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Risk Reduction and Environmental Stewardship—Environmental Characterization and Remediation

Standard Operating Procedure

for Headspace Vapor Screening with a Photoionization Detector

☑ **NES Approved**

Responsible Division Leader: Doug Stavert	Signature & Date 12/14/05
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SOP-06.33, R0, Revision Log

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Rev. 0	09/13/2004	Becky Coel-Roback	New Procedure	All

SOP-06.33, R0, Headspace Vapor Screening with a Photoionization Detector

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List of Acronyms and Abbreviations

ECR	Environmental Characterization and Remediation
eV	electron volts
FID	flame ionization detector
IWD	integrated work document
LANL	Los Alamos National Laboratory
M&TE	measuring and test equipment
NMED	New Mexico Environment Department
PPE	personal protective equipment
ppm	part per million
QII	Quality Improvement and Integration Team
QP	quality procedure
PID	photoionization detector
RPF	Records Processing Facility
RRES-RS	Risk Reduction and Environmental Stewardship—Remediation Services
SOP	standard operating procedure
SSHASP	Site-specific health and safety plan (SSHASP)
UV	ultraviolate
VOC	volatile organic compound

SOP-06.33, R0, Headspace Vapor Screening with a Photoionization Detector

1.0 PURPOSE

This standard operating procedure (SOP) states the responsibilities and describes the process for screening headspace vapor for volatile organic compounds (VOC) in soil samples with a photoionization detector (PID) for the Los Alamos National Laboratory (LANL) Risk Reduction and Environmental Stewardship Division (RRES), the Environmental Characterization and Remediation (ECR) Group. This procedure integrates the criteria of the "Risk Reduction and Environmental Stewardship – Remediation Services Project Quality Management Plan," hereinafter referred to as the Quality Management Plan.

2.0 SCOPE

All **RRES-RS/ECR participants** shall implement this procedure when performing headspace vapor screening on soil samples using a PID. A PID is capable of detecting and measuring real-time concentrations of many organic and inorganic vapors in air. This screening technique is strictly a tool to choose which soil samples (if any) may contain VOCs and subsequently submitted for laboratory analysis. This vapor screening SOP is *NOT* for health and safely purposes.

3.0 TRAINING

3.1 **RRES-RS/ECR participants** shall train (e.g., by reading and/or completing on-the-job or classroom training) to and use the current version of this procedure.

3.2 **RRES-RS/ECR participants** shall document training to this procedure in accordance with QP-2.2, "Personnel Training."

3.3 **RRES-RS/ECR participants** implementing approved statements of work and/or QP-5.3, "Readiness, Planning and Review," shall submit training records as required by these documents.

3.4 The responsible **project leader** shall monitor the proper implementation of this procedure.

3.5 The responsible **field team leader** shall ensure that RRES-RS/ECR participants complete all training assignments applicable to this procedure.

3.6 **RRES-RS/ECR participants** may request any needed assistance with implementation of this procedure from the RRES-ECR Quality Integration and Improvement (QII) team.

4.0 DEFINITIONS

4.1 *Integrated work document (IWD)*— Hazard control documentation that integrates work definition, hazards, and controls for work authorization and user-friendly communication to the workers. The IWD may be a subset of a larger "work package," such as the field readiness review package, that includes other documents and information relating to an activity, but not addressing hazard controls.

4.2 *Standard operating procedure (SOP)*—A document within RRES-ECR that describes work processes governed by the RRES-RS "Quality Management Plan."

4.3 *Photoionization detector (PID)*— The PID is a portable, nonspecific, vapor/gas detector employing the principle of photoionization to detect and measure real-time concentrations of a variety of chemical compounds, both organic and inorganic, in air.

4.4 *RRES-RS/ECR participant* — An inclusive term for any LANL, staff augmentation employee, deployed worker, or subcontractor, inclusive of project leaders, team leaders, and project personnel, who participates in activities conducted as part of or on behalf of RRES-RS/ECR.

4.5 *Site-specific health and safety plan (SSHASP)*—Health and safety plan that is specific to a site or RRES-RS-related field activity that has been approved by an RRES-RS health and safety representative. This document contains information specific to the project including scope of work, relevant history, descriptions of hazards by activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment [PPE]) and hazard mitigation.

