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Exposure Assessment Concepts

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Section A

Introduction

Origin of Hygiene

- Hygeia was the Greek goddess of health
- Rene Dubos wrote: “For the worshippers of Hygeia, health is … a positive attribute to which men are entitled if they govern their lives wisely”
- Prevention is key

Exposure—Definition

- Contact between the outer boundary of the human body (skin, nose, lungs, GI tract) and a contaminant
- Requires the simultaneous presence of a contaminant and the contact between the person and that medium
- Quantified by concentration of contaminant and time and frequency of contact

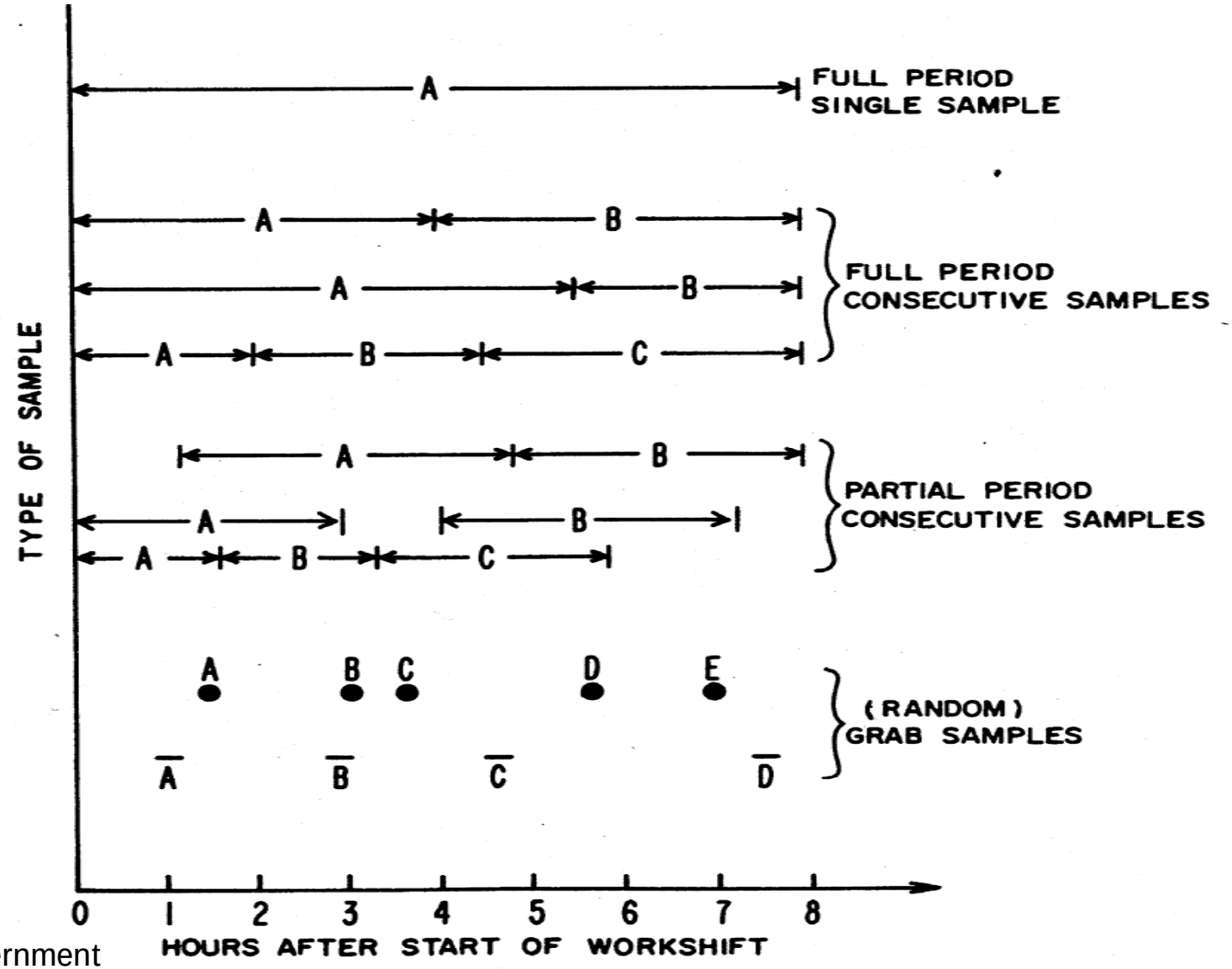
Route of Exposure

- Inhalation
- Ingestion
- Dermal
- Direct injection
- Inhalation is most common in workplace—but not in general environment
- Moving towards concept of total exposure

