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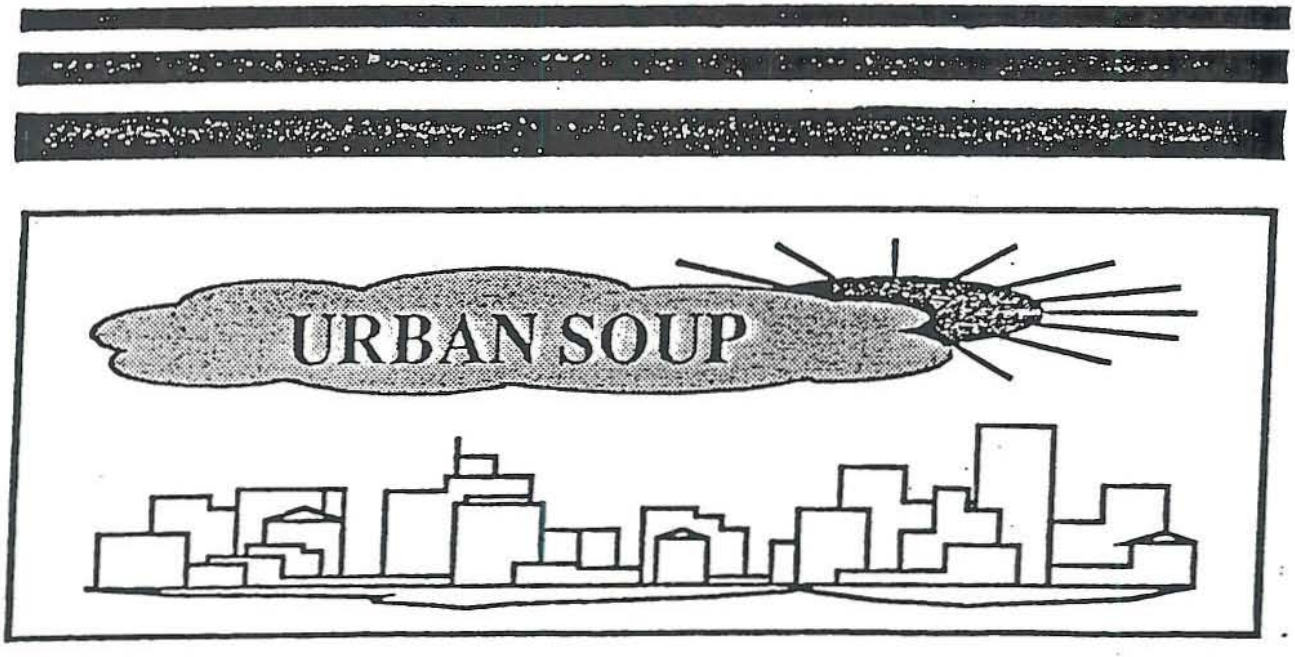
Air

APTI Correspondence Course 404 Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics

Guidebook



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APTI Correspondence Course 404 Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics

Guidebook

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Under Contract No.
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EPA Project Officer
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Notice

This is not an official policy and standards document. The opinions and selections are those of the authors and not necessarily those of the Environmental Protection Agency. Every attempt has been made to represent the present state of the art as well as subject areas still under evaluation. Any mention of products or organizations does not constitute endorsement by the United States Environmental Protection Agency.

Table of Contents

Course Introduction

Overview of Course

Course Description

This training course is a 24-hour correspondence course dealing with methods that have been used in assessing multiple source, multiple pollutant risks from air toxics exposures in urban areas. The course presents synopses of assessment procedures that have been used to quantify urban air toxics exposure and risks, and offers insights into the suitability of these procedures in particular applications. Course topics include:

- use of ambient air monitoring data, emission inventories, and dispersion modeling in urban assessments
- the purposes to which exposure and risk assessments have been put
- the use of simulation in evaluating potential risk reduction of specific control strategies for urban air toxics exposures
- data handling options and selection

Course Goal

The goal of this course is to familiarize you with general assessment tools for exposure and risk from urban air toxics and with specific considerations for selecting the appropriate methods for conducting such assessments.

Course Objectives

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

- understand the purposes for which urban air toxics assessments have been undertaken;
- identify techniques that have been used by others;
- describe the strengths and weaknesses of various methods for estimating exposures (ambient air quality monitoring versus emission inventories/dispersion modeling);
- select appropriate tools, including data handling systems, for specific urban air toxics assessments; and
- understand the appropriate interpretations and applications of the results of exposure and risk assessments and control strategy simulations.

Lesson Titles, Sequence, and Trainee Involvement Time

Lesson Number	Lesson Title	Trainee Involvement time (hours)
1	Ambient Air Quality Monitoring	4
2	Emission Inventories	4
3	Dispersion Modeling	5
4	Exposure and Risk Assessment	5
5	Control Strategy Simulation and Evaluation	3
6	Computerized Data Handling	3

Requirements for Successful Completion of this Course

In order to receive 2.5 Continuing Education Units (CEUs) and a certificate of course completion, you must:

- take two quizzes and a final examination.
- achieve a 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 404"
- EPA 450/2-89-010," Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics: Summary of Approaches and Insights from Completed and Ongoing Urban Air Toxics Assessments Studies."
- pencil or pen
- calculator
- quizzes and exams

Use of this Guidebook

Relationship Between Guidebook and Assigned Reading Materials

This guidebook directs your progress through the reference text "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics."

Description of Guidebook Sections

This guidebook contains six reading assignment sections that correspond to the six 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, two quizzes and a final examination.
- Quiz No. 1 covers the first three sections of the guidebook. Take this quiz after you have completed these three sections and the review questions for each section.
- Quiz No. 2 covers the last three sections of the guidebook. Take this quiz after you have completed the last three sections and the review questions for each section.
- After completing each quiz and the final exam, mail the quiz/exam answer sheet to the following address:

  Air Pollution Training Institute
  Environmental Research Center
  MD-17
  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-17
Research Triangle Park, NC 27711

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

Section 1

Ambient Air Quality Monitoring

Reading Assignment

Pages 23-72 of EPA-450/2-89-010, "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics."

