area source emissions are usually available for counties but should be subdivided into smaller areas or grids where possible, especially if diffusion modeling is to be used as a basis for determining where stations should be located. Sometimes this must be done rather crudely, for example, on the basis of population or housing units. In general, the grids should be smaller in areas of dense population than in less densely populated regions.

Emission inventory information for point sources should be generally available for any area of the country for annual and seasonal averaging times. Specific information characterizing the emissions from large point sources for the shorter averaging times (diurnal variations, load curves, etc.) can often be obtained from the source. Area source emission data by season, although not available from the EPA, can be generated by apportioning annual totals according to degree days.

Detailed area source data are also valuable in evaluating the adequacy of an existing station in terms of whether the station has been located in the desired spatial scale of representativeness. For example, it may be the desire of an agency to have an existing CO station measuring in the neighborhood scale.

By examining the traffic data for the area and examining the physical location of the station with respect to the roadways, a determination can be made as to whether or not the station is indeed measuring the air quality on the desired scale.

The climatological summaries of greatest use are the frequency distributions of wind speed and direction. The wind rose is an easily interpreted graphical presentation of the directional frequencies. Other types of useful climatological data are also available, but generally are not as directly applicable to the site selection process as are the wind statistics.

In many cases, the meteorological data originating from the most appropriate (not necessarily the nearest) national weather service (NWS) airport station in the vicinity of the prospective siting area will adequately reflect conditions over the area of interest, at least for annual and seasonal averaging times. In developing data in complex meteorological and terrain situations, diffusion meteorologists should be consulted. NWS stations can usually provide most of the relevant weather information in support of network design activities anywhere in the country. Such information includes joint frequency distributions of winds and atmospheric stability (stability-wind roses).

The geographical material is used to determine the distribution of natural features, such as forests, rivers, lakes, and manmade features. Useful sources of such information may include road and topographical maps, aerial photographs, and even satellite photographs. This information may include the terrain and land-use setting of the prospective monitor siting area, the proximity of larger water bodies, the distribution of pollutant sources in the area, the location of NWS airport stations from which weather data may be obtained, etc. Land use and topographical characteristics of specific areas of interest can be determined from U.S. Geological Survey (USGS) maps and land use maps. Detailed information on urban physiography (building/street dimensions, etc.) can be obtained by visual observations, aerial photography, and also surveys to supplement the information available from those sources. Such information could be used in determining the location of local pollutant sources in and around the prospective station locations.

2.2 *Total Suspended Particulates (TSP) Design Criteria for SLAMS*

The first step in designing the TSP SLAMS network is to collect the necessary background information as discussed previously. For TSP monitoring purposes, emphasis on background information would be placed on regional and traffic maps and aerial photographs showing topography, settlements, major industries, and highways. These maps and photographs would be used to identify areas of the type that are of concern to the particular monitoring objective. After potentially suitable monitoring areas for TSP have been identified on a map, a model [4] may be used to provide an estimate of TSP concentrations throughout the area of interest.

The second step is to evaluate existing TSP stations which are candidates for SLAMS designation. Stations meeting one or more of the four monitoring objectives shown in Section 1, must be classified into one of four scales of representativeness (middle, neighborhood, urban, and regional) if the stations are to become SLAMS. In siting and classifying TSP stations, the procedures described in reference 1 should be used to evaluate existing stations and must be used to relocate an existing station or to locate any new SLAMS stations.

The following describes in detail the characteristics of each of the four scales relevant to TSP SLAMS.

• *Middle Scale.*—Much of the measurement of short-term public exposure to particulates is on this scale. People moving through downtown areas, or living near major roadways, encounter particulates that would be adequately characterized by observations of this spatial scale. Thus, measurements of this type would be appropriate for the evaluation of possible short-term public health effects of particulate pollution. This scale also includes the characteristic concentrations for other areas with dimensions of a few hundred meters such as the parking lot and feeder streets associated with indirect sources, that is, complexes that do not produce pollutants themselves but which attract a significant number of autos. Shopping centers, stadia, and office buildings are examples of indirect sources. In the case of TSP, unpaved or seldom swept parking lots associated with indirect sources could be an important source in addition to the vehicular emissions themselves.

• *Neighborhood Scale.*—Measurements in this category would represent conditions throughout some reasonably homogeneous urban subregion with dimensions of a few kilometers and generally more regularly shaped than the middle scale. Homogeneity refers to the TSP concentration, as well as the land use and land surface characteristics. In some cases, a location carefully chosen to provide neighborhood scale data would represent not only the immediate neighborhood but also neighborhoods of the same type in other parts of the city. Stations of this kind provide good information about trends and compliance with standards because they often represent conditions in areas where people commonly live and work for periods comparable to those specified in the NAAQS. In the sense used here, this category includes industrial and commercial neighborhoods, as well as residential.

Neighborhood scale data could provide valuable information for developing, testing, and revising models that describe the larger-scale concentration patterns, especially those models relying on spatially smoothed emission fields for inputs. The neighborhood scale measurements could also be used for neighborhood comparisons within or between cities. This is the most likely scale of measurement to meet the needs of planners.

• *Urban Scale.*—This class of measurement would be made to typify the particulate concentration over an entire metropolitan area. Such measurements would be useful for assessing trends in city-wide air quality, and hence, the effectiveness of large scale air pollution control strategies.

• *Regional Scale.*—These measurements would characterize conditions over areas with dimensions of as much as hundreds of kilometers. As noted earlier, using representative conditions for an area implies some degree of homogeneity in that area. For this reason, regional scale measurements would be most applicable to sparsely populated areas with reasonably uniform ground cover. Data characteristics of this scale would provide information about larger-scale processes of particulate emissions, losses, and transport.

2.3 *Sulfur Dioxide (SO_2) Design Criteria for SLAMS*

The spatial scales for SO_2 SLAMS monitoring are the middle, neighborhood, urban, and regional scales. Because of the nature of SO_2 distributions over urban areas, the middle scale is the most likely scale to be represented by a single measurement in an urban area, but only if the undue effects from local sources (minor or major point sources) can be eliminated. Neighborhood scales would be those most likely to be represented by single measurements in suburban areas where the concentration gradients are less steep. Urban scales would represent areas where the concentrations are

[4] See Reference at end of Appendix E.

uniform over a larger geographical area. Regional scale measurements would be associated with rural areas.

• *Middle Scale.*—Some data uses associated with middle scale measurements for SO_2 include assessing the effects of control strategies to reduce urban concentrations (especially for the 3-hour and 24-hour averaging times) and monitoring air pollution episodes.

• *Neighborhood Scale.*—This scale applies in areas where the SO_2 concentration gradient is relatively flat (mainly suburban areas surrounding the urban center) or in large sections of small cities and towns. In general, these areas are quite homogeneous in terms of SO_2 emission rates and population density. Thus, neighborhood scale measurements may be associated with baseline concentrations in areas of projected growth and in studies of population responses to exposure to SO_2. Also concentration maxima associated with air pollution episodes may be uniformly distributed over areas of neighborhood scale, and measurements taken within such an area would represent neighborhood, and to a limited extent, middle scale concentrations.

