Designation: D4844 – 16

Standard Guide for Air Monitoring at Waste Management Facilities for Worker Protection[1]

This standard is issued under the fixed designation D4844; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide is intended to provide a standardized approach for establishing and carrying out an air monitoring program to protect workers at waste management facilities. This guide may apply to routine operations at an active treatment, storage, or disposal site or the extraordinary conditions that can be encountered in opening and cleaning up a remedial action site.

1.2 The user shall understand that it is impossible to predict all the issues that could arise at a waste management facility due to hazardous airborne emissions. Although air contaminant measurements obtained in accordance with this guide may indicate acceptable or tolerable levels of toxic agents are present, care and judgment must still be exercised before concluding that all atmospheric contaminants at the site are under control and that a reasonable safe work environment exists.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1356 Terminology Relating to Sampling and Analysis of Atmospheres

D1605 Practices for Sampling Atmospheres for Analysis of Gases and Vapors (Withdrawn 1992)[3]

D2820 Test Method for C Through C Hydrocarbons in the Atmosphere by Gas Chromatography (Withdrawn 1993)[3]

D2913 Test Method for Mercaptan Content of the Atmosphere

D3162 Test Method for Carbon Monoxide in the Atmosphere (Continuous Measurement by Nondispersive Infrared Spectrometry)

D3249 Practice for General Ambient Air Analyzer Procedures

D3269 Test Methods for Analysis for Fluoride Content of the Atmosphere and Plant Tissues (Manual Procedures) (Withdrawn 2010)[3]

D3413 Test Method for Lead (Inorganic) in Workplace Atmospheres by Atomic Absorption Spectrometry (Withdrawn 1989)[3]

D3449 Test Method for Sulfur Dioxide in Workplace Atmospheres (Barium Perchlorate Method) (Withdrawn 1989)[3]

D3476 Test Method for bis (Chloromethyl) Ether (bis CME) in Workplace Atmospheres (Gas Chromatography-Mass Spectrometry (Withdrawn 1989)[3]

D3614 Guide for Laboratories Engaged in Sampling and Analysis of Atmospheres and Emissions

D3686 Practice for Sampling Atmospheres to Collect Organic Compound Vapors (Activated Charcoal Tube Adsorption Method)

D3687 Practice for Analysis of Organic Compound Vapors Collected by the Activated Charcoal Tube Adsorption Method

D3824 Test Methods for Continuous Measurement of Oxides of Nitrogen in the Ambient or Workplace Atmosphere by the Chemiluminescent Method

D4185 Practice for Measurement of Metals in Workplace Atmospheres by Flame Atomic Absorption Spectrophotometry

D4240 Test Method for Airborne Asbestos Concentration in Workplace Atmosphere (Withdrawn 1995)[3]

D4323 Test Method for Hydrogen Sulfide in the Atmosphere by Rate of Change of Reflectance

D4490 Practice for Measuring the Concentration of Toxic Gases or Vapors Using Detector Tubes

D4532 Test Method for Respirable Dust in Workplace Atmospheres Using Cyclone Samplers

D4599 Practice for Measuring the Concentration of Toxic Gases or Vapors Using Length-of-Stain Dosimeters

D4600 Test Method for Determination of Benzene-Soluble Particulate Matter in Workplace Atmospheres

D4687 Guide for General Planning of Waste Sampling

D5681 Terminology for Waste and Waste Management

[1] This guide is under the jurisdiction of ASTM Committee D22 on Air Quality and is the direct responsibility of Subcommittee D22.04 on Workplace Air Quality.

Current edition approved Feb. 1, 2016. Published February 2016. Originally approved in 1988. Last previous edition approved in 2009 as D4844 – 03(2009). DOI: 10.1520/D4844-16.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

D6561 Test Method for Determination of Aerosol Monomeric and Oligomeric Hexamethylene Diisocyanate (HDI) in Air with (Methoxy-2–phenyl-1) Piperazine (MOPIP) in the Workplace

D6562 Test Method for Determination of Gaseous Hexamethylene Diisocyanate (HDI) in Air with 9-(N-methylaminomethyl) Anthracene Method (MAMA) in the Workplace

D6785 Test Method for Determination of Lead in Workplace Air Using Flame or Graphite Furnace Atomic Absorption Spectrometry

D6832 Test Method for the Determination of Hexavalent Chromium in Workplace Air by Ion Chromatography and Spectrophotometric Measurement Using 1,5-diphenylcarbazide

D7035 Test Method for Determination of Metals and Metalloids in Airborne Particulate Matter by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

D7036 Practice for Competence of Air Emission Testing Bodies

D7539 Practice for Using a Test Chamber for Humidity Conditioning of Test Panels of Pavement Marking Paints