Reading Assignment Topics

- Use of ambient air monitoring data in urban assessments
- Pollutant coverage
- Site selection
- Sampling periods, frequencies, and duration
- Evolving monitoring techniques
- Insights into the use of monitoring in air toxics programs

Learning Goal and Objectives

Learning Goal

To familiarize the reader with decisions involved in developing and implementing an ambient air quality monitoring plan, and, through the examination of example plans, to illustrate the types of trade-offs and compromises involved in these decisions.

Learning Objectives

When you have completed this section, you should be able to:

- understand the usage of ambient air monitoring data in an urban air toxics program
- evaluate the tradeoffs and compromises inherent in design of an effective monitoring plan
- describe the technical issues involved in sample accuracy, site selection, and sample analysis
- understand the objectives for the air toxics monitoring programs
- define terms such as pollutant coverage, spatial coverage, temporal coverage, and sampling period, frequency and duration
- be familiar with some basic sampling and analysis methods
- describe some evolving monitoring technologies
- describe ways to cut costs in monitoring programs

Reading Guidance

- 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(s) 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. Identify as many of the following that are evaluated better by air monitoring than by air pollution dispersion models:

   a. transformation products
   b. pollutants emitted directly
   c. gradual buildup of background level pollutants
   d. pollutant transport from other areas

2. Ambient air monitoring data provide all the following for multi-source, multi-pollutant urban assessment except:

   a. assessment of dispersion model performance
   b. characterization of toxic pollutant exposures and risks
   c. high accuracy measurement and analysis for many substances found at low concentration
   d. evaluation of emission inventory accuracy

3. Ambient air monitoring data can be used in _____.

   a. verifying specific operating permit conditions
   b. mutagenic bioassays
   c. source apportionments
   d. none of the above
   e. all of the above

4. The cost of monitoring programs for toxic air pollutants can be reduced by:

   a. sampling over shorter time periods
   b. sampling over longer time periods

5. Order the following a through d to describe the process by which excess cancer cases are estimated:

   ___ multiply exposure levels by cancer unit risk factor
   ___ estimate population exposure
   ___ superimpose cancer risk over population distribution
   ___ measure ambient air toxics levels

6. True or False? The greater the number of samples analyzed, the more variations in the concentration of pollutant in time and space can be described.

7. Site selection for sampling is influenced by:

   a. gradient of concentrations
   b. laboratory detection limit of pollutants
   c. air quality statistics of concern
   d. a and b above
   e. a, b, and c above

8. Sampling locations with _____ gradients require the most careful site location:

   a. flat
   b. gradual
   c. steep

9. Which two of the following pollutant groups have been emphasized in monitoring programs to date:

   a. aldehydes
   b. volatile organics
   c. semi volatile organics
   d. metals
   e. ketones

10. Which of the following pollutants were covered in <u>all</u> of the nine programs described in this chapter:

   a. asbestos
   b. carbon tetrachloride
   c. benzene
   d. toluene
   e. chloroform
   f. xylene
   g. perchloroethylene

11. Match the type of site selection below to a program purpose:

SITE SELECTION		PROGRAM PURPOSE
a. Site only where concentration gradients of targeted pollutants are steepest.	___	Characterize regional pollutants and variation.
b. Many sites, few specific substances measured.	___	Verify emission inventory and assess maximum individual risk.
c. Few sites, in-depth and broad spectrum analysis.	___	Compare with specific model outputs.

12. Which one of the following is <u>not</u> true of a good sampling station?

   a. sampling line intake should be from 2 to 10 m above the ground
   b. sampling probe should extend at least 2 m from supporting structure
   c. distance between obstruction and the sampler should be at least the height of the obstruction
   d. sampling probe must be mounted on the windward side if located on a building

13. Based on the studies reviewed, rooftop sampling _____ (was/was not) demonstrated to interfere with the collection of representative data.

14. Assign each design factor to its correct definition:

a. sampling period	___	number of hours that compose each sample
b. sampling duration	___	length of time field program is operational
c. sample frequency	___	separation of sample days (every 2nd, every 5th, etc.)

15. A minimum sampling period of one season may be reasonable for which of the following objectives?

    a. to assess model performance
    b. to estimate annual average concentration

16. To show diurnal differences while retaining the ability to compute daily averages, one would choose the following type of sampling duration:

    a. 24-hour samples
    b. 12-hour daytime samples
    c. 12-hour daytime and nighttime sets

17. Place a T for "Tenax®" or a C for "canister" in each of the sets of statements below describing sampling techniques for volatile organics.

    ___ absorbent material
    ___ collects ambient air samples
    ___ lower detection limits
    ___ higher detection limits
    ___ documented unreliability
    ___ greater day-to-day consistency in results

18. "Distributed volume sampling protocol" for use of Tenax® is:

    a. combining gas chromatography and mass spectrometry analysis methods
    b. varying sampling volume by probe location
    c. use of 4 sampling tubes at different flow rates

19. Semivolatile organic pollutants can be sampled by collection on _____.

    a. Tenax® or canister
    b. polyurethane foam or XAD-2
    c. gas chromatograph or mass spectrometer

20. True or False? Metals can be collected using either high volume samplers or fine particulate samplers.

21. Formaldehyde, aldehydes, and ketones were sampled by which of the following methods in some of these studies:

    a. polyurethane foam
    b. 2-4,dinitrophenylhydrazine cartridges
    c. high volume samplers
    d. a and b

23. Match the pollutant to an appropriate sampling method, and to an appropriate analyzation method.

Pollutants

a. volatile organics
b. semivolatile organics
c. metals
d. aldehydes and ketones

Sampling	Analyzation
___ high volume samplers	___ GC/MS
___ Tenax®	___ HPLC
___ 2-4,dinitrophenyl-hydrazine cartridges	___ GC/MS with HPLC
___ polyurethane foam	___ X-ray fluorescence spectroscopy

23. The Total Exposure Assessment Methodology (TEAM) studies collect _____ data on 20 air pollutants.

a. personal and stack
b. stack and ambient
c. ambient and personal
d. personal, ambient, and stack

24. Match the following acronym to its definition. [Hint: All concern evolving monitoring techniques.]

___ IACP
___ TAGA®
___ ROSE®

a. Portable infrared sensor housed in van.

b. Mobile mass spectrometry/mass spectrometry system used to collect near real-time air quality concentrations.

c. Broad program designed to identify species most likely to be carcinogenic and their sources.