Exposure Assessment

- Magnitude
  - Concentration in media (ppm, f/cc)
- Duration
  - Minutes, hours, days, working life, lifetime
- Frequency
  - Daily, weekly, seasonally

Types of Air Sampling: Time



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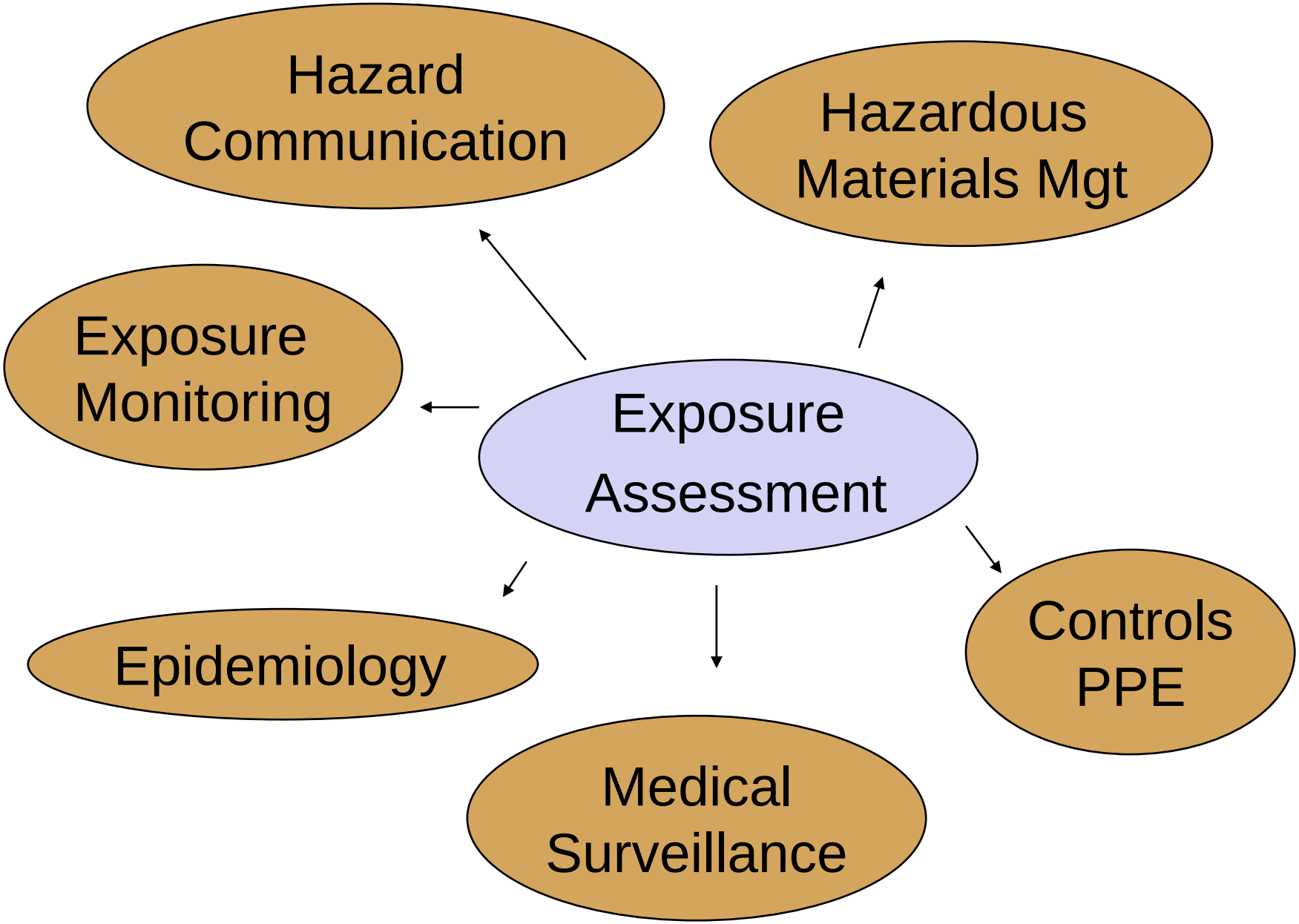
Section B