• *Urban Scale.*—Data from this scale could be used for the assessment of air quality trends and the effect of control strategies on urban scale air quality.

• *Regional Scale.*—These measurements would be applicable to large homogeneous areas, particularly those which are sparsely populated. Such measurements could provide information on background air quality and interregional pollutant transport.

After the spatial scale has been selected to meet the monitoring objectives for each station location, the procedures found in reference 2 should be used to evaluate the adequacy of each existing SO_2 station and must be used to relocate an existing station or to locate any new SLAMS stations. The background material for these procedures should consist of emission inventories, meteorological data, wind roses, and maps for population and topographical characteristics of specific areas of interest. Isopleth maps of SO_2 air quality as generated by diffusion models[3] are useful for the general determination of a prospective area within which the station is eventually placed.

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3. Network Design for National Air Monitoring Stations (NAMS)

The NAMS must be stations selected from the SLAMS network with emphasis given to urban and multisource areas. Areas to be monitored must be selected based on urbanized population and pollutant concentration levels. Generally, a larger number of NAMS are needed in more polluted urban and multisource areas. The network design criteria discussed below reflect these concepts. However, it should be emphasized that deviations from the NAMS network design criteria may be necessary in a few cases. Thus, these design criteria are not a set of rigid rules but rather a guide for achieving a proper distribution of monitoring sites on a national scale.

The primary objective for NAMS is to monitor in the areas where the pollutant concentration and the population exposure are expected to be the highest consistent with the averaging time of the NAAQS. Accordingly, the NAMS fall into two categories:

Category (a): Stations located in the area(s) of expected maximum concentrations (generally neighborhood scale, except micro scale for CO and urban scale for O_3);

Category (b): Stations which combine poor air quality with a high population density but not necessarily located in an area of expected maximum concentrations (neighborhood scale, except urban scale for NO_2). Category (b) monitors would generally be representative of larger spatial scales than category (a) monitors.

For each urban area where NAMS are required, both categories of monitoring stations must be established. In the case of TSP and SO_2 if only one NAMS is needed, then category (a) must be used. The analysis and interpretation of data from NAMS should consider the distinction between these types of stations as appropriate.

The concept of NAMS is designed to provide data for national policy analyses/trends and for reporting to the public on major metropolitan areas. It is not the intent to monitor in every area where the NAAQS are violated. On the other hand, the data from SLAMS should be used primarily for nonattainment decisions/analyses in specific geographical areas. Since the NAMS are stations from the SLAMS network, station locating procedures for NAMS are part of the SLAMS network design process.

3.1 *Total Suspended Particulates (TSP) Design Criteria for NAMS*

Table 2 indicates the approximate number of permanent stations needed in urban areas to characterize national and regional TSP air quality trends and geographical patterns. The criteria require that the number of stations in areas where urban populations exceed 500,000 and concentrations exceed the primary NAAQS range from 6 to 8 but in small urban areas, no more than two stations are required. A range of monitoring stations is specified in Table 2 because sources of pollutants and local control efforts can vary from one part of the country to another and therefore, some flexibility is allowed in selecting the actual number of stations in any one locale. For those cases where more than one station is required for an urban area, there should be at least one station for category (a) and category (b) objectives as discussed in Section 3. Where three or more stations are required, the mix of category (a) and (b) stations is determined on a case-by-case basis. The actual number of NAMS and their locations must be determined by EPA Regional Offices and the State agencies subject to the approval of EPA Headquarters (OANR). The EPA Headquarters approval is necessary to insure that individual stations conform to the NAMS selection criteria and the network as a whole is sufficient in terms of number and location for purposes of national analyses.

TABLE 2.—*TSP National Air Monitoring Station Criteria (Approximate Number of Stations Per Area)*[a]

Population category	High concentration[b]	Medium concentration[c]	Low concentration[d]
High population, >500,000	6–8	4–6	0–2
Medium population, 100,000–500,000	4–6	2–4	0–2
Low population, 50,000–100,000	2–4	1–2	0

[a] Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.

[b] High concentration—exceeding level of the primary NAAQS by 20 percent or more.

[c] Medium concentration—exceeding secondary NAAQS.

[d] Low concentration—less than secondary NAAQS.

The estimated number of TSP NAMS required nationwide will range from approximately 600 to 700. This range of stations is based on a statistical analysis of the data and computations of the probability of detecting certain rates of change over a specific number of years. An assumption was made that the variability of the data was 20 percent, i.e., a 95 percent confidence interval around the annual mean would be 20 percent. This assumption may be regarded as a "ballpark figure." The sampling error from an every sixth-day schedule would be roughly 10 percent so an overall variability of 20 percent may be regarded as a reasonable approximation.

For TSP, it is unlikely that the same rate of change would apply throughout the nation. Regional differences in the TSP problem make it essential that the networks also be useful for regional trend assessments. In most practical applications, trends will be assessed on the basis of 3-5 years of data to minimize the impact of meteorological influences. With 60 to 70 sites in each geographical region, there is a reasonably good chance of detecting 3-year trends of more than 2 percent per year.

Using a TSP trend network of 600-700 stations there would be a reasonable chance of determining 5-year trends of more than 3 percent per year in the medium population cities with high TSP, but less than 50/50 chance of detecting 3-year trends of less than 5 percent per year in any city. Therefore, the overall range of 600-700 TSP NAMS seems to be acceptable for the purposes of national and regional trends. The actual number of monitors in any specific area would depend on local factors such as meteorology, topography, urban and regional air quality gradients, and the potential for significant air quality improvement or degradation. Generally, the greatest density of stations would occur in the northeastern States, where urban populations are large and where pollutant levels are high.

Generally, the worst air quality in an urban area should be used as the basis for determining the required number of TSP NAMS (see Table 2). This includes air quality levels, within populated parts of urbanized areas, that are affected by one or two point sources of particulates if the impact of the source(s) extends over a reasonably broad geographic scale (neighborhood or larger). Maximum air quality levels in remote unpopulated areas should be excluded as a basis for selecting TSP NAMS regardless of the sources affecting the concentration levels. Such remote areas are more appropriately monitored by SLAMS or SPM networks and/or characterized by diffusion model calculations as necessary.

3.2 *Sulfur Dioxide (SO_2) Design Criteria for NAMS*

As with TSP monitoring, it is desirable to have a greater number of NAMS in the more polluted and densely populated urban and multisource areas. The data in Table 3 show the approximate number of permanent stations needed in urban areas to characterize the national and regional SO_2 air quality trends and geographical patterns. These criteria require that the number of NAMS in areas where urban populations exceed 500,000 and concentrations also exceed the primary NAAQS may range from 6 to 8 and that in areas where the SO_2 problem is minor, only one or two (or no) monitors are required. For those cases where more than one station is required for an urban area, there should be at least one station for category (a) and category (b) objectives as discussed in Section 3. Where three or more stations are required, the mix of category (a) and (b) stations is determined on a case-by-case basis. The actual number and location of the NAMS must be determined by EPA Regional Offices and the State agency, subject to the approval of EPA Headquarters (OANR).