25. True or False? Both the TAGA® and the ROSE® systems suffer from having high pollutant detection limits.

26. True or False? Sample compositing has been used successfully for many years for ambient air sampling.

27. Sample compositing involves __?__

a. combining short-term samples (e.g., ≤ 24 hours) after collection
b. collecting long-term, intermittent samples
c. neither a nor b
d. both a and b

28. True or False? In selective analysis, easily measured pollutants that relate to pollutants more difficult to measure are selected for analysis.

29. True or False? Measured air quality data are inherently better than modeled concentrations.

30. Circle any of the following which are true limitations of measured air quality data.

    a. low number of sites and samples
    b. sampling and analytical uncertainties
    c. inability to characterize concentrations at key receptors
    d. high cost to obtain representative data

31. Ideally, for studies that emphasize cancer risks, pollutant concentrations should be estimated over a period of _____.

    a. 24 hours
    b. one season
    c. one year

32. True or False? Among the studies described in this chapter, the sampling networks had a size range of from 1 to 13 sites in an urban area.

33. Which of the following will cause temporal patterns of pollutant concentration to vary if the receptors are dominated by area-sources:

    a. seasonal variability
    b. industrial clusters
    c. diurnal patterns
    d. a and c
    e. a through c above

34. Acute noncancer risks pose substantial challenges in terms of temporal coverage because of their relation to _____.

    a. short-term exposures
    b. long-term exposures
    c. both a and b

Review Exercise Answers

		Page(s) of Urban Air Toxics Manual
1.	a, c, d	24
2.	c	23-25
3.	e	24-25
4.	b	25
5.	c, b, d, a	23-24
6.	True	25-27
7.	e	26-27
8.	c	26
9.	b, d	33
10.	b, c, e, g	34-37
11.	c, a, b	39-47
12.	c	47
13.	was not	47-48
14.	b, a, c	48
15.	a	48-51
16.	c	52
17.	T, C, T, C, T, C	54
18.	c	54
19.	b	58
20.	True	58
21.	b	59
22.	c, a, d, b and a, d, b, c	54-59
23.	c	59
24.	c, b, a	61-62
25.	True	62
26.	False	63
27.	d	63
28.	False	64-65
29.	False	66
30.	a, b, and d	66-67
31.	c	68
32.	True	69
33.	d	70
34.	a	71

Section 2

Emission Inventories

Reading Assignment

Pages 73-94 of EPA-450/2-89-010, "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics."

Reading Assignment Topics

- Use of emission inventories in multi-pollutant, multi-source urban air toxics assessments
- Pollutant coverage
- Source coverage
- Estimating emissions
- Spatial and temporal resolution
- Quality assurance
- Insights into compiling inventories for urban air toxics assessments

Learning Goal and Objectives

Learning Goal

To teach the reader the uses of emission inventories in urban air toxics assessments, define and describe the components of inventories, and consider some insights into building inventories.

Learning Objectives

When you have completed this section, you should be able to:

- understand the usage of emission inventories in multi-pollutant, multi-source urban air toxics assessments;
- identify pollutants and sources covered by urban air toxics assessments;
- identify several approaches for estimating emissions of air toxics;
- understand basic aspects associated with incorporating point and area sources into an emissions inventory; and
- identify methods for assessing the quality of an emissions inventory.

Reading Guidance

- 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), 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. Emission inventory data are used as input to air dispersion models for estimating _____ across an urban area.

   a. concentrations
   b. exposures
   c. risks
   d. all of the above
   e. a and b only

2. The chapter lists the following 20 compounds that account for the vast majority of aggregate cancer incidence in most of the studies reviewed. Of these, which five contributed most to aggregate incidence? _____

   a. Arsenic
   b. Benzene
   c. BaP
   d. Beryllium
   e. 1,3-butadiene
   f. Cadmium
   g. Carbon tetrachloride
   h. Chloroform
   i. Chromium (total or $^{+}6$)
   j. Ethylene dibromide
   k. Ethylene dichloride
   l. Gasoline vapors
   m. Ethylene oxide
   n. Formaldehyde
   o. Methylene chloride
   p. Perchloroethylene
   q. POM
   r. Trichloroethylene
   s. Vinyl chloride

3. POM is the acronym for _____.

4. The problematic form of chromium from a cancer risk stand point is _____.

5. True or false? POM is sometimes called products of incomplete combustion.

6. One approach to inventory emissions of POM was to use emissions of the surrogate compound _____ as representative.

7. When using the "comparative potency factor approach" method to estimate risk from POM, _____ can be inventoried as representative of POM emissions.

   a. total particulate emissions
   b. the solvent extractable fraction of total particulate
   c. both a and b
   d. neither a nor b

8. True or False? There is a general consensus among study managers that the comparative potency factor approach, rather than the BaP surrogate approach, is most suitable for estimating cancer risk from POM.

9. To model both ambient Cr^{+6} and total chromium levels, one must:

   a. measure the ambient level of each
   b. assume all chromium is Cr^{+6}
   c. distinguish between Cr^{+6} and total chromium directly in the inventory
   d. a or c

10. True or false? Cr^{+6} can not be directly measured at typical ambient levels.

11. Which of the following forms of beryllium is <u>not</u> considered to be the one of the more carcinogenic forms.

   a. ore
   b. oxide
   c. fluoride
   d. phosphate
   e. sulfate

12. True or false? The various studies done so far seem to show that risks are reasonably estimated if one assumes that all beryllium and nickel emissions are as carcinogenic as the most potent compounds containing these elements.

13. The studies discussed in this section used _____ to estimate exposure to secondarily formed formaldehyde.

   a. emission inventories of precursors
   b. ambient air monitoring data

14. True or false? No validated models exist yet for predicting transformation products from precursor inventory data.

15. Which of the following types of sources are included in any comprehensive emission inventory?

   a. industrial point
   b. TSDFs
   c. area
   d. mobile
   e. a, c, d
   f. a through d above

16. Which of the following was <u>not</u> used in the studies reviewed to estimate toxic emissions from existing data bases?

   a. conduct source specific surveys for the toxic pollutants
   b. use the species factor method
   c. apply an air toxics emission factor to the existing throughput or activity level

17. True or False? The species factor method of toxic emissions estimation involves applying species factors to existing toxic survey data.