D7773 Test Method for Determination of Volatile Inorganic Acids (HCl, HBr, and HNO_3) Using Filter Sampling and Suppressed Ion Chromatography

D7948 Test Method for Measurement of Respirable Crystalline Silica in Workplace Air by Infrared Spectrometry

E1370 Guide for Air Sampling Strategies for Worker and Workplace Protection

2.2 *ISO Standard:*

ISO 17025 General Requirements for the Competence of Testing and Calibration Laboratories[4]

2.3 *Federal Standards:*

OSHA Analytical Methods Manual[5]

NIOSH Manual for Analytical Methods[6]

OSHA, 29 CFR Part 1910 Hazardous Waste Operations and Emergency Response; Interim Final Rule, December 1986[7]

3. Terminology

3.1 *Definitions:*

3.1.1 *General*—Terminology commonly used in air monitoring can be found in Terminology D1356. Terminology commonly used in waste and waste management can be found in Terminology D5681.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *operating site*—an operating site is a location or facility where waste is treated, stored, or disposed as part of an on-going operation.

3.2.2 *remedial action site*—a remedial action site is a location or facility that may pose a threat to human health and the environment.

4. Summary of Guide

4.1 The procedures described in this guide address safety considerations, acute health hazards, and chronic health hazards due to airborne hazardous materials.

4.2 Monitoring concepts are described for cleanup operations at remedial action sites as well as routine activities at operational waste management sites.

5. Significance and Use

5.1 The techniques of air monitoring are many and varied. This guide is intended to describe standard approaches that are used in designing an air monitoring program to protect waste management site workers.

5.2 When entering a remedial action site to initiate an investigation or a cleanup operation, operating personnel may be faced with fire, explosion, and acute or chronic health hazards. A robust safety and health program, including site-specific injury and illness prevention program (IIPP) and a safety and health plan, must be in place to direct worker activity. Details for such plans can be found in the OSHA Interim Final Rule for Hazardous Waste Operations and Emergency Response and Refs (**1, 2**).[8] Air monitoring is an integral part of such a program. This guide describes equipment and sampling procedures which can be used to evaluate the airborne hazard potential so as to gain and maintain a safe work environment at the site.

5.3 Upon obtaining air quality measurements at the site, a decision must be made as to whether conditions are under control and safe or not. That decision will depend on the nature and concentrations of the contaminants (toxicity, reactivity, volatility, etc.), the spatial extent (area affected, number of workers, etc.) of the contaminants, and the level of worker protection available and needed. Since all such parameters are typically site specific, this guide does not include air quality measurement based guidance on decision making.

5.4 This guide does not include monitoring sites containing radioactive materials, nor does it cover general safety aspects, such as access to emergency equipment or medical support for emergency needs. These items should be covered in a work place safety and health plan.

5.5 Ideally, this guide is used in combination with Guide D4687.

6. General Considerations

6.1 The scientific field addressing the assessment of airborne hazards to workers is industrial hygiene. Professional industrial hygienists, besides performing such tasks as measuring the concentration of contaminants in air, recommend the means for controlling such airborne hazards, protecting

[4] Adopted by ASTM as an American National Standard.

[5] 1985 manual available from Occupational Safety and Health Administration, OSHA Analytical Laboratory, Salt Lake City, UT.

[6] Fifth edition manual, January 2015, available from the National Institute of Occupational Safety and Health, (NIOSH), Cincinnati, OH.

[7] Available from the Superintendent of Documents, Government Printing Office, Washington, DC, 20401.

[8] The boldface numbers in parentheses refer to the list of references at the end of this guide.

workers, and demonstrating compliance with applicable laws and regulations. A certified industrial hygienist generally offers the optimum combination of background and credentials for recognizing, evaluating, and controlling workplace health hazards. If industrial hygiene staff support is not available on site, coverage can be obtained through the use of consultants and possibly through loss prevention insurance carriers. The remainder of this guide reflects the general thought process that an industrial hygiene professional would likely go through in establishing an air monitoring program to protect workers at a waste management site.

6.2 *Establishing a Test Protocol:*

6.2.1 Various combinations of equipment and sampling techniques are used in work place air monitoring. The best monitoring program is one that combines accuracy with timely response in a cost effective manner.

6.2.2 The particular test protocol that is selected for an industrial hygiene study depends on the nature of the contaminants and the end purpose of the monitoring effort (that is, routine monitoring, searching for worst case exposure, looking for contaminant leaks in a process, etc.) (See Guide E1370.)