5.0 RESPONSIBLE PERSONNEL

The following identifies the personnel responsible for actions in this procedure:

- field team members
- project leader (field team leader)
- quality specialist
- RRES-RS/ECR participants

6.0 BACKGROUND AND PRECAUTIONS

6.1 Reference the web sites http://www.tis.eh.doe.gov/ll/ll.html and http://www.lanl.gov/projects/lessons_learned/ for lessons learned information and reporting that might apply to the requirements in this procedure.

6.2 Use this procedure in conjunction with an approved SSHASP.

6.3 Report any deviation from this procedure in accordance with QP-5.7, "Notebook Documentation for Environmental Restoration Technical Activities," and/or SOP-01.01, "General Instructions for Field Investigations."

6.4 As with any field instrument, accurate results depend on the operator's complete familiarity with the operator's manual. Follow the instructions in the operating manual explicitly in order to obtain accurate results, while taking care to prevent the PID's exposure to excessive moisture, dirt, or contamination.

6.5 The PID employs the principle of photoionization. The analyzer responds to most vapors that have an ionization potential less than or equal to that supplied by the ionization source, which is an ultraviolet (UV) lamp. Photoionization occurs when an atom or molecule absorbs a photon of sufficient energy to release an electron and form a positive ion. This occurs when the ionization potential of the molecule in electron volts (eV) is less than the energy of the photon. The sensor is housed in a probe and consists of a sealed ultraviolet light source that emits photons with an energy level high enough to ionize many trace organics, but not enough to ionize the major components of air (e.g., nitrogen, oxygen, carbon dioxide). The ionization chamber exposed to the light source contains a pair of electrodes, one a bias electrode, and the second the collector electrode. When a positive potential is applied to the bias electrode, it creates an electro-magnetic field in the chamber. Ions formed by the adsorption of photons are driven to the collector electrode. The current produced is then measured and the corresponding concentration displayed on a meter, directly, in units above background, usually part per million (ppm). Three probes, each having a different eV lamp and a different ionization potential, are available for use with the PID; the light energies are 9.5, 10.2, and 11.7 eV. All three probes detect various aromatic and large molecular hydrocarbons. In addition, the 10.2 eV and 11.7 eV probes detect some smaller organic molecules and halogenated hydrocarbons. The *10.2 eV probe is the most useful for environmental response work*, as it is more durable than the 11.7 eV probe and detects more compounds than the 9.5 eV probe. Gases with ionization potentials near to or less than those of the lamp are ionized. These gases are thus

detected and measured by the analyzer. Gases with ionization potentials higher than that of the lamp are not detected. The selection of the appropriate probe is essential in obtaining useful field results. Though it can be calibrated to a particular compound, the instrument cannot distinguish between detectable compounds in a mixture of gases and, therefore, indicates an integrated response to the mixture. A PID is similar to a flame ionization detector (FID) in application. However, the PID is unable to respond to certain low molecular weight hydrocarbons, such as methane and ethane that are readily detected by FID instruments. See Tables 1-3 of Appendix A at the EPA PID headspace analysis SOP website (www.ert.org/SOPS/2114.PDF) for 1) a list of ionization potentials for a large number of individual species, Table 1; 2) the relative photoionization sensitivities for gases, Table 2.

6.6 In all instances, document and associate the ultimate procedures employed with the final report. Mention of trade names or commercial products does not imply LANL endorsement or recommendation for use.

6.7 Use this procedure in conjunction with an approved IWD to familiarize personnel to hazards of reagents or calibration gas handling and use.

6.8 PID Instrument Limitations

- The PID is a nonspecific total vapor detector. Do not use to identify unknown substances; it only roughly quantifies them.
- Calibrate the PID to a specific compound.
- The PID does not respond to certain low molecular weight hydrocarbons, such as methane and ethane.
- The PID does not detect a compound if the probe has a lower energy than the compound's ionization.
- The PID does not detect certain toxic gases and vapors, such as carbon tetrachloride and hydrogen cyanide, which possess high ionization potentials.
- Certain models of PID instruments are not intrinsically safe; use in conjunction with a combustible gas indicator.
- Electrical power lines or power transformers may cause interference with the instrument and thus cause measurement errors. Static voltage sources such a power lines, radio transmissions, or transformers may also interfere with measurements.
- High winds and high humidity affects measurement readings. The PID may become unusable under foggy or humid conditions. An indication

of this is the needle dropping below zero, or a slow constant climb on the read-out dial.