18. _____ is a measure of how finely emissions data are subdivided in space.

19. True or False? A measure of how finely emissions data are subdivided in time is called temporal resolution.

20. The resolution of any risk estimates can exceed the resolution of input data _____.

    a. none
    b. by no more than a factor of 2
    c. by no more than a factor of 10

21. Typically, point sourbe locations are known to the nearest _____ km for areawide cancer assessments.

    a. 0.01
    b. 0.1
    c. 1.0
    d. 10.0

22. Configuration of the emissions release point is especially important: (Circle as many as apply)

    a. within small tightly contained facilities
    b. within large sprawling facilities
    c. where release points are under GEP stack height
    d. where different types of release points exist
    e. when evaluating maximum individual exposures and risks

23. Which of the following were identified as a surrogate indicator for area source allocation?

    a. population
    b. vehicle miles traveled
    c. employment within certain SICs
    d. land use data
    e. all of the above
    f. a through c only

24. True or False? The simplest approach to apportion all area source emissions is by population.

25. True or False? When assessing long-term pollutant exposure, diurnal and seasonal emissions variations are critical.

26. Meteorological dispersion conditions during the night are generally _____ those during the day.

    a. poorer than
    b. the same as
    c. better than

27. Quality assurance of inventories can be provided by which of the following:

    a. emission inventory review
    b. data verification
    c. monitoring vs. modeling comparisons
    d. all of the above
    e. a and b only

28. Emission inventory review should be conducted _____ to help ensure the best possible inventory procedures and data are being used.

    a. during the planning stages
    b. at the end of the data collection effort
    c. when the results were compiled
    d. all of the above
    e. a and b only

29. True or False? Defining the study area as large as possible may help to account for local background levels of pollutants that are not secondarily formed or due to gradual buildup.

30. Aggregate cancer risk due to exposure to primary formaldehyde emissions is probably _____ from secondary formaldehyde.

    a. less than
    b. about the same as
    c. greater than

31. Point source characterization is likely to be _____ for areawide aggregate cancer incidence estimates than for maximum individual risks.

    a. less complex
    b. about the same in complexity
    c. more complex

32. True or False? The use of several socioeconomic or land use parameters as surrogates for allocating area source emissions is to be preferred to the use of a single indicator, such as population.

33. True or False? EPA's Human Exposure Model internally allocates emissions to the subcounty level.

34. True or False? Temporal resolution of hourly variability is probably more useful for studies that focus on cancer than for studies that focus on noncancer effects.

Review Exercise Answers

		Page(s) of Urban Air Toxics Manual
1.	d	74
2.	b, e, i, n, and q	79
3.	polycyclic organic matter	79
4.	Cr^{+6} or hexavalent chromium	79
5.	True	80
6.	benzo(a)pyrene or BaP	80
7.	c	80
8.	False	80
9.	c	81
10.	True	81
11.	b	81
12.	False	81
13.	b	82
14.	True	82
15.	e	82
16.	a	83-84
17.	False	84
18.	Spatial resolution	86
19.	True	86
20.	a	86
21.	b	87
22.	b,d,e	87-92
23.	e	88-89
24.	True	88
25.	False	89
26.	a	89
27.	d	90-91
28.	d	90
29.	True	91-92
30.	a	92
31.	a	92
32.	True	92
33.	True	92
34.	False	93

Section 3

Dispersion Modeling

Reading Assignment

Pages 95-145 of EPA-450/2-89-010, "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics".

Reading Assignment Topics

- Use of models for estimating exposure in multi-pollutant, multi-source urban assessments.
- Decisions affecting modeling protocols
- Model Selection
- Release specifications
- Selection of receptor network
- Meteorological data
- Decay, transformation, deposition
- Model execution
- Model performance evaluation
- Insights

Learning Goal and Objectives

Learning Goal

To grasp that a model's performance for a specific use depends upon the accuracy of emissions data, the representativeness of meteorological data, and how well the application matches the source and terrain types for which the model was originally developed.

Learning Objectives

When you have completed this section, you should be able to:

- understand that dispersion modeling is a powerful tool as applied to air toxics studies;
- recognize the limitations on modeled results as a function of available input data, as well as the compatibility of the model to the particular application;
- identify the strengths and weaknesses of modeled results vs. those obtained by ambient monitoring; and

- recognize that there are a wide variety of dispersion models available (some of which are not EPA-approved) specific to some of the following factors: short-term vs. long-term analysis, complex vs. simple terrain, urban vs. rural areas, and point vs. area sources;

Reading Guidance

- Many of the dispersion models discussed are identified and discussed in the EPA document, "Guideline on Air Quality Models (Revised)" EPA-450/2-78-027R, OAQPS, Durham, NC, 1986.
- UNAMAP is an acronym for User's Network for Applied Modeling of Air Pollution. This is a collection of FORTRAN source codes for air quality models. The most recent version of UNAMAP (Version 6, dated July 1986) contains 23 models and associated processors.
- The term formulation refers to a dispersion model run with specific input data and control settings. A dispersion model can be run with multiple formulations.
- 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. Dispersion modeling is a powerful tool as applied to toxic air pollutant studies. Modeling may be used to:

   a. estimate ambient concentrations of pollutants
   b. assist in the planning of monitoring programs
   c. verify emission inventories when used in conjunction with monitoring data
   d. all of the above
   e. a and c only

2. True or False? Gaussian models currently in use for toxic pollutant analysis were originally developed for criteria pollutants, and therefore had to be extensively revised for air toxics analysis.

3. How well a model performs for a specific use depends upon which of the following:

   a. the accuracy of emissions data
   b. the emission source release specifications
   c. the representativeness of meteorological data
   d. how well the application matches the source and terrain types for which the model was originally developed
   e. all of the above
   f. only a, b, and d

For the following questions (4-7), indicate by inserting the appropriate letter whether either a modeling analysis (A) or a monitoring analysis (B) is more appropriately described.

4. _____ Generally requires a smaller amount of resources to conduct a comprehensive ambient air quality assessment.

5. _____ Provides extensive spatial and temporal resolution of estimated concentrations.