6.3 *Selecting Specific Methods:*

6.3.1 The choice of sampling method is generally dependent on analytical methodology to be employed. There may be no difference in the analytical work whether it is for a 15-min ceiling sample or a 7-h integrated sample. If an analytical method has poor sensitivity, however, it may be necessary to increase the pump flow rate for the short duration sampling to make certain that sufficient sample is collected for a meaningful analysis. Adjustments such as this are determined by sampling personnel and laboratory personnel based upon the measurement needs of the study and workplace limitations. Guidance on air sampling strategies for worker and workplace protection can be found in Test Method E1370. Extensive guidance on the latest developments in air sampling technology is available in Refs **(3, 4)**.

6.3.2 Information describing general methodology is available from a number of sources. Practice D1605 lists some of the classic methods that have been used when sampling for gases or vapors. The American Conference of Governmental Industrial Hygienists offers a publication, Ref **(5)**, that provides a review of some equipment and methodologies. The combination of equipment and procedures selected is based on the precision, accuracy, and sensitivity needed to support the test protocol.

6.3.3 Once the goals and protocol for the sampling program have been defined, specific sampling/analytical methods are selected. Within the *Annual Book of ASTM Standards*, Volume 11.03 is dedicated to atmospheric analysis and to occupational health and safety issues. Some applicable methods from that reference are listed in Annex A1. Other sources of health and safety support include the NIOSH Manual of Analytical Methods and the OSHA Analytical Methods Manual. Specific equipment and sampling media for a particular set of airborne contaminants and sampling conditions are selected from these types of sources.

7. Procedures

7.1 *Operating Site:*

7.1.1 The procedures described in this section apply to air monitoring activities at an operational waste treatment, storage, or disposal site. At an operating site, controls (work practices, engineering controls, and personal protective equipment) are used to minimize the exposure of workers to hazardous conditions. These are defined in the site health and safety plan.

7.1.2 *Knowledge of Materials*—Knowledge of the materials arriving at or present at an operating site is critical to the design of a sampling plan. If hazardous wastes are received by a site, it is critical that they be listed on a manifest. The results of incoming shipment waste sample analyses is also helpful for identifying substances of greatest threat to healthy and safety. Information on wastes and their hazards may also be available from knowledge that specific disposal site users will tend to deliver the same types of wastes to the site due to a consistent generating process and shipment history. For example, paint manufacturers will tend to send mixtures of solvents, resins, and pigments, whereas plating firms will generally send alkaline heavy metal waste sludge, and so on. Deviation from established patterns, however, is possible and should not be discounted in sampling plan design.

7.1.3 *Worker Sampling:*

7.1.3.1 Personal sampling of the worker's breathing zone is typically the most critical of workplace sampling that is needed. While some workers may be stationed in an operations trailer at a control panel and sedentary, others may be moving about the work site and very physically active. Addressing these different situations requires an assessment capable of following and appropriate to the activity of the worker.

7.1.3.2 The first type of personal monitoring to consider is long duration time-weighted-average (TWA) sampling. For an 8-h work shift, ensure that TWA samples are at a minimum of 7-h duration either as a single sample or a series of two or more samples. For any other work hour situation, the procedure is to sample for the duration of the shift less 1 h. For workers handling organic wastes (for example, vapor degreaser solvent waste) the sampling program could include charcoal tube sampling followed by analysis for one or two of the solvents most likely to be present in the waste. Such TWA monitoring would be repeated periodically to asses worker exposure and ensure that exposure is not increasing.

7.1.3.3 Another type of personal monitoring that can be carried out is for peak exposures. For example, a 15-min ceiling sample might be taken while a set of containers is being opened for inspection or removal of its contents. The same type of sampling might be done while contents of a truck are pumped into a holding tank. In cases such as these, personal protective equipment (for example, respiratory protection) is often used to minimize worker exposure to vapors. Ceiling samples help ensure that workers are using respirators having a sufficient filtration and capture efficiency for worker safety.

7.1.3.4 In some cases, ceiling samples might be the only type of monitoring necessary for certain toxic agents. For example, steel mill waste acid pickling solution received for neutralization may only require sampling for and determination of hydrogen chloride. In that instance, only 15-min samples

would be of interest, since exposure to HCl is controlled on a 15 min exposure basis by health/regulatory agencies.

7.1.3.5 Personal dosimeters, worn by the employees, have come into general use. These devices give an overall average exposure assessment and also record the instantaneous exposures of the worker during the day. These units, which are read out on a smartphone, laptop, or notebook computer, are generally good for only one specific contaminant, although the same electronic system can be used for other specific contaminants. These might be very useful in monitoring a heavy equipment operator for exposure to carbon monoxide or a waste treatment plant attendant for exposure to sulfur dioxide.