TABLE 3—*SO_2 National Air Monitoring Station Criteria (Approximate Number of Stations Per Area)*[a]

Population category	High Concentration[b]	Medium Concentration[c]	Low Concentration[d]
High population, >500,000	6–8	4–6	0–2
Medium population, 100,000–500,000	4–6	2–4	0–2
Low population, 50,000–100,000	2–4	1–2	0

[a] Selection of urban areas and actual number of stations per area will be jointly determined by EPA and the State agency.
[b] High concentration—exceeding level of the primary NAAQS.
[c] Medium concentration—exceeding 60 percent of the level of the primary or 100 percent of the secondary NAAQS.
[d] Low concentration—less than 60 percent of the level of the primary or 100 percent of the secondary NAAQS.

The estimated number of SO_2 NAMS which would be required nationwide ranges from approximately 200 to 300. This range in the number of stations is less than for TSP. This is because there are more urban areas with high TSP levels than with high SO_2 levels. Also, the background air quality levels are higher for TSP than for SO_2, and thus air quality is more sensitive to SO_2 emission changes than for TSP. Therefore, fewer NAMS are needed on a national basis for SO_2 than for TSP. The actual number of stations in any specific area depends on local factors such as meteorology, topography, urban and regional air quality gradients, and the potential for significant air quality improvements or degradation. The greatest density of stations should be where urban populations are large and where pollution levels are high. Fewer NAMS are necessary in the western States since concentrations are seldom above the NAAQS in their urban areas. Exceptions to this are in the areas where an expected shortage of clean fuels indicates that ambient air quality may be degraded by increased SO_2 emissions. In such cases, a minimum number of NAMS is required to provide EPA with a proper national perspective on significant changes in air quality.

Like TSP, the worst air quality in an urban area is to be used as the basis for determining the required number of SO_2 NAMS (see Table 3). This includes SO_2 air quality levels within populated parts of urbanized areas, that are affected by one or two point sources of SO_2 if the impact of the source(s) extends over a reasonably broad geographic scale (neighborhood or larger). Maximum SO_2 air quality levels in remote unpopulated areas should be excluded as a basis for selecting NAMS regardless of the sources affecting the concentration levels. Such remote areas are more appropriately monitored by SLAMS or SPM networks and/or characterized by diffusion model calculations as necessary.

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4. Summary

Table 4 shows by pollutant, all of the spatial scales that are applicable for SLAMS and the required spatial scales for NAMS. There may also be some situations, as discussed later in Appendix E, where additional scales may be allowed for NAMS purposes.

Table 4—Summary of Spatial Scales for SLAMS and Required Scales for NAMS

Spatial scale	Scales applicable for SLAMS					Scales required for NAMS				
	TSP	SO_2	CO	O_3	NO_2	TSP	SO_2	CO	O_3	NO_2
Micro			✓					✓		
Middle	✓	✓	✓	✓	✓					
Neighborhood	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Urban	✓	✓		✓	✓				✓	✓
Regional	✓	✓		✓						

Figure 5-2. Particulate field data.

5. References

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[44 FR 27571, May 10, 1979; 44 FR 72592, Dec. 14, 1979]

APPENDIX E—PROBE SITING CRITERIA FOR AMBIENT AIR QUALITY MONITORING

1. Introduction
2. Total Suspended Particulates (TSP)
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2.2 Spacing from Obstructions
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3. Sulfur Dioxide (SO_2)
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4.1 Horizontal and Vertical Probe Placement
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7. Probe Material and Pollutant Sample Residence Time
8. Waiver Provisions
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1. INTRODUCTION

This appendix contains probe siting criteria to be applied to ambient air quality monitors or monitor probes after the general station location has been selected based on the monitoring objectives and spatial scale of representativeness as discussed in Appendix D of this part. Adherence to these siting criteria is necessary to ensure the uniform collection of compatible and comparable air quality data.

The probe siting criteria as discussed below must be followed to the maximum extent possible. It is recognized that there may be situations when the probe siting criteria cannot be followed. If the siting criteria cannot be met this must be thoroughly documented with a written request for a waiver which describes how and why the siting criteria differs. This documentation should help to avoid later questions about the data. Conditions under which EPA would consider an application for waiver from these siting criteria are discussed in Section 8 of this appendix.

The spatial scales of representativeness used in this appendix, i.e., micro, middle, neighborhood, urban, and regional are defined and discussed in Appendix D of this part. The pollutant specific probe siting criteria generally apply to all spatial scales except where noted otherwise. Specific siting criteria that are prefaced with a "must" are defined as a requirement and exceptions must be approved through the waiver provisions. However, siting criteria that are prefaced with a "should" are defined as a goal to meet for consistency but are not a requirement.

2. TOTAL SUSPENDED PARTICULATES (TSP)

2.1 *Vertical Placement*

The most desirable height for a TSP monitor is near the breathing zone. Practical considerations such as prevention of vandalism, security, accessibility, availability of electricity, etc., require that the sampler be elevated and that a range of acceptable heights be specified. For TSP, the air intake for a TSP monitor must be located 2 to 15 meters above ground level. The lower limit was based on a compromise between ease of servicing the sampler and the desire to avoid reentrainment from dusty surfaces. The upper limit represents a compromise between the desire to have measurements which are most representative of population exposures, and the consideration for the location of existing monitors.

2.2 *Spacing from Obstructions*

If the sampler is located on a roof or other structure, then there must be a minimum of 2 meters separation from walls, parapets, penthouses, etc. No furnace or incineration flues should be nearby. This separation distance from flues is dependent on the height of the flues, type of waste or fuel burned, and quality of the fuel (ash content). For example, if the emissions from the chimney are the result of natural gas combustion, no special precautions are necessary except for the avoidance of obstructions, i.e., at least 2 meters separation.

On the other hand, if fuel oil, coal, or solid waste is burned and the stack is sufficiently short so that the plume could reasonably be expected to impact on the sampler intake a significant part of the time, other buildings/locations in the area that are free from these types of sources should be considered for sampling. Trees provide surfaces for particulate deposition and also restrict airflow. Therefore, the sampler should be placed at least 20 meters from trees.

The sampler must also be located away from obstacles such as buildings, so that the distance between obstacles and the sampler is at least twice the height that the obstacle protrudes above the sampler. Sampling stations that are located closer to obstacles than this criterion allows should not be classified as neighborhood, urban, or regional scale, since the measurements from such a station would closely represent middle scale stations. Therefore, stations not meeting the criterion should be classified as middle scale. There must also be unrestricted airflow in an arc of at least 270° around the sampler, and the predominant wind direction for the season of greatest pollutant concentration potential must be included in the 270° arc.