6. _____ Can isolate the effect of any single source or evaluate the impact of any aggregate of sources.

7. _____ Cannot analyze hypothetical situations, such as the imposition of a range of control scenarios.

8. True or False? Long-term modeling is typically conducted in air toxics risk assessments due to the emphasis on chronic health effects. However, short-term modeling is also employed to aid in model performance evaluation.

9. True or False? A combination of models was employed in the studies of interest because none of the current models in the EPA Guideline on Air Quality Models provide adequate treatment of complex industrial sources and urban-scale area sources.

10. True or False? SHOUT is a version of HEM/SHEAR as developed by the South Coast Study.

In questions 11-15, match each of the following dispersion models with the characteristic most representative of each.

11. HEM/SHEAR ___
12. GAMS ___
13. ISCLT ___
14. CDM ___
15. SHORTZ ___

a. second level screening model for estimating short-term averages in urban areas with complex terrain

b. provides flexibility for evaluating complex industrial sources

c. exposure modeling system that internally includes national population data

d. its greatest strength for modeling urban soup is its detailed area source treatment

e. similar operation to HEM, although the approaches differ for close-in receptors

16. True or False? Exposure modeling without consideration of terrain rise (e.g., complex terrain) can lead to large model inaccuracies for source categories that release from high stacks. A bias to overestimate impacts for tall stacks can occur on this basis for areas with moderate to high terrain.

17. The following meteorological parameters are required for optimal use of the dispersion models used in these studies:

    a. wind speed/wind direction
    b. polar coordinates
    c. atmospheric stability
    d. ambient temperature
    e. all of the above
    f. a, b, and d
    g. a, c, and d

18. Atmospheric stability is a term used within a dispersion model to indicate the rate of horizontal and vertical pollutant mixing within a plume. _____ conditions produce vigorous mixing, _____ conditions indicate moderate mixing, and _____ conditions result in very limited mixing.

    a. Neutral / stable / unstable
    b. Unstable / neutral / stable
    c. Stable / neutral / unstable

19. True or False? The incorporation of diurnal or seasonal differences in meteorological conditions can be important when modeling industrial facilities or area source categories that have distinct diurnal or seasonal patterns in emission rates.

20. True or False? The models used in all of these studies contain simplified treatments for decay, deposition, and transformation. These factors have been significant issues in most studies of urban air toxics.

21. True or False? Model performance evaluations are only an option for studies that have an adequate measured data set against which to compare the modeled values.

22. True or False? It is a common misconception of reviewers of studies that have undertaken model performance testing that measured data are used to calibrate model output to reduce bias, thereby showing a better match with observed results.

In questions 23 through 31, a characteristic or effect of dispersion modeling is presented. For each of these, insert the letter of the type of model input data (meteorological, source, or receptor) which most closely matches.

a. Meteorological data
b. Source data
c. Receptor data

23. Direction and speed of pollutant transport ____

24. Emission release temperature and velocity ____

25. Horizontal and vertical dispersion ____

26. Grid-based vs. polar coordinates ____

27. Complex terrain considerations ____

28. Release height ____

29. Vertical extent of turbulent mixing ____

30. Location of maximum exposures ____

31. Types of pollutants ____

Review Exercise Answers

		Page(s) of Urban Air Toxics Manual
1.	d	96
2.	False	96
3.	e	96
4.	A	97
5.	A	97
6.	A	97
7.	B	97
8.	True	102
9.	True	103
10.	False	104
11.	c	103
12.	e	105
13.	b	105
14.	d	106
15.	a	106
16.	False	118
17.	g	119
18.	b	121
19.	True	122
20.	False	124
21.	True	127
22.	True	129
23.	a	97
24.	b	100
25.	a	97
26.	c	111
27.	c	111
28.	b	100
29.	a	97
30.	c	102
31.	b	100

Section 4

Exposure and Risk Assessment

Reading Assignment

Pages 146-171 of EPA 450/2-89-010, "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics."

Reading Assignment Topics

- Use of and issues associated with exposure and risk assessments in air toxic studies
- Comparison of approaches to exposure and risk interpretation and assessment
- Insights into the use of exposure and risk assessment in air toxic studies

Learning Goal and Objectives

Learning Goal

To familiarize you with the role of and methodologies used in exposure and risk estimation in urban air toxics assessment.

Learning Objective

When you have completed this section, you should be able to:

- identify the various ways risks have been estimated, reported, and compared
- identify assumptions and uncertainties associated with exposure and risk estimates

Reading Guidance

- 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), 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.

1. Estimating exposures and risks from air toxics is a _____ issue that has been addressed in a _____ manner.

   a. simple/highly simplified
   b. simple/highly sophisticated
   c. complex/highly simplified
   d. complex/highly sophisticated

2. True or False? Field-oriented studies concerned with ambient outdoor air concentrations of air toxics typically include exposure contributions from residential, commercial, occupational, and transportation-related microenvironments.

3. The Total Exposure Assessment Methodology is investigating more _____, while the Integrated Cancer Project is investigating _____.

   a. comprehensive exposures/individual microenvironments.
   b. individual microenvironments/comprehensive exposures.

4. Most studies calculated areawide cancer incidence using the same basic formula. This formula was:

   a. Σ (Ambient Concentration x Number of People Exposed to Ambient Concentration + Cancer Unit Risk Factor)

   b. Σ (Ambient Concentration x Cancer Unit Risk Factor + Number of People Exposed to Ambient Concentration)

   c. Σ (Ambient Concentration x Number of People Exposed to Ambient Concentration x Cancer Unit Risk Factor)

   d. Σ (Ambient Concentration x Cancer Unit Risk Factor x Square miles of Geographic area of Study x Number of People Exposed to Ambient Concentration)

5. In the equation in Question 4 above, the areawide cancer incidence is computed by summing over each _____ and each _____.

   a. subarea/pollutant
   b. pollutant/source category
   c. subarea/source category

6. True or False? Most of the studies used cancer unit risk factors developed by EPA's Cancer Assessment Group?

7. The health hazards index is an indicator of concern associated with _____ effects.

   a. cancer
   b. noncancer
   c. cancer and noncancer

8. If the health hazard index exceeds 1, the concern is _____ if the no-effect threshold were exceeded by the same amount by an individual pollutant.