7.1.3.6 Another consideration in monitoring, safety, and health plans is the additive effect of certain substances. Paragraph 7.1.3.2 presented the concept of screening for only one or two solvents. When this is done, the eventual comparison with permissible exposure limits must be done using a safety factor. This safety factor is intended to account for the possible effects of other similar compounds that may be present, but are not measured routinely.

7.1.4 *Area Monitoring:*

7.1.4.1 A good complement to personal monitoring is fixed location area monitoring. This can be done with either sample collecting-type equipment, direct measurement instruments, or specialized fixed-parameter monitors such as those described in 7.1.3.5. Area monitoring offers the advantage of potentially providing an early warning for area worker exposure.

7.1.4.2 A combustible vapor meter in a solvent storage area can give a warning before an employee enters the area.

7.1.4.3 A carbon monoxide monitoring system around a pyrolyzer or incinerator can warn both the operator in the control room and workers in the loading area of a hazard due to a system upset or other unexpected event.

7.1.4.4 An oxygen meter permanently mounted in a below ground pit can warn an employee of an oxygen-deficient atmosphere before they enter the confined space.

7.1.4.5 Direct reading colorimetric tubes Ref (**6**), offer a convenient means for obtaining a quick reading. Besides their suitability for qualitative checks (see Annex A2), they also provide reasonable quantitative estimates.

7.1.5 *Complex Exposure Potential:*

7.1.5.1 Although much of the sampling effort may involve monitoring for one or two particular contaminants, there will be other times when the exposure potential is more complex. Examples of more complex monitoring might include:

(1) where a sludge is handled on site, and there is a chance of spillage and eventual spreading of the debris around the site by vehicular traffic and wind—monitoring will include periodic collection of dust samples requiring analysis for heavy metals;

(2) where waste from a polymer plant (such as one processing nitrile rubber, acrylonitrile butadiene styrene, or (ABS) plastic, or a combinations thereof) is handled on site. This may require a sampling protocol that looks for trace quantities of acrylonitrile in an atmosphere dominated by one or two less harmful organic vapors;

(3) where polychlorinated biphenyl, (PCB) vapor can be carried into the atmosphere by methane gas evolving from a closed site. Fugitive emission (see Ref **7**) monitoring shall include these and perhaps other compounds; and

(4) where a range of similar compounds are present, such as in some organic wastes and landfill gas. In this case, the cumulative effect shall be estimated rather than the potential effect of individual contaminants.

7.1.6 *Data Storage and Analysis:*

7.1.6.1 The various forms of air monitoring described in 7.1.3, 7.1.4, and 7.1.5 will result in the accumulation of a large amount of data by the site operator. The data need to be recorded and catalogued in a manner that provides for ready retrieval and comparison.

7.1.6.2 Store and retrieve data so that the level of airborne contamination can be reviewed over time. In this way annual, seasonal, or diurnal trends as well as source specific contamination may be identified.

7.1.6.3 The site operator may want to determine if certain shipments or customers are sending waste material that is particularly hazardous and difficult to handle.

7.1.7 *Quantitative Considerations*—Even the best run waste site may have to analyze for unknowns in the work atmosphere. Following are situations that can arise and will require appropriate monitoring and mitigative action to ensure worker safety.

7.1.7.1 The premise of most of the discussion of Section 7 is that the site operator has at least some working knowledge of the materials being handled. This may not always be the case.

7.1.7.2 An unexpected odor or phase separation may indicate an unknown or unexpected substance is present in the waste material.

7.1.7.3 An abnormal reaction in a neutralization process may be a sign that an unexpected volatile is being emitted.

7.2 *Remedial Action Site:*

7.2.1 The level of hazard that is found by air monitoring at a remedial action waste site can vary from relatively innocuous to very dangerous. The uncertainty associated with the types and composition of wastes present at these sites complicates virtually every aspect of site cleanup and monitoring. For these reasons a thorough site characterization must be made before work is started to provide data for development of a site-specific health and safety plan, including subsequent air monitoring needs.

7.2.2 *Qualitative Assessment:*

7.2.2.1 From an operational viewpoint, a prime difference between a remedial action site and an operating site is the need for qualitative assessment. The unknowns at an abandoned site require a qualitative analysis of the work environment prior to any quantitative measurements.

7.2.2.2 Before starting cleanup activity, check available records to gain knowledge of the materials that were or might have been treated, stored, or buried on the site. Be sure that labels on drums also are checked to see if there is some information on the hazardous nature of the material contained inside the drums.

7.2.2.3 Qualitative assessment must be conducted in a systematic fashion. Be sure that the operating areas are mapped and perhaps gridded so that the assessment can be done with minimal chance of overlooking zones.