2.3 *Spacing from Roads*

A number of studies[1-8] support the conclusion that TSP concentrations decrease with increasing height of the monitor and distance from roads. Quite high concentrations have been reported at monitors located at a low elevation close to heavily traveled roads. Moreover, monitors located close to streets are within the concentrated plume of particulate matter emitted and generated by vehicle traffic. Except for special purpose monitoring studies where the monitoring objective is to determine the impact of a single source, ambient monitors should not be located so as to measure the plume of a single source. For TSP, it is appropriate that ambient monitors be located beyond the concentrated particulate plume generated by traffic, and not so close that the roadway totally dominates the measured ambient concentration.

An analysis of various monitoring studies[9] shows that a linear relationship between sampler height and distance from roadways defines a zone where the plume generated by traffic greater than approximately 3,000 vehicles per day is diminished. Figure 1 illustrates this relationship by showing two zones where TSP SLAMS could be located. Zone A represents locations which are recommended for the neighborhood, urban and regional scales and also for most middle scale locations. Zone B represents locations which should be avoided in order to minimize undesirable roadway influences.

Because of the pronounced TSP air quality gradients generally expected near roadways SLAMS which for certain reasons cannot be located in Zone A and are located in Zone B would be classified as having a middle scale of representativeness. NAMS must be located in Zone A, and it is recommended that most SLAMS be located in Zone A.

In light of several street canyon studies cited above, it appears that the street canyon may confine resuspended roadway dust and may not be a suitable location for ambient monitors. However, since roads with lower traffic (less than approximately 3,000 vehicles per day) generally do not generate a concentrated particulate plume, monitors located in Zone B should not be adversely influenced. Therefore, for those cases where the traffic is less than approximately 3,000 vehicles per day, the monitor must be located greater than 5 meters from the edge of the nearest traffic lane and 2 to 15 meters above ground level (either Zone A or Zone B).

In the case of elevated roadways where the monitor must be placed below the level of the roadway, then the monitor should be located no closer than approximately 25 meters from the edge of the nearest traffic lane. This separation distance applies for those situations where the road is elevated greater than 5 meters above the ground level, and applies to all traffic volumes.

2.4 *Other Considerations*

Stations should not be located in an unpaved area unless there is vegetative ground cover year round so that the impact of reentrained or fugitive dusts will be kept to a minimum. Addtional information on TSP probe siting may be found in reference 10.

[1-8]See references at end of this Appendix.

[9]See References at end of this Appendix.

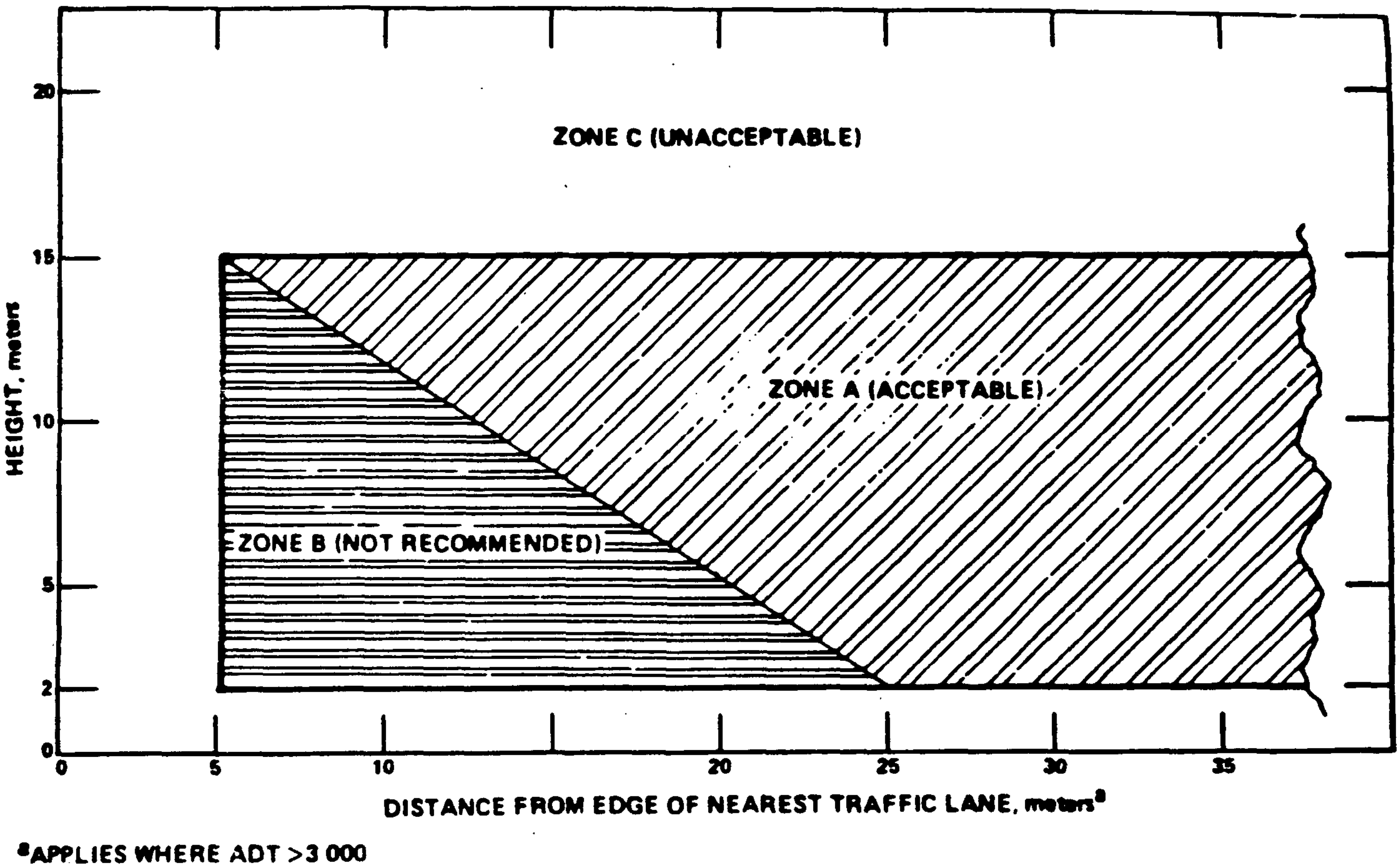

Figure I. Acceptable zone for siting TSP monitors.

3. SULFUR DIOXIDE (SO_2)

3.1 *Horizontal and Vertical Probe Placement*

As with TSP monitoring, the most desirable height for an SO_2 monitor inlet probe is near the breathing height. Various factors enumerated before may require that the inlet probe be elevated. Therefore, the inlet probe must be located 3 to 15 meters above ground level. If the inlet probe is located on the side of a building, then it should be located on the windward side of the building relative to the prevailing winter wind direction. The inlet probe must also be located more than 1 meter vertically or horizontally away from any supporting structure and also away from dirty, dusty areas.

