

**DRYWALL INVESTIGATION
INDOOR AIR MONITORING PROTOCOLS DEVELOPMENT**

Prepared by

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A. PROJECT MANAGEMENT

Purpose. Indoor/outdoor air monitoring and air sampling will be performed for pre-selected parameters in three homes in Florida and Louisiana to determine how this initial protocol for indoor air monitoring should be modified in the future to evaluate the concentrations of designated compounds and environmental parameters potentially associated with off gases from Chinese drywall. This protocol will derive the coefficient of variance of analytical procedures to inform power curve calculations for the appropriate number of samples to detect significant differences in future experimental designs. Data will be collected to identify current air concentrations in homes containing imported drywall. The analytical target compounds and suggested analytical methods will be provided to the Federal Consumer Products Safety Commission (CPSC), Florida Department of Health (FDOH), Louisiana Department of Health and Hospitals (LDHH), and the Agency for Toxic Substances and Disease Registry (ATSDR) to evaluate under their Quality Assurance Project Plans (QAPP) utilizing Data Quality Objectives (DQOs) related to human health exposures.

These sampling, monitoring and analysis protocols were prepared at the request of the United States Environmental Protection Agency (USEPA) senior management to support the drywall investigation at the request of the states of Florida and Louisiana. The protocols included in this QAPP follow the graded approach outlined in the Uniform Federal Policy (UFP) – QAPP guidance

The Technical Work Group, which includes the USEPA (OSWER, OPPTS, OEM, OSW and Regions 4, 6 and 9), ATSDR, CPSC and various States (Alabama, Florida, Louisiana, Mississippi, Texas, and Virginia), was formed to develop/assist with the preparation of protocols for additional upcoming testing of drywall and air monitoring in several homes in Florida and Louisiana at the direction of senior USEPA management to support the imported drywall investigation.

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Doug Neeley- USEPA Region IV
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Dianne Dugas – Louisiana Department of Health
Keith Casanova – Louisiana Department of Environmental Quality
Douglas Campbell – North Carolina State Department of Health
Kay Soper – Texas Department of State Health Services
Robert Smith – Virginia Department of Health
Laura White – Washington Department of Health

A3 DISTRIBUTION LIST

The following will receive copies of the approved QAPP for the drywall investigation being conducted by ERI in three houses in Florida and Louisiana:

1. Arnold E. Layne, Director, IIFSD, Project Manager
2. David P. Wright, Director, ERT Management Lead
3. Raj Singhvi, Chemist, ERT Technical Lead
4. Technical Team Members
5. Dennis Miller, Response Engineering and Analytical Contract (REAC) Program Manager

A4. PROJECT ORGANIZATION

The following individuals will participate in conducting indoor air monitoring for the drywall project:

USEPA/ERT

David P. Wright - Director, ERT – Project Lead
 Raj Singhvi – Chemist, Technical Lead
 Philip R. Campagna - Chemist, Technical Team Member
 Alan M. Humphrey- Environmental Scientist, Technical Team Member
 David W. Charters – Quality Assurance (QA) Manager, Office of Superfund Remediation and Technology Innovation (OSRII)

REAC (ERT Contractor Staff - Lockheed Martin Inc.)

Dennis Miller, Program Manager
 Amy DuBois – Senior Environmental Scientist - Task Lead
 Philip Solinski – Air Response Group Leader
 REAC Sampling Team Members
 Deborah Killeen – Quality Assurance Officer (QAO)
 Jay Patel – Inorganic Group Leader
 Dennis Kalnicky - Inorganic Chemist
 Naresh Bhatt - Inorganic Sample Preparation Chemist
 Shiv Shani - Organic Sample Preparation Chemist
 Vinod Kansal - Analytical Section Leader
 Yihua Lin – Organic Group Leader/Method Development
 Larry Martin – Sample Receiving/Analytical Subcontracting
 Joseph Soroka – Data Validation
 Donna Getty - Statistician

Analyses will be conducted by the following laboratories: ERT/REAC Laboratory, Edison, New Jersey, and other outside laboratories to be determined.