Exposure Assessment


Hazard Communication
Hazardous Materials Mgt
Exposure Monitoring
Exposure Assessment
Epidemiology
Controls PPE
Medical Surveillance

Exposure Assessment

1. Assessment of hazard
   - Identification of potential hazards
   - Qualitative assessment of exposure
   - Exposure potential, magnitude, toxicity, etc.
   - Exposure modeling
2. Identification of concerns (hypothesis)

Continued

Exposure Assessment

3. Quantification of exposure
4. Determine acceptability
   - Comparison with measure of safe or acceptable
   - Professional judgment and other factors
5. Decision on appropriate action
6. Periodically re-evaluate

1. Assessment of Hazard

- Process description with emphasis on:
  - Raw materials
  - Contaminant chemicals
  - Intermediates
  - By-products
  - Decomposition products
  - Additives

Continued

1. Assessment of Hazard

- Sources of chemical use information
  - Material Safety Data Sheets (MSDS)
  - Inventories
  - Purchasing records
  - Standard operation procedures (SOPs)
  - Inspections of workplace
  - Interviews with workers

Continued

1. Assessment of Hazard

- Methods of chemical use
  - Focus on opportunities for contaminant release to the workplace environment
  - Physical-chemical factors governing release
  - Physical-chemical factors influencing magnitude

Source: U.S. Government

Continued

1. Assessment of Hazard

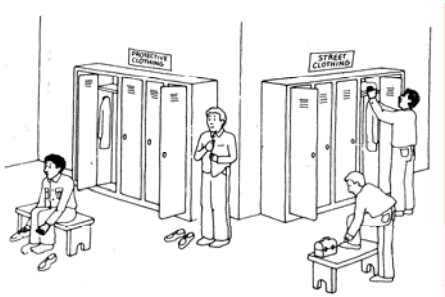
- Methods of chemical use
  - Focus on opportunities for exposure
  - Routes of exposure
  - Influence of work practices

Source: U.S. Government

Continued

1. Assessment of Hazard

- Preliminary inspection and observations
  - Worker and management interviews
  - Evaluate work practices
  - Note personal protective equipment
  - Note ventilation/other controls



Source: U.S. Government

Source: U.S. Government

Continued

1. Assessment of Hazard

- Additional preliminary observations
  - Housekeeping
  - Maintenance
  - Emergency procedures
  - Perceptions/experience

Source: U.S. Government

Continued

1. Assessment of Hazard

- Review of documents
  - Internal reports and records
  - Industry reports
  - Government reports and publications
  - Texts, other publications
- Note: This can be time-consuming

Source: U.S. Government

Continued

1. Assessment of Hazard

- Review of documents
  - Previous inspections
  - Medical complaints
  - OSHA 200 log
- Note: This can be time-consuming

Source: U.S. Government

Continued

1. Assessment of Hazard

- Exposure modeling
  - Use a mathematical construct to quantitatively estimate exposures
  - Models will typically include
    - Source term
    - Transport in time and space
    - Receptor factors (time activity information)

2. Identification of Concerns

- Given limited resources, focus on limited number of possible exposures
- Develop exposure assessment goals
  - Can be hypotheses about exposures to be tested by quantitative assessment
- Create a written exposure assessment program