3.2 *Spacing from Obstructions*

No furnace or incineration flues, or other minor sources of SO_2 should be nearby. The separation distance is dependent on the height of the flues, type of waste or fuel burned, and the quality of the fuel (sulfur content). If the inlet probe is located on a roof or other structure, it must be at least 1 meter from walls, parapets, penthouses, etc.

The inlet probe should be placed more than 20 meters from trees and must be located away from obstacles and buildings. The distance between the obstacles and the inlet probe must be at least twice the height that the obstacle protrudes above the inlet probe. Sampling stations that are located closer to obstacles than this criterion allows should not be classified as a neighborhood scale, since the measurements from such a station would closely represent middle scale stations. Therefore, stations not meeting the criterion should be classified as middle scale. Airflow must also be unrestricted in an arc of at least 270° around the inlet probe, and the predominant wind direction for the season of greatest pollutant concentration potential must be included in the 270° arc. If the probe is located on the side of a building, 180° clearance is required. Additional information on SO_2 probe siting criteria may be found in reference 11.

7. Probe Material and Pollutant Sample Residence Time

For the re[illegible]ve gases. SO_2, NO_2, and O_3, special probe [illegible]aterial must be used. Studies [14-18] have been conducted to determine the suitability of materials such as polypropylene, polyethylene, polyvinylchloride, tygon, aluminum, brass, stainless steel, copper, pyrex glass and teflon for use as intake sampling lines. Of the above materials, only pyrex glass and teflon have been found to be acceptable for use as intake sampling lines for all the reactive gaseous pollutants. Furthermore, EPA[19] has specified borosilicate glass or FEP teflon as the only acceptable probe materials for delivering test atmospheres in the determination of reference or equivalent methods. Therefore, borosilicate glass, FEP teflon, or their equivalent must be used for existing and new NAMS or SLAMS.

No matter how nonreactive the sampling probe material is initially, after a period of use reactive particulate matter is deposited on the probe walls. Therefore, the time it takes the gas to transfer from the probe inlet to the sampling device is also critical. Ozone in the presence of NO will show significant losses even in the most inert probe material when the residence time exceeds 20 seconds.[20] Other studies[21-22] indicate that a 10-second or less residence time is easily achievable. Therefore, sampling probes for reactive gas monitors at SLAMS or NAMS must have a sample residence time less than 20 seconds.

[14-18] See References at end of this Appendix.

[19] See References at end of this Appendix.

[20] See References at end of this Appendix.

[21-22] See References at end of this Appendix.

8. Waiver Provisions

It is believed that most sampling probes or monitors can be located so that they meet the requirements of this appendix. New stations with rare exceptions, can be located within the limits of this appendix. However, some existing stations may not meet these requirements and yet still produce useful data for some purposes. EPA will consider a written request from the State Agency to waive one or more siting criteria for some monitoring stations providing that the State can adequately demonstrate the need (purpose) for monitoring or establishing a monitoring station at that location. For establishing a new station, a waiver may be granted only if both of the following criteria are met:

- The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.
- The monitor or probe cannot reasonably be located so as to meet the siting criteria because of *physical constraints* (e.g., inability to locate the required type of station the necessary distance from roadways or obstructions).

However, for an existing station, a waiver may be granted if either of the above criteria are met

Cost benefits, historical trends, and other factors may be used to add support to the above, however, they in themselves, will not be acceptable reasons for granting a waiver. Written requests for waivers must be submitted to the Regional Administrator. For those SLAMS also designated as NAMS, the request will be forwarded to the Administrator.

9. Discussion and Summary

Table 4 presents a summary of the requirements for probe siting criteria with respect to distances and heights. It is apparent from Table 4 that different elevation distances above the ground are shown for the various pollutants. The discussion in the text for each of the pollutants described reasons for elevating the monitor or probe. The differences in the specified range of heights are based on the vertical concentration gradients. For CO, the gradients in the vertical direction are very large for the microscale, so a small range of heights has been specified. For SO_2, NO_2, TSP, and O_3 (except near roadways), the vertical gradients are smaller and thus a larger range of heights can be used. The upper limit of 15 meters was specified for consistency between pollutants and to allow the use of a single manifold for monitoring more than one pollutant.

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Table 4. Summary of probe siting criteria

Pollutant	Scale	Height above ground, meters	Distance from supporting structure, meters: Vertical	Distance from supporting structure, meters: Horizontal[a]	Other spacing criteria
TSP	All	2 - 15	--	> 2	1. Should be >20 meters from trees. 2. Distance from sampler to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the sampler. 3. Must have unrestricted airflow 270° around the sampler. 4. No furnace or incineration flues should be nearby.[c] 5. Must have minimum spacing from roads. This varies with height of monitor and spatial scale (see Figure 1).
SO_2	All	3 - 15	> 1	> 1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. No furnace or incineration flues should be nearby.[c]
CO	Micro	3 ± 1/2	> 1	> 1	1. Must be >10 meters from intersection and should be at a midblock location. 2. Must be 2-10 meters from edge of nearest traffic lane. 3. Must have unrestricted airflow 180° around the inlet probe.
	Middle Neighborhood	3 - 15	> 1	> 1	1. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 2. Spacing from roads varies with traffic (see Table 1).
O_3	All	3 - 15	> 1	> 1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe. 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic (see Table 2).
NO_2	All	3 - 15	> 1	> 1	1. Should be >20 meters from trees. 2. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet probe.[b] 3. Must have unrestricted airflow 270° around the inlet probe, or 180° if probe is on the side of a building. 4. Spacing from roads varies with traffic (see Table 3).

[a] When probe is located on rooftop, this separation distance is in reference to walls, parapets, or penthouses located on the roof.

[b] Sites not meeting this criterion would be classified as middle scale (see text).

[c] Distance is dependent on height of furnace or incineration flue, type of fuel or waste burned, and quality of fuel (sulfur and ash content). This is to avoid undue influences from minor pollutant sources.

Excerpts of Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD) EPA-450/4-80-012

3. *NETWORK DESIGN AND PROBE SITING CRITERIA*

A source subject to PSD should only proceed with designing a PSD monitoring network only after going through the procedure in Appendix A to determine if monitoring data will be required. To fulfill that requirement, a source may use representative air quality data which was discussed in *section 2.4* or monitor This section presents guidance to be used if an applicant decides to monitor in lieu of using representative air quality data.