ERT Technical Lead Raj Singhvi is the primary point of contact for all technical issues. David Wright is the ERT Project Lead, reporting to Arnold E. Layne, USEPA Project Lead. Barnes Johnson is the alternate USEPA Project Lead.

A5. PROBLEM DEFINITION/BACKGROUND

Drywall from China has been imported to address the shortage of essential construction materials created following record-breaking 2004 and 2005 hurricane seasons and a national demand for new home construction. Based on preliminary estimates, as many as 60,000 to 100,000 houses may have been affected; it is uncertain how many homes have this specific drywall. Initial data analysis of drywall by laboratories shows elevated sulfur compounds, which are suspected to be the basis for concerns by newspaper account. It has been reported in the press that as the drywall is exposed to elevated levels of humidity, as well as elevated temperatures, the imported drywall may be off-gassing sulfur-based gases that have been associated with the odor and corrosion complaints.

ATSDR contacted OSRII/ERT for analytical assistance with the Chinese-manufactured drywall used in Florida. ATSDR and ERT have a longstanding professional relationship and ATSDR is familiar with ERT's expertise in this type of investigation. On March 5, 2009, a teleconference was held between ERT, ATSDR and the FDOH. The FDOH provided background information.

(<http://www.doh.state.fl.us/Environment/community/indoor-air/drywall.html>) including the work that had been performed by contractors from Lennar and Knauf (a German company that manufactures drywall in China) ATSDR requested that ERT conduct an independent analysis of the wallboard. At ATSDR's request, six wallboard samples were selected for analysis (two drywall painted samples manufactured in China that were extracted from two Florida houses, and four from the United States, not painted, which were purchased in local stores in Edison, New Jersey).

The drywall samples were analyzed for organic compounds, metals, sulfides, sulfates, elemental sulfur, formaldehyde, total organic carbon (TOC), water soluble chlorides, loss on ignition (LOI), pH and alkalinity, and were also subjected to an optical microscopic examination to determine presence of fly ash. The drywall sample manufacturers and product names are as follows: US Gypsum/Hamilton (US); PROROC/Certainteed (US); National Gypsum/Gold Bond (US); GP/Tough Rock (US); Knauf/33928-20055 (China); and MIC/33966-12077 (China). The ERT/REAC analytical methods were modified to accommodate these samples as standard methods were not available in the area of sample digestion/preparation procedures.

Notable differences between the Chinese-manufactured and US manufactured drywall samples were observed. The ERT analysis showed the presence of sulfur ranging between 83 parts per million (ppm) to 119 ppm in the Chinese-manufactured drywall samples. No sulfur was detected (10ppm) in the four US-manufactured drywall samples. The metals analysis shows the presence of strontium at concentrations of 2570 ppm and 2670 ppm in the Chinese-manufactured drywall samples, whereas strontium concentrations ranging from 244 ppm to 1130 ppm were found in the US-manufactured drywall samples. Total acid soluble sulfides were not detected in either the US- and Chinese-manufactured drywall samples. Further investigations on the drywall samples are needed to determine if the strontium is present as strontium sulfate or strontium sulfide using X-ray diffraction (XRD). Iron concentrations of 1390 ppm and 1630 ppm were found in the two Chinese-manufactured drywall samples. Iron concentrations ranging from 841 ppm to 3210 ppm were found in the US-manufactured drywall samples. The highest concentration of iron detected in National Gypsum/Gold Bond sample was twice as high as that found in the Chinese-manufactured drywall. No evidence of Fly Ash presence was noted in the Chinese-manufactured drywall samples based upon optical microscopic examination. The chamber study for the off gases from the drywall is being conducted by the Federal Consumer Products Safety Commission.