3. Quantitative Assessment

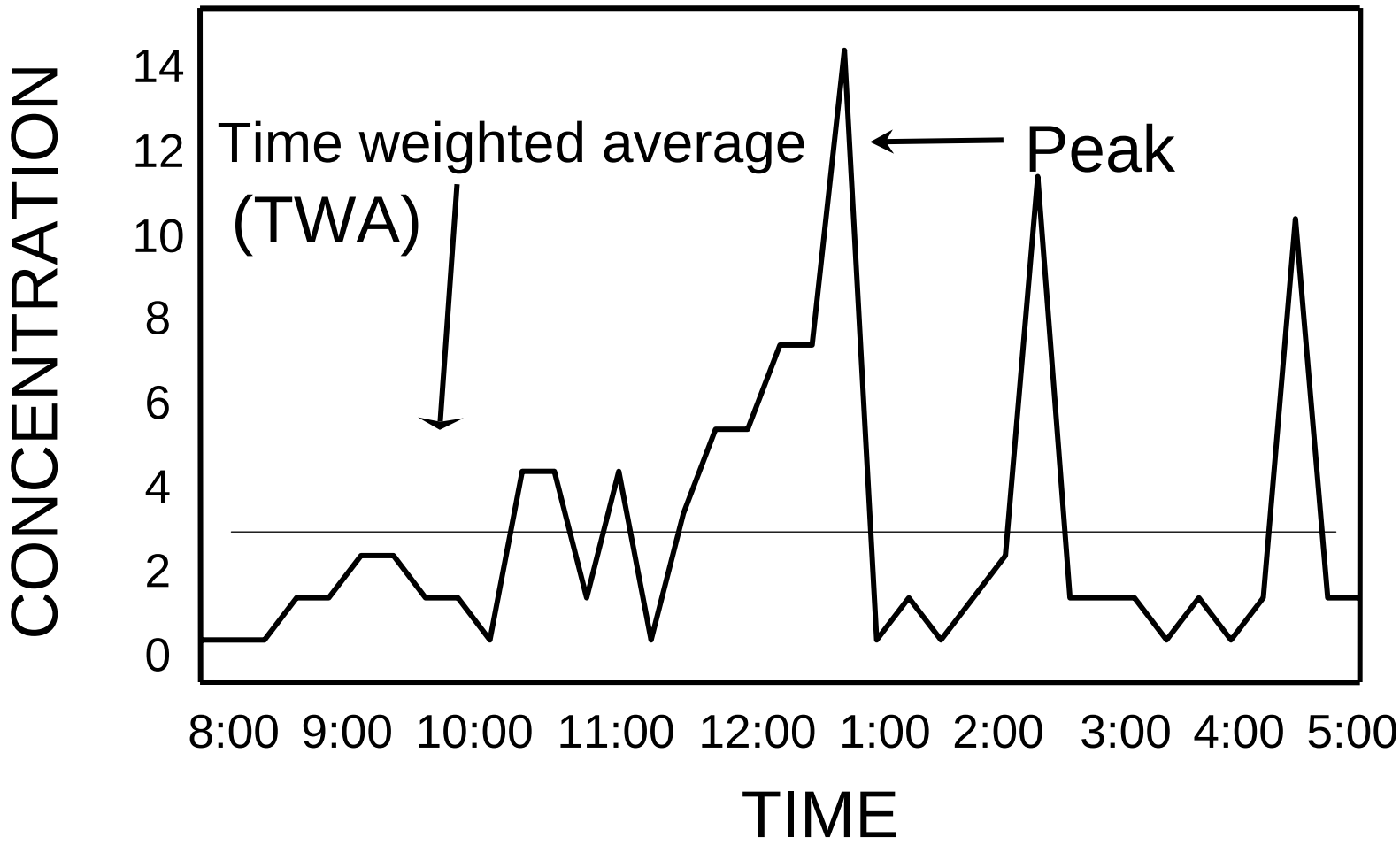
- To confirm or refute exposure hypotheses and to serve as a basis for decision making
- Quantitative assessment of exposure via air sampling (i.e., measurement of air concentrations of a contaminant) is a tool for estimating risk or hazard
- Used in conjunction with observations, calculations, discussions, medical data, etc.

Continued

3. Quantitative Assessment

- Ideally would like to know or estimate
  - Exposure magnitude or intensity
  - Exposure duration
  - Exposure frequency
  - Numbers exposed
  - Population characteristics
- Statistical description
  - Make inferences in absence of data

Exposure Profile



Sources of Variability

- Methodological variability
  - Random error from sampling and analysis process
  - ± 5–30 percent
- Environmental variability
  - Non-random error from:
    - Manufacturing process
    - Environment

} Spatial/temporal

Continued

Sources of Variability

- Environmental variability
  - Inter- and intra-person
  - ± order(s) of magnitude