- Periodically clean the lamp window to ensure ionization of the new compounds by the probe (i.e., new air contaminants).
- The PID measures concentrations from about 1-2000 ppm, although the response is not linear over this entire range. For example, if calibrated to benzene, the response is linear from about 0-600 units (ppm) above background. This means the PID reads a true concentration of benzene only between 0 and 600 ppm. Greater concentrations are detected at a lower level than the true value.
- Do not expose this instrument to precipitation (e.g., rain). The units are not designed for operation under wet conditions.
- Do not use this instrument for headspace analysis where liquids are inadvertently drawn into the probe.

7.0 EQUIPMENT

7.1 **RRES-RS/ECR participants** shall use the equipment and supplies authorized by the responsible team leader and field team leader.

7.2 The responsible **field team leader** shall ensure that the equipment and supplies identified in Attachment A, Equipment and Supplies Checklist, are correct and available. One may add additional items to the checklist, as appropriate, and procure any equipment or supplies as necessary following QP-7.1, "Procurement" and LIR 308-00-04.2, "Quality Management for Procurements of Items and Services."

7.3 **RRES-RS/ECR participants** shall report to the field team leader any unavailable equipment or supply item or the need for additional equipment or supply items or different from the equipment and supplies listed on the checklist.

8.0 PROCEDURE

8.1 Perform Field Calibration

RRES-RS/ECR participants shall implement and document the following field calibration in accordance with the manufacturer's operations manual, which is similar to the following example of calibration:

8.1.1 Calibrate the monitoring instruments each day to the manufacturer's standard for instrument operation. Follow the start-up procedure in the manufacturer's operations manual.

8.1.2 Record the following information in the site logbook:

- the instrument's ID number (U.S. EPA decal or serial number if the instrument is a rental)
- the initial and final span settings, the date and time, concentration and type of calibration gas used
- the name of the person who field calibrated the instrument

8.1.3 Refer to calibration requirements specified in QP-5.2, "Control of Measuring and Test Equipment," which states the responsibilities and describes the process for identifying, maintaining, and managing measuring and test equipment (M&TE) within RRES-RS/ECR.

8.1.4 Set the "function" switch to the range setting, which includes the concentration of the calibration gas.

8.1.5 Attach a regulator to a disposable cylinder of calibration gas. Connect the regulator to the probe of the PID with a piece of clean Tygon tubing. Open the valve on the regulator.

8.1.6 After 15 seconds, the meter reading should equal the response value as indicated on the calibration gas cylinder used. If the reading is within ±15% of the response value, then the instrument is field calibrated to the response value using the external "span adjustment" control. Adjust the "span adjustment" control to a lower setting until the correct reading is obtained. The lower the number on the "span adjustment" control, the greater the instrument sensitivity. If the "span adjustment" control is adjusted below a setting of 4.00, red-tag the unit and return to the manufacturer for repairs.

8.1.7 If the meter reading is greater than ±15% of the response value of the used calibration gas, then red tag, recalibrate, and recertify the instrument prior to use according to QP-5.2, "Control of Measuring and Test Equipment."

8.1.8 If the PID does not start up, check out, or calibrate properly, do not use the instrument. Under no circumstances perform work requiring air monitoring with a PID without a properly functioning instrument.

8.2 Perform Operation

RRES-RS/ECR participants shall implement and document the following operations:

- Use a photo-ionization detector (PID) equipped with a 10.2 or higher electron volt (eV) lamp (in most cases with VOCs, 10.6 eV) and a

combustible gas indicator for VOC headspace vapor screening and as applicable to the monitored species.

- Conduct headspace vapor screening by placing a soil or rock sample in a plastic sample bag or a foil-sealed container allowing space (the container is one-third to one-half empty) for ambient air.
- Seal and gently shake the container to expose the soil or rock to the air trapped in the container.
- Allow the sealed container to rest for a minimum of five minutes while vapors equilibrate.
- Measure vapors present within the sample bag headspace by inserting the probe of the PID instrument in a small opening in the bag or through the foil.
- Record all readings in the site logbook according to QP-5.7, "Notebook Documentation for Environmental Restoration Technical Activities." Record the maximum value and the ambient-air temperature of the headspace air on the field sample log for each sample. Record readings as ppm, following background readings, also listed as ppm (e.g., background = 0 ppm; sample = 10 ppm). The background reading is the reading of ambient air outside the sample container.
- Under no circumstances immerse the probe tip assembly in fluid. In some field applications, with the exception of the probe's inlet and exhaust, wrap the PID in clear plastic to prevent contamination and to prevent water from getting inside in the event of precipitation.