   a. less than
   b. the same as
   c. greater than

9. Most studies emphasized estimating _____ and only a subset emphasized estimating _____.

   a. areawide annual population exposures/maximum exposed individuals
   b. maximum exposed individuals/areawide annual population exposures

10. Pollutant ranking involves the ranking of the relative importance of pollutants in terms of:

    a. the number of sources emitting each pollutant
    b. the contribution of each pollutant to ambient concentrations
    c. the contribution of each pollutant to potential risk
    d. all of the above

11. Source categories can be _____, such as _____ vs _____ and _____ vs _____.

    a. broad, mobile/stationary, industrial/non-industrial
    b. narrow, industrial/non-industrial, commercial/residential
    c. broad, area/point, mobile/stationary
    d. narrow, mobile/stationary, industrial/non-industrial

12. Culpability analysis applies to:

    a. individual pollutants or groups of pollutants
    b. particular sources or source groups
    c. a and b

13. Examining of the ratio of MEI to average values is an example of:

    a. ranking the relative importance of pollutants
    b. ranking the relative importance of sources or source categories
    c. culpability analysis of sources or source categories
    d. evaluating variations in exposures and risks

14. The total number of cancer cases _____ (is/is not) dependent on the size of the exposed population and the average probabilistic risk _____ (is/is not) dependent on the size of the exposed population.

For questions 15 through 20, which of the following methodological issues are associated with exposure assessments and which with risk assessments? (Circle your answer)

15.	Selection of study boundaries	Exposure	Risk
16.	Additivity assumptions	Exposure	Risk
17.	Location of monitoring sites	Exposure	Risk
18.	Development of dose-response data	Exposure	Risk
19.	Assumption of constant exposures for 70 years	Exposure	Risk
20.	Population mobility	Exposure	Risk

21. The HEM uses a (polar coordinate/rectangular grid) system to link population and exposure data.

22. SHED is considered (less accurate than, about the same as, more accurate than) SHEAR for estimating maximum lifetime risks, but (less accurate, not significantly more accurate) than SHEAR for estimating aggregate incidence.

23. True or False? Based on empirical evidence, air pollutant concentration in the center of a city are about the same as at the outskirts of the city because of regional mixing.

For questions 24 through 27, which of the following statements concerning the modified NEM are true and which are false?

24.	Photochemical reactions are taken into account.	T	F
25.	Predicted exposure levels are those resulting from direct exhaust emissions.	T	F
26.	Assumes pollutant of interest has emission formulation and dispersion characteristics similar to CO.	T	F
27.	Uses an activity pattern model to simulate day-to-day activities.	T	F

28. Two examples of microenvironments are:

    a. indoors, automobiles
    b. automobiles, parks
    c. parks, office
    d. gas station, indoors

For questions 29 through 32, True or False? The unit risk factor ...

29.	represents the probability of contacting cancer	T	F
30.	from constant inhalation and ingestion	T	F
31.	over a nominal lifetime of 65 years	T	F
32.	of 1 $\mu g/m^3$.	T	F

33. For most studies of carcinogenicity at the low levels encountered in ambient air, the shape of the dose-response function is assumed to be:

    a. linear
    b. log-normal
    c. normal
    d. varies with the pollutant

34. The following formula is used to derive potency estimates for _____ .

$$\text{Estimated Human Risk}_{\text{Untested Mixture}} = \text{Known Human Risk}_{\text{Tested Carcinogen}} \times \frac{\text{Bioassay Potency}_{\text{Untested Mixture}}}{\text{Bioassay Potency}_{\text{Tested Carcinogen}}}$$

    a. CAG does-response relationships
    b. Structure-activity method
    c. comparative risk method

35. One advantage of the (comparative risk method, Structure-Activity Method) is that it directly evaluates complex organic mixtures, potentially taking into account synergistic or antagonistic effects.

36. True or False? Even for dissimilar endpoints, the assumption of additivity is appropriate for noncancer health effects.

37. True or False? Data are available to determine the relationship between health effect and the length of time the threshold is exceeded for many pollutants.

38. True or False? Threshold levels for the same pollutant may vary among individuals or across population groups.

39. True or False? Most studies of noncancer health effects disregard the dose-response curve, focusing only on whether the threshold value is exceeded.

40. True or False? Because health data on noncarcinogens are limited, EPA has endorsed the use of industrial exposure standards for use in ambient air toxic risk assessments.

41. True or False? The accuracy of potencies has been an important general issue in ranking the relative significance of pollutants.

42. One problem facing the ranking of individual pollutants is speciation. The problem of speciation in this regard deals with:

    a. estimating the quantity of individual components of total emissions of a compound.
    b. assigning potency factors to each individual component of total emissions of a compound.
    c. determining the relative contribution of sources to the total emissions of a compound.

43. True or False? Modeled exposures tend to be consistently (higher/lower) than monitoring concentrations of the same pollutant because of (uncertain estimates of emission factor, inability to model background concentrations).

Review Exercise Answers

		Page(s) of Urban Air Toxics Manual
1.	c	146
2.	False	146
3.	a	146
4.	c	147
5.	a	147
6.	True	147
7.	b	148
8.	b	148
9.	a	148
10.	e	148
11.	c	149
12.	b	149
13.	d	149
14.	is, is not	149
15.	exposure	149
16.	risk	156
17.	exposure	150
18.	risk	155
19.	risk	156
20.	exposure	152
21.	polar coordinate	150
22.	more accurate, not significantly more accurate	151
23.	False	152
24.	False	153
25.	True	153
26.	True	153
27.	True	152
28.	a	154
29.	True	155
30.	False	155
31.	False	155
32.	True	155
33.	a	156
34.	c	157
35.	comparative risk method	158
36.	False	158
37.	False	158, 159
38.	True	159
39.	True	159
40.	False	159
41.	True	162
42.	b	162
43.	higher, inability to model background concentrations	163

Section 5

Control Strategy Simulation and Evaluation

Reading Assignment

Pages 179-190 of EPA-450/2-89-010, "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics."