3.1 *Network Design*

The design of a network for criteria and noncriteria pollutants will be affected by many factors, such as topography, climatology, population, and existing emission sources. Therefore, the ultimate design of a network for PSD purposes must be decided on a case-by-case basis by the permit granting authority. *Section 3.2* discusses the number and location of monitors for a PSD network. Additional guidance on the general siting of the monitors may be found in references 6-9 which discuss highest concentration stations, isolated point sources, effects of topography, etc. Probe siting criteria for the monitors are discussed in *section 3.3*. The guidelines presented here should be followed to the maximum extent practical in developing the final PSD monitoring network.

3.2 *Number and Location of Monitors*

The number and location of monitoring sites will be determined on a case-by-case basis by the source owner or operator and reviewed by the permit granting authority. Consideration should be given to the effects of existing sources, terrain, meteorological conditions, existence of fugitive or reentrained dusts, averaging time for the pollutant, etc. Generally, the number of monitors will be higher where the expected spatial variability of the pollutant in the area(s) of study is higher.

3.2.1 *Preconstruction Phase*

Information obtained in the ambient air quality analysis in Appendix A will be used to assist in determining the number and location of monitors for the preconstruction phase. The air quality levels before construction were determined by modeling or in conjunction with monitoring data. The screening procedure (or more refined model) estimates were determined in Appendix A.

The source should first use the screening procedure or refined model estimates to determine the general location(s) for the maximum air quality concentrations from the proposed source or modification. Secondly, the source should determine by modeling techniques the general location(s) for the maximum air quality levels from existing sources. Thirdly, the modeled pollutant contribution of the proposed source or modification should be analyzed in conjunction with the modeled results for existing sources to determine the maximum impact area. Application of these models must be consistent with EPA's *"Guideline on Air Quality Models"* [34]. This would provide sufficient information for the applicant to place a monitor at (a) the location(s) of the maximum concentration increase expected from the proposed source or modification, (b) the location(s) of the maximum air pollutant concentration from existing sources of emissions, and (c) the location(s) of the maximum impact area, i.e., where the maximum pollutant concentration would hypothetically occur based on the combination effect of existing sources and the proposed new source or modification. In some cases, two or more of these locations may coincide and thereby reduce the number of monitoring stations.

Monitoring should then be conducted in or as close to these areas as possible (also see discussion in *section 3.2.3*). Generally, one to four sites would cover most situations in multisource settings. For remote areas in which the permit granting authority has determined that there are no significant existing sources, a minimum number of monitors would be needed, i.e., one or probably two at the most. For new sources, in these remote areas, as opposed to modifications, some concessions will be made on the locations of these monitors. Since the maximum impact from these new sources would be in remote areas, the monitors may be located, based on convenience or accessibility, near the proposed new source rather than near the maximum impact area since the existing air quality would be essentially the same in both areas. However, the maximum impact area is still the preferred location.

3.2.2 Postconstruction Phase

As discussed above for preconstruction monitoring, appropriate dispersion modeling techniques are used to estimate the location of the air quality impact of the new source or modification. Monitors should then be placed at (a) the expected area of the maximum concentration from the new source or modification, and (b) the maximum impact area(s), i.e., where the maximum pollutant concentration will occur based on the combined effect of existing sources and the new source or modification. It should be noted that locations for these monitors may be different from those sites for the preconstruction phase due to other new sources or modifications in the area since the preconstruction monitoring.

Generally, two to three sites would be sufficient for most situations in multisource areas. In remote areas where there are no significant existing sources, one or two sites would be sufficient. These sites would be placed at the locations indicated from the model results. The same concerns discussed in *section 3.2.1* regarding industrial process fugitive particulate emissions, fugitive hydrocarbon emissions, and ozone monitoring would also be applicable for the postconstruction phase.

3.2.3 *Special Concerns for Location of Monitors*

For the preconstruction and postconstruction phases, modeling is used to determine the general area where monitors would be located. Some of the modeled locations may be within the confines of the source's boundary. However, monitors should be placed in those locations satisfying the definition of ambient air. Ambient air is defined in 40 CFR 50.1(e) as "that portion of the atmosphere, external to buildings, to which the general public has access." Therefore, if the modeled locations are within an area excluded from ambient air, the monitors should be located downwind at the boundary of that area.

In some cases, it is simply not practical to place monitors at the indicated modeled locations. Some examples may include over open bodies of water, on rivers, swamps, cliffs, etc. The source and the permit granting authority should determine on a case-by-case basis alternative locations.

3.3 *Probe Siting Criteria*

The desire for comparability in monitoring data requires adherence to some consistent set of guidelines. Therefore, the probe siting criteria discussed below must be followed to the maximum extent possible to ensure uniform collection of air quality data that are comparable and compatible.

Before proceeding with the discussion of pollutant specific probe siting criteria, it is important to expand on the discussion in *section 3.2* of the location of monitors. In particular, reference is made to two monitoring objectives.

- Case 1: Locating monitors to determine the maximum concentration from the proposed source and/or existing sources.
- Case 2: Locating monitors to determine where the combined impact of the proposed source and existing sources would be expected to exhibit the highest concentrations.

For Case 1, the driving force for locating the siting area of the monitor as well as the specific location of the probe or instrument shelter is the objective of measuring the maximum impact from the proposed source. Two Case 1 examples are given. Consider the first situation in which a proposed source would be emitting pollutants from an elevated stack. Under these circumstances, sufficient mixing generally occurs during the transport of the emissions from the stack to the ground resulting in small vertical gradients near ground level, thus, a wide range of probe heights, 3-15 meters for gases and 2-15 meters for particulates is acceptable. For the same objective (maximum concentration from proposed source), consider the second example in which pollutants would be emitted from a ground level source. In this case, the concentration gradient near the ground can be large, thereby requiring a much tighter range of acceptable probe heights. For ground level sources emitting pollutants with steep vertical concentration gradients, efforts should be made to locate the inlet probe for gaseous pollutant monitors as close to 3 meters (a reasonable practical representation of the breathing zone) as possible and for particulate monitors using the hi-volume sampler 2 to 7 meters above ground level. The rationale for the 3 meters is that for gaseous pollutant measurements, the inlet probe can be adjusted for various heights even though the monitor is located in a building or trailer. Conversely, the 2-3 meter height for the hi-volume sampler placement is not practical in certain areas. The 7 meter height allows for placement on a one story building and is reasonably close to representing the breathing zone.

Turn now to the second monitoring objective, Case 2, which is locating monitors to determine the maximum impact area taking into consideration the proposed source as well as existing sources. The critical element to keep in mind in locating a monitor to satisfy this objective is that the intent is to maximize the combined effect. Thus, in one circumstance, the existing source might contribute the largest impact. The importance of the above discussion to the topic of probe siting criteria is that in attempting to locate a monitor to achieve this objective, the placement of the probe or instrument shelter can vary depending upon which source is the predominant influence on the maximum impact area. As an extreme example, consider the situation where a proposed elevated source would emit CO into an urban area and have maximum combined CO impact coincident to an area adjacent to a heavily traveled traffic corridor. It is known that traffic along corridors emit CO in fairly steep concentration gradients so the placement of the probe to measure the areas of highest CO concentration can vary significantly with probe height as well as distance from the corridor. In this example, the traffic corridor has the major influence on the combined impact and therefore controls the probe placement. As noted in the CO probe siting criteria in *section 3.3.3* as well as Appendix E of the May 10, 1979 Federal Register promulgation of the Ambient Air Monitoring Regulations [10], the required probe height in such microscale cases is given as 3 $\pm$ 1/2 meters while the distance of the probe from the roadway would be between 2 and 10 meters.