4. Determine Acceptability

- Role of air sampling
  - Used as a tool for estimating risk or hazard
  - Other observations, calculations, discussions with workers, medical data, etc.
- Comparison with measure of safe or acceptable
- Professional judgment and other factors

Introduction to TLV Book

- The values listed in this book are:
  - Guidelines to assist in the control of workplace hazards
  - Not fine lines between safe and dangerous
- TLVs should be used by trained IHs
- Need to refer to individual documentation

5. Decision on Appropriate Action

- Prioritize
- Develop workplace control plan
  - Short term
    - PPE
    - Administrative
    - Work practices
  - Long term
    - Engineering controls

6. Periodically Re-Evaluate

- Whenever significant process or workforce change occurs
- Develop schedule for routine periodic re-evaluation
  - Basic workplace characterization
  - Exposure assessment program
  - Workplace control plan

Record Keeping

- Set up occupational exposures database
  - Can be complicated
  - Keep indefinitely
- Hazard communication
- Workplace control changes

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Section C

Standard Methods

Use of Standard Methods

- Developed by NIOSH, OSHA, EPA, and others
- Standardize sampling and analytical procedures
- Limits of detection known
- Sampling and analytical error determined

NIOSH Manual of Analytical Methods

CHEMICAL NAME **METHOD #**

FORMULA Molecular Weight Chemical Abstracts Service # RTECS #

Method numbers are the same as those in the 3rd edition. **Evaluation** (Full, Partial, Unrated, N/A) is assigned as described in Method Classification of these "blue pages." **Issue date** reflects current version (e.g., August 15, 1994) and previous 3rd edition versions, if any.

OSHA : **NIOSH:** **ACGIH:** These exposure limit values are those in effect at the time of printing of the method.

PROPERTIES: Boiling/melting points, equilibrium vapor pressure, and density help determine the sample aerosol/vapor composition.

SYNONYMS: Common synonyms for the substance. These are all listed alphabetically in the **Index of Names and Synonyms** ("yellow pages" in this Manual).

SAMPLING

SAMPLER: Brief description of sampling EQUIPMENT

FLOW RATE: Acceptable sampling range, L/min

VOL-MIN: Minimum sample volume (L); corresponds to Limit of Quantitation (LOQ) at OSHA PEL

-MAX: Maximum sample volume (L) to avoid analyte breakthrough or overloading

BLANKS: Each set should have at least 2 field blanks, up to 10% of samples, plus 6 or more media blanks in the case of coated sorbents, impinger solutions, or other special samplers.

ACCURACY

Data are for experiments in which known atmospheres of the substance were generated and analyzed according to the method. Target accuracy is less than 25% difference from actual concentration over the range of the method.

MEASUREMENT

TECHNIQUE: The measurement technique used

ANALYTE: The chemical species actually measured

A summary of the measurement EQUIPMENT, SAMPLE PREPARATION, and MEASUREMENT steps appearing on the second page of the method is given here.

CALIBRATION: Summary of type of standards used

RANGE: Range of calibration standards to be used; from **LOQ** to **upper limit of measurement** (Note: More concentrated samples may be diluted in most cases to fall within this calibration range.)

ESTIMATED LOD: Limit of detection (background + 3)

PRECISION (,): Experimental precision of spiked samplers

APPLICABILITY: The conditions under which the method is useful, including the working range in mg/m^3 (from the LOQ to the maximum sampler loading) for a stated air volume are given here.

INTERFERENCES: Compounds or conditions which are known to interfere in either sampling or measurement are listed.

OTHER METHODS: Methods from the 2nd edition ("P&CAM" and "S" methods) and current methods which are related to this one, as well as similar OSHA and literature methods are keyed to REFERENCES.

Source: U.S. Government

NIOSH Methods

Method #	Substances
0001-0799	General air samples
0800-0999	Bioaerosols
1000-1999	Organic vapors on charcoal
2000-3499	Organic vapors on other solid sorbents
3500-3999	Organic vapors on other samplers (e.g., liquids, direct-reading)
4000-4999	Organic vapors on diffusive samplers
5000-5999	Organic aerosols
6000-6999	Inorganic gases
7000-7999	Inorganic aerosols
8000-8999	Biological samples

Source: U.S. Government