Reading Assignment Topics

- Use of control strategy and evaluation in urban air toxics assessments
- Comprehensive vs. site-specific strategy simulation
- Control strategy simulation procedures in the 5 City Controllability Study
- Insights on control strategy simulation and evaluation

Learning Goal and Objectives

Learning Goal

To recognize that the potential risk reductions achievable through alternative control measures is the principal objective of the methodologies and studies reviewed.

Learning Objectives

When you have completed this section you should be able to:

- recognize that the concept of co-control is an important consideration in air toxic control strategy evaluation;
- recognize that control strategy analyses are conducted on comprehensive and site-specific scales;
- identify the differences between comprehensive and site-specific control strategy analyses;
- know how the regulatory impact model (RIM) assists in control strategy simulation and evaluation;
- realize that the basis of derived cost-effectiveness values is as important as the values themselves; and
- recognize that incidence reduction can be based on both areawide incidence and risk to the most exposed individual (MEI).

Reading Guidance

- The reading assignment discusses the concept of risk assessment vs. risk management. Risk assessment is the use of the factual base to define the health effects of exposure of individuals or populations to hazardous materials. Risk management is the process of weighing policy alternatives and selecting the most appropriate regulatory action, integrating the results of risk assessment with engineering data and with social, economic and political concerns to reach a decision.
- "Co-control" potential is discussed as an important factor in control strategy evaluation. In this context, co-control is defined as the extent to which controls designed for ozone, PM_{10} or other criteria pollutants also control air toxics.
- The acronym IEMP refers to the "Integrated Environmental Management Program". Within target cities (such as Philadelphia, Baltimore, and Santa Clara), specific sites were chosen for the IEMP analyses.
- 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 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. _____ are suitable for control analyses, because emissions can reasonably be projected into the future, both as a function of anticipated growth in an area and as a function of alternative control measures that may be applied.

   a. Ambient air monitoring studies
   b. Dispersion modeling studies

2. Once the control analysis is completed, ____ can use the information to prioritize various alternative measures, based upon risk reduction.

   a. risk managers
   b. risk assessors

3. True or False? The concept of co-control is an important consideration in control strategy evaluation because measures designed for air toxics control may help "sell" certain criteria pollutant control measures that may otherwise have marginal acceptability on their own merits.

4. What are the two types of control strategy analyses employed in the studies reviewed?

   a. co-control and separate control
   b. comprehensive and site-specific
   c. maximum exposed individual and aggregate

5. A ___ analysis was employed in the 5 City Controllability Study and a __ analysis was used in the IEMP evaluations.

   a. co-control/separate control
   b. comprehensive/site-specific
   c. maximum exposed individual/aggregate

6. True or False? In both types of control strategy analyses employed, emissions projections are made corresponding to the control scenarios simulated.

7. Fundamental differences between the two types of control strategy analyses include the following:

   a. the extent of source coverage
   b. the consideration of multiple vs. single control strategies
   c. the number of individuals living within the area of concern
   d. the incorporation of growth and plant retirement into future projections of emissions and risk
   e. all of the above
   f. a, b, and c
   g. a, b, and d

8. In the 5 City Controllability Study, a period of __ years was considered long enough that new source growth and old source retirement could be factored into the analysis.

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

9. True or False? When future projections were made in the 5 City Controllability Study, control efficiencies applied to existing sources vs. new growth and replacement growth sources were considered to be the same.

10. True or False? The regulatory impact model (RIM) is used to project emissions from a base year inventory by incorporating different combinations of control measures.

11. True or False? In this analysis, RIM calculates PM and VOC reductions and assumes that particulate toxics and toxic VOC are controlled the same extent.

12. Because the 5 City Controllability Study was a broad national scoping study, several important assumptions were made. Which of the following assumptions was <u>not</u> important?

    a. The baseline emissions and control efficiency are assumed to be accurate.
    b. Control levels of toxics organics and toxic PM are assumed proportional to control levels of VOC and PM, respectively.
    c. Assumed that EPA would focus control of toxic air emissions on Section 112 of the Clean Air Act.
    d. Control measures are assumed to be applicable to the targeted sources, without regard for technical feasibility on a case-by-case basis.

Match each of the following point and area source categories with its most likely control option. (Questions 13-17).

13. Degreasing _____	a. Leak detection and repair program
14. Refinery _____	b. Inspection and maintenance, carbon adsorption
15. Gasoline Marketing _____	c. Cover during the idle time
16. Dry Cleaning _____	d. Secondary seals
17. Storage Tanks _____	e. Stage II controls

18. True or False? Cost-effectiveness is measured in terms of control strategy cost per reduced cancer case. Generally, the reductions in the incidence rate are calculated from average risk values (i.e., the number of excess cancer cases divided by the overall study population).

19. True or False? Taken together, risks to the most exposed individual (MEI), as well as areawide cancer incidence, offer qualitative insight into the merits of various controls. The determination of cost-effective controls based on both approaches usually results in similar conclusions.

20. True or False? Generally, the studies reviewed focused on areawide cancer incidence reductions. While MEI reductions can also readily be projected, they are more difficult to evaluate from a cost-effectiveness standpoint.

Review Exercise Answers

		Page(s) of Urban Air Toxics Manual
1.	b	173
2.	a	174
3.	True	174
4.	b	174
5.	b	174-175
6.	True	175
7.	g	175
8.	c	175-176
9.	False	176
10.	True	176
11.	True	178
12.	c	179
13.	c	181
14.	a	181
15.	e	182
16.	b	182
17.	d	181-182
18.	True	185-186
19.	False	186
20.	True	188-190

Section 6

Computerized Data Handling

Reading Assignment

Pages 191-209 of EPA 450/2-89-010, "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics."

Reading Assignment Topics

- Identification of considerations in using computerized data handling systems
- Identification of available computerized data handling systems
- Insights on computerized data handling

Learning Goal and Objectives

Learning Goal

To familiarize you with the availability, capabilities, and considerations of computerized data handling systems in urban air toxics assessment.

Learning Objectives

When you have completed this section, you should be able to:

- describe the basic considerations in selecting a data handling system
- identify various data handling systems available
- identify various cost saving techniques

Reading Guidance

- When you have finished the reading assignment, complete the review exercise for Section 6. It begins on page 6-3.
- 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 direction listed in the Course Introduction section of this guidebook.
- Your course grade results will be mailed to you.