As another example, consider the case where the same proposed CO source would emit CO at elevated heights and have a combined maximum CO impact in an urban area that is only slightly affected by CO emissions from a roadway. The combined impact area in this case is far enough away from the two sources to provide adequate mixing and only small vertical concentration gradients at the impact area. In this case, the acceptable probe height would be in the range of 3-15 meters.

It is recognized that there may be other situations occurring which prevent the probe siting criteria from being followed. If so, the differences must be thoroughly documented. This documentation should minimize future questions about the data.

Review Exercise

Now that you've completed the assignment for Section 7, please answer the following questions. These will help you determine whether or not you are mastering the material.

1. Which of the following is(are) a basic monitoring objective(s) of a SLAMS network?
   a. determination of the highest air pollutant concentrations that are expected to occur in the area covered by the network
   b. determination of representative air pollutant concentrations in areas of high population density
   c. determination of the impact on air pollution levels of significant sources or source categories
   d. determination of general background air pollutant concentration levels
   e. all of the above
2. True or False? The number of monitoring stations required for a SLAMS network is specified in Appendix D of 40 CFR 58.

Match each of the following SLAMS monitoring objectives with its appropriate type of monitoring site. (Questions 3-6)

3. determination of the highest air pollutant concentrations that are expected to occur in the area covered by the network
4. determination of representative air pollutant concentrations in areas of high population density
5. determination of the impact on air pollution levels of significant sources or source categories
6. determination of general background air pollutant concentration levels

a. neighborhood and regional
b. neighborhood and urban
c. micro, middle, and neighborhood
d. micro, middle, neighborhood, and urban

7. True or False? The primary monitoring objective of NAMS is to monitor in areas where pollutant concentrations and population exposure are expected to be the highest consistent with the averaging times of the National Ambient Air Quality Standards.

8. Which of the following is(are) a NAMS category(ies)?
   a. monitoring stations located in areas of expected maximum pollutant concentrations
   b. monitoring stations located in areas of combined poor air quality and high population density
   c. both a and b, above
   d. none of the above

9. Which of the following is(are) a primary use(s) of NAMS data?
   a. analyzing national policy and trends
   b. reporting air quality information concerning major metropolitan areas to the public
   c. both a and b, above
   d. none of the above

Match each of the following urban areas with its required number of TSP NAMS. (Questions 10-15)

10. Population: greater than 500,000; TSP concentrations exceeding the TSP primary NAAQS by 20 percent or more	a. 6 to 8
11. Population: 100,000-500,000; TSP concentrations greater than the TSP secondary NAAQS but not exceeding the TSP primary NAAQS by 20 percent or more	b. 0
12. Population: 50,000-100,000; TSP concentrations less than the TSP secondary NAAQS	c. 2 to 4
13. Population: 100,000-500,000; TSP concentrations exceeding the TSP primary NAAQS by 20 percent or more	d. 4 to 6
14. Population: 50,000-100,000; TSP concentrations greater than the TSP secondary NAAQS but not exceeding the TSP primary NAAQS by 20 percent or more	e. 1 to 2
15. Population: greater than 500,000; TSP concentrations less than the TSP secondary NAAQS	f. 0 to 2

Match each of the following urban areas with its required number of SO_2 NAMS. (Questions 16-21)

16. Population: 100,000-500,000; SO_2 concentrations less than 60 percent of the SO_2 primary NAAQS or 100 percent of the SO_2 secondary NAAQS
17. Population: 50,000-100,000; SO_2 concentrations exceeding the SO_2 primary NAAQS
18. Population: 100,000-500,000; SO_2 concentrations exceeding the SO_2 primary NAAQS
19. Population: greater than 500,000; SO_2 concentrations exceeding the SO_2 primary NAAQS
20. Population: 50,000-100,000; SO_2 concentrations less than 60 percent of the SO_2 primary NAAQS or 100 percent of the SO_2 secondary NAAQS
21. Population: 50,000-100,000; SO_2 concentrations exceeding 60 percent of the SO_2 primary NAAQS or 100 percent of the SO_2 secondary NAAQS but not exceeding the SO_2 primary NAAQS

a. 0
b. 1 to 2
c. 2 to 4
d. 4 to 6
e. 0 to 2
f. 6 to 8

22. True or False? Generally, the worst air quality in an urban area should be used as the basis for determining the required number of TSP and SO_2 NAMS for the urban area.

23. TSP and SO_2 NAMS are required to be ___(?)___ scale monitoring stations.
    a. middle
    b. neighborhood
    c. urban
    d. regional

Select the TSP SLAMS/NAMS siting criterion specified in Appendix E of 40 CFR 58 for each of the following parameters. (Questions 24-27)

24. Height range of TSP sampler's air intake above ground level (meters):
    a. 2 to 10
    b. 3 to 10
    c. 2 to 15
    d. 3 to 15

25. Minimum separation distance from walls, parapets, and penthouses for a roof-located TSP sampler (meters):
    a. 1
    b. 2
    c. 4
    d. 10

26. TSP sampler's minimum separation distance from trees (meters):
    a. 2
    b. 5
    c. 10
    d. 20

27. Arc of unrestricted air flow around TSP sampler (degrees):
    a. 90
    b. 180
    c. 270
    d. 360

28. Appendix E of 40 CFR 58 requires that a TSP sampler be located away from obstacles such as buildings, so that the distance between an obstacle and the sampler is at least ___(?)___ times the height that the obstacle protrudes above the sampler.
    a. 2
    b. 4
    c. 5
    d. 10

29. Appendix E of 40 CFR 58 requires that TSP NAMS be located greater than ___(?)___ meter(s) from the edge of the nearest traffic lane of roadways.
    a. 1
    b. 3
    c. 5
    d. 10

30. If a TSP sampler must be placed more than five meters below a roadway, Appendix E of 40 CFR 58 recommends that the sampler be located no closer than approximately ___(?)___ meters from the edge of the nearest traffic lane of the roadway.
    a. 5
    b. 10
    c. 25
    d. 50

31. True or False? Appendix E of 40 CFR 58 recommends that TSP samplers should not be located in an unpaved area unless there is year-around vegetative ground cover.