A6. PROJECT DESCRIPTION AND SCHEDULE

Air Monitoring in Homes in Florida and Louisiana: Based on the work performed to date, two homes that met the case definition and one home that did not meet the case definition constructed (<http://www.doh.state.fl.us/Environment/community/indoor-air/drywall.html>) with US-manufactured drywall in both Florida and Louisiana will be selected in consultation with FDOH, LDHH, and USEPA HQ. To reduce the hardship that will be imposed upon the various homeowners, one unoccupied residence in Florida will first be selected to refine the conditions (varying temperature and humidity) under which air monitoring and sampling will be conducted. Real-time continuous monitoring will be conducted for total VOCs, hydrogen sulfide (H₂S), sulfur dioxide (SO₂), sulfuric acid (H₂SO₄), CO, CO₂, temperature and relative humidity at two locations (living room and bedroom) in the homes.

Air Exchange Rates and Preparation for Indoor Air Monitoring and Sampling in Homes in Florida and Louisiana: Air exchange measurements will be performed in the houses by states or their designee using a tracer gas decay method. The protocols will be provided by FDOH. The results will be shared by FDOH and LDHH with USEPA. In addition to the ventilation rate assessment a preliminary walk-through will be performed to identify and eliminate indoor air contaminants including tobacco smoking, aromatic candles, aromatic dispensers and aerosols, stored paint cans, fuel storage cans, etc.

Air Sampling in Homes in Florida and Louisiana: Air sampling will be performed for VOCs using SUMMA[®] canisters, VOCs in sorbent tubes, PAHs, inorganic acids, aldehydes/ketones and aliphatic and aromatic amines. Air samples for sulfur-containing compounds such as H₂S, carbonyl sulfide, carbon disulfide, dimethyl sulfide, dimethyl disulfide and mercaptans will be collected in 1-liter (L) or 3-L Tedlar bags with polypropylene fittings (Zefon[®] or SKC) during each sampling event at one selected location. One sampling location in the living room area and one sampling location in the master bedroom or other sleeping

area will be selected. Four sampling events will be conducted in unoccupied/occupied homes in each state of approximately 8-12 hours in duration. Two sampling events will occur during the day and the other two during night time hours. Ambient air samples will be collected in conjunction with the indoor air samples outside of each home; the number of ambient air samples may vary depending upon the locations of the homes selected. Grab samples will be taken in SUMMA® canisters once during each event for VOC analysis using USEPA Method TO-15. Three collocated air samples will be collected at one location in each house using appropriate sampling methods for each analysis during the four events. Continuous reading monitoring instruments will be recorded concurrently during the sampling events at both locations within the home.

Triplicate air samples from wall cavity will be collected once a day from each house into 1-L or 3-L Tedlar bags with polypropylene fittings and analyzed for hydrogen sulfide, carbonyl sulfide, carbon disulfide, dimethylsulfide and dimethyldisulfide by an outside laboratory using gas chromatography (GC) with Sulfur Chemiluminescence Detection (SCD).

Meteorological data will be collected by using a portable 3-meter tower located on site. Data collected from the station will include ambient temperature, relative humidity, wind speed, wind direction, and station pressure. The data will be downloaded, compiled and wind roses prepared for each sampling day.

Digital photographs will be taken to identify each of the monitoring and sampling locations. The layout of each location will be sketched by hand and transferred to graphing software at a later date.

The schedule of activities and reports is as follows:

- Draft Protocols June 30, 2009
- Air Monitoring and Sampling (Florida) June 1- June 20, 2009
- Air Monitoring and Sampling (Louisiana) June 22- July 10, 2009
- Analytical Reports TBD
- Final Report (Protocols for States) TBD

A7. DATA QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT OF DATA

Data will be collected to evaluate the sample collection methods and analytical procedures to assess indoor air levels potentially associated with imported drywall. The results will be utilized to assess if the detection limits are adequate for the future use by public health agencies to evaluate potential exposures associated with the drywall.

The design of the study will collect information related to variance of the different methods in six houses (two houses in Florida and two houses in Louisiana with imported drywall and one house in Florida and one house in Louisiana without imported drywall). Coefficients of variance will be derived to assist future studies in developing power curves for purposes of experimental design.

The typical detection or reporting limits for this