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. True or false? The development of exposure and risk estimates in multi-source, multi-pollutant assessments involves extensive data handling.

2. The best time for a study manager to consider the data handling aspects of an urban air toxics study is:

   a. After the initial data have been gathered so an evaluation can be made of data handling needs.
   b. At the outset of the study, as part of the overall study protocol.

3. Which of the following is true?

   a. Development of specialized data handling software is expensive and time consuming.
   b. Utilization of existing software can help avoid expenses.
   c. Most of the studies reviewed developed their own capabilities.
   d. all of the above.
   e. a and b.
   f. a and c.

4. Data handling complexity in ambient air monitoring studies is (more complex, less complex, about the same) as in emission inventory/dispersion modeling studies.

5. Ambient air concentrations are applied to population data to estimate population-averaged exposures in:

   a. emission inventory/dispersion modeling studies
   b. ambient air monitoring studies
   c. both a and b

6. True or False? Only a few State and local agencies can access EPA's mainframe computers through remote terminals.

7. The extent to which exposure and risk estimation and control strategy evaluation can be arrived at on personal computers depends on:

   a. the number of pollutants
   b. the sources of pollution
   c. the spatial resolution of the analysis
   d. all of the above
   e. a and b

8. True or False? Regardless of the extent of mainframe involvement in "number crunching," personal computers can be useful for analyzing summary data sets created by the mainframe and for tailoring special reports and graphics.

9. True or False? Data summaries can be produced using spreadsheets and database management programs that are commonly available for most personal computers.

10. Many studies used PIPQUIC to:

    a. store their data
    b. develop estimates of exposure
    c. develop estimates of risk
    d. all of the above
    e. a and b
    f. b and c

11. PIPQUIC was developed for:

    a. The South Coast MATES
    b. The IEMP studies
    c. The Southeast Chicago study
    d. The 5-City Controllability study

12. PIPQUIC executes which two EPA models:

    a. ISCLT and ISCST
    b. ISCLT and CDM
    c. ISCLT and HEM
    d. CDM and HEM

13. True or False? PIPQUIC allows the user to run his/her own models in lieu of the two EPA already in PIPQUIC.

14. PIPQUIC's Tool 440 does which of the following:

    a. create a broad range of study maps
    b. allows the user to rank order his/her source and emission data
    c. pinpoint sites of maximum concentrations.

15. PIPQUIC's Tool 450 does which of the following:

    a. create a broad range of study maps
    b. allows the user to rank order his/her source and emission data
    c. pinpoint sites of maximum concentrations.

16. PIPQUIC's Tool 453 does which of the following:

    a. create a broad range of study maps
    b. allows the user to rank order his/her source and emission data
    c. pinpoint sites of maximum concentrations.

17. In addition to sites of maximum concentration, PIPQUIC allows the user to pinpoint sites of:

    a. individual risk
    b. aggregate cancer incidence
    c. a and b
    d. neither a nor b

18. True or False? PIPQUIC Tool 453 allows the use to assess the impact of each pollutant and source at any receptor within the study area.

19. True or False? PIPQUIC is designed so that a user can download maps of graphs to a PC and then re-create and edit them without having to re-enter PIPQUIC.

20. Of the studies reviewed, which two were identified as developing their own data handling capabilities?

    a. the 5 City Controllability Study and the Southeast Chicago Study
    b. the Southeast Chicago Study and the South Coast Study
    c. the South Coast Study and the 5 City Controllability Study

21. True or False? RIM allows the user to project future emissions and cancer incidence by simulating various hypothetical growth scenarios.

22. Which of the following (is) are PC-based model(s):

    a. HEM/SHEAR
    b. SCREAM
    c. RIM
    d. all of above

23. True or False? The SCREAM model, which was used for the Los Angeles area, is applicable to other geographical areas.

24. The practice of normalized modeling is a cost-saving technique because:

    a. it aggregates similar sources
    b. reduces the number of dispersion model runs needed
    c. reduces the time it takes to make a dispersion model run

25. True or False? Most of the studies reviewed did not use normalized modeling.

26. The cost and execution time of modeling point sources is _____ (much less than, about the same as, much greater than) for modeling area sources.

27. Data handling for the ambient air monitoring studies reviewed is being conducted using:

    a. dBase®
    b. Lotus 1,2,3®
    c. individually-designed spreadsheets.

28. Various functions that can be done more efficient and more readily on personal computers than on a mainframe computer are:

    a. preparation of emission data
    b. dispersion models
    c. editing of various outputs
    d. creation of summaries and graphs
    e. all of the above
    f. a, b, c
    g. a, c, d
    h. b, c, d
    i. a and d

29. True or False? Normalized modeling assumes a linear relationship between emission changes and model-predicted concentrations.

30. If the release specifications change as emission change (e.g., a control device may alter a plant's stack/exhaust parameters as well as its emissions), then which of the following cost-saving techniques may no longer be valid:

    a. normalized modeling
    b. modeling small point sources as area sources
    c. both a and b

31. True or False? Modeling small point sources as area sources may change the exposures resulting from those sources.

Review Exercise Answers

		Page(s) of Urban Air Toxics Manual
1.	True	191
2.	b	191
3.	e	191
4.	less complex	192
5.	c	192
6.	False	192
7.	d	192
8.	True	192, 193
9.	True	193
10.	d	193
11.	b	193
12.	b	193
13.	True	193
14.	b	194
15.	a	194
16.	c	199
17.	c	199
18.	True	199
19.	True	199
20.	c	199
21.	False	199
22.	c	199
23.	False	205
24.	b	205
25.	False	205
26.	much greater than	205
27.	b	206
28.	g	206
29.	True	206
30.	a	206
31.	True	206

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16. ABSTRACT

This Guidebook is used in taking APTI Course CC:404, "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics." It is used in conjunction with EPA Publication EPA-450/2-89-010, "Assessing Multiple Pollutant Multiple Source Cancer Risks from Urban Air Toxics." This Guidebook directs the student through the supplemental text. Questions and answers help the student understand the material presented.

Major topics include: Summary of Urban Air Toxics Assessment Studies, Monitoring Approaches, Exposure and Risk, Control Strategy Evaluation, Data Handling, and Evolving Technologies.

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