Select the SO_2 SLAMS/NAMS siting criterion specified in Appendix E of 40 CFR 58 for each of the following parameters. (Questions 32-38)

32. Height range of SO_2 monitor's inlet probe above ground level (meters):
    a. 2 to 10
    b. 3 to 10
    c. 2 to 15
    d. 3 to 15

33. Minimum horizontal separation distance of SO_2 monitor's inlet probe from its supporting structure (meters):
    a. 0.5
    b. 1
    c. 2
    d. 5

34. Minimum vertical separation distance of SO_2 monitor's inlet probe from its supporting structure (meters):
    a. 0.5
    b. 1
    c. 2
    d. 5

35. Minimum separation distance from walls, parapets, and penthouses for a roof-located SO_2 monitor inlet probe (meters):
    a. 0.5
    b. 1
    c. 2
    d. 5

36. SO_2 monitor inlet probe's minimum separation distance from trees (meters):
    a. 2
    b. 5
    c. 10
    d. 20

37. Arc of unrestricted air flow for SO_2 monitor inlet probes which are ***not*** located on sides of buildings (degrees):
    a. 90
    b. 180
    c. 270
    d. 360

38. Arc of unrestricted air flow for SO_2 monitor inlet probes which are located on sides of buildings (degrees):
    a. 45
    b. 90
    c. 135
    d. 180

39. Appendix E of 40 CFR 58 requires that the inlet probe of an SO_2 monitor be located away from obstacles such as buildings, so that the distance between an obstacle and the probe is at least ___(?)___ times the height that the obstacle protrudes above the probe.

a. 2
b. 4
c. 5
d. 10

40. True or False? Appendix E of 40 CFR 58 requires that intake sampling lines for existing and new SO_2 SLAMS/NAMS be constructed of borosilicate glass, FEP teflon, or their equivalent.

41. Appendix E of 40 CFR 58 requires that sampling probes at SO_2 SLAMS/NAMS have a sample residence time of less than ___(?)___ seconds.

a. 5
b. 10
c. 15
d. 20

42. True or False? If the probe siting criteria specified in Appendix E of 40 CFR 58 cannot be met, a written request for a waiver must be submitted to EPA.

43. In establishing a new SLAMS/NAMS, which of the following conditions must be met in order to obtain a waiver from the monitor siting criteria specified in Appendix E of 40 CFR 58?

a. The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.
b. The monitor or probe cannot reasonably be located so as to meet the siting criteria.
c. both a and b, above
d. either a or b, above

44. For an existing monitoring station, which of the following conditions must be met in order to obtain a waiver from the monitor siting criteria specified in Appendix E of 40 CFR 58?

a. The site can be demonstrated to be as representative of the monitoring area as it would be if the siting criteria were being met.
b. The monitor or probe cannot reasonably be located so as to meet the siting criteria.
c. both a and b, above
d. either a or b, above

45. For preconstruction PSD ambient air quality monitoring, monitors should be sited at which of the following locations?
    a. area(s) of the maximum air pollutant concentration increase expected from the proposed source or modification
    b. area(s) of the maximum air pollutant concentration resulting from existing sources of emissions
    c. area(s) where the maximum air pollutant concentration would hypothetically occur based on the combined effect of existing sources and the proposed new source or modification
    d. all of the above

46. For postconstruction PSD ambient air quality monitoring, monitors should be sited at which of the following locations?
    a. expected area of the maximum air pollutant concentration resulting from the new source or modification
    b. area(s) where the maximum pollutant concentration will occur based on the combined effect of existing sources and the new source or modification
    c. area(s) of the maximum air pollutant concentration resulting from existing sources of emissions
    d. all of the above
    e. a and b, above

47. For preconstruction PSD ambient air quality monitoring in a multisource setting, ___(?)___ to ___(?)___ monitoring sites will be sufficient for most situations.
    a. 1, 3
    b. 1, 4
    c. 2, 5
    d. 2, 6

48. For postconstruction PSD ambient air quality monitoring in a multisource setting, ___(?)___ or ___(?)___ monitoring sites will be sufficient for most situations.
    a. 1, 2
    b. 2, 3
    c. 3, 4
    d. 4, 5

49. For preconstruction or postconstruction PSD ambient air quality monitoring in a remote area, ___(?)___ or ___(?)___ monitoring sites will be sufficient for most situations.
    a. 1, 2
    b. 2, 3
    c. 3, 4
    d. 4, 5

50. True or False? Ambient air is defined in 40 CFR 50 as "that portion of the atmosphere, external to buildings, to which the general public has access".

51. True or False? PSD ambient air quality monitors should be placed in locations which satisfy the definition of ambient air.

52. For PSD purposes, when monitoring TSP concentrations resulting from a ground-level source, a TSP sampler's air intake should be located ___(?)___ to ___(?)___ meters above ground level.
    a. 2, 7
    b. 2, 10
    c. 2, 15
    d. 3, 15

53. For PSD purposes, when monitoring SO_2 concentrations resulting from a ground-level source, an SO_2 monitor's inlet probe should be located as close as possible to ___(?)___ meter(s) above ground level.
    a. 1
    b. 3
    c. 10
    d. 15

Review Exercise Answers

	Answer	Page(s) of Section 7 of Guidebook
1.	e	4
2.	False	4
3.	d	4
4.	b	4
5.	c	4
6.	a	4
7.	True	6
8.	c	6
9.	c	6
10.	a	6
11.	c	6
12.	b	6
13.	d	6
14.	e	6
15.	f	6
16.	e	7
17.	c	7
18.	d	7
19.	f	7
20.	a	7
21.	b	7
22.	True	6-7
23.	b	7
24.	c	8
25.	b	8
26.	d	8
27.	c	8
28.	a	8
29.	c	8
30.	c	8
31.	True	8
32.	d	9

	Page(s) of Section 7 of Guidebook
33. b	9
34. b	9
35. b	9
36. d	9
37. c	9
38. d	9
39. a	9
40. True	10
41. d	10
42. True	8
43. c	10
44. d	10
45. d	13
46. e	13
47. b	13
48. b	13
49. a	13
50. True	14
51. True	14
52. a	14
53. b	14

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16. ABSTRACT

This Guidebook was developed for use in the Air Pollution Training Institute's Correspondence Course 436, "Site Selection for the Monitoring of SO_2 and TSP in Ambient Air." It contains reading assignments and review exercises covering the following topics:

- Use of Monitoring Data and Related Monitor Siting Objectives
- Special Considerations Associated with SO_2 and TSP Monitoring
- Procedures and Criteria for Site Selection for SO_2 and TSP Monitors
- Rationale for SO_2 and TSP Monitor Siting Criteria
- Network Design and Probe Siting Criteria for SO_2 and TSP SLAMS, NAMS, and PSD Monitoring Stations

The Guidebook is designed for use in conjunction with "Optimum Site Exposure Criteria for SO_2 Monitoring" (EPA 450/3-77-013) and "Selecting Sites for Monitoring Total Suspended Particulates" (EPA 450/3-77-018).

17. KEY WORDS AND DOCUMENT ANALYSIS

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