8.3 Perform General Post-Operation Tasks

RRES-RS/ECR participants shall implement and document the following (see manufacturer's operations manual for specific information):

8.3.1 Turn "function switch" to OFF.

8.3.2 Return the PID to a secure area and check the calibration before charging.

8.3.3 Connect the instrument to charger and plug in the charger; ensure that the probe is connected to the readout unit to charge the PID

8.3.4 Complete logbook entries, verifying the accuracy of entries and signing/initialing all pages as specified above in Section 8.1.2.

8.3.5 Check the equipment, repair or replace damaged equipment, and charge the batteries. (Following completion of a series of "0" readings, verify the instrument is working.)

9.0 LESSONS LEARNED

9.1 Before performing work described in this SOP, **ECR participants** should go to the Department of Energy Lessons Learned Information Services home page, located at http://www.tis.eh.doe.gov/ll/ll.html, and/or to the LANL Lessons Learned Resources web page, located at http://www.lanl.gov/projects/lessons_learned/, and search for applicable lessons.

9.2 During work performance and/or after the completion of work activities, **RRES-RS/ECR participants**, as appropriate, shall identify, document, and submit lessons learned in accordance with the LANL, Lessons Learned System located at http://www.lanl.gov/projects/lessons_learned/.

10.0 RECORDS

The **project leader** shall submit the following records to the Records Processing Facility, in accordance with QP-4.4, "Record Transmittal to the Records Processing Facility":

- Completed logbook
- Completed calibration records

11.0 REFERENCES

To implement properly this procedure, **RRES-RS/ECR participants** should become familiar with the contents of the following documents, available at http://erinternal.lanl.gov/home_links/Library_proc.shtml:

- "Quality Management Plan"
- QP-2.2, "Personnel Training Management"
- QP-3.4, "Corrective Action Process"
- QP-4.4, "Record Transmittal to the Records Processing Facility"
- QP-5.2, "Control of Measuring and Test Equipment"
- QP-5.7, "Notebook Documentation for Environmental Restoration Technical Activities"
- QP-7.1, "Procurement"
- LIR 308-00-04.2, "Quality Management for Procurements of Items and Services"
- SOP-01.01, "General Instructions for Field Investigations"
- US EPA PHOTOIONIZATION DETECTOR (PID) HNU SOP#: 2114 DATE: 10/06/94 REV. #: 0.0

- HNU Systems, Inc. 1975. "Instruction Manual for Model PI-101 Photoionization Analyzer"
- U.S. Code of Federal Regulations, 49 CFR Parts 100 to 177, Transportation, revised November 1, 1985. U.S. Environmental Protection Agency.
- "Characterization of Hazardous Waste Sites – A Methods Manual: Volume II, Available Sampling Methods, Second Edition", EPA-600/4-84-076, Environmental Monitoring Systems Laboratory, Office of Research and Development, Las Vegas, Nevada.
- ANSI/NCSL Z540-1-1994, American National Standards for Calibration

12.0 ATTACHMENTS

RRES-RS/ECR participants may locate all example forms associated with this procedure at http://erinternal.lanl.gov/Quality/user/forms.asp.

Attachment A: Equipment and Supplies Checklist (1 page)

Using a CRYPTOCard, click here to record "self-study" training to this procedure.

Attachment A: Equipment and Supplies Checklist

	ITEM	QUANTITY
☐	PID (HNU)	
☐	Operating manual	
☐	Probes: 9.5 eV, 10.2 eV, or 11.7 eV	
☐	Battery charger for PID	
☐	Spare batteries	
☐	Jeweler's screwdriver for adjustments	
☐	Tygon tubing	
☐	NBS traceable calibration gas	
☐	"T" valve for calibration	
☐	Field Data Sheets/Site Logbook	
☐	Intake assembly extension	
☐	Strap for carrying PID	
☐	Teflon tubing	
☐	Sample containers (plastic baggies or glass jars)	
☐	Aluminum foil to cover mouth of sample jar	
☐	Plastic bags for protecting the PID from moisture and dirt	
	REAGENTS (some may require special handling/waste disposal, Refer to site IWD)	**QUANTITY**
☐	Isobutylene standards for calibration	
☐	Benzene reference standard	
☐	Methanol for cleaning ionization chamber (GC grade)	
☐	Mild soap solution for cleaning unit surfaces	
☐	Specific gas standards when calibrating to a specific compound	
☐	Light source cleaning compound Cat. No. PA101534-A1 (For use only with 9.5 and 10.2 lamps)	
☐		
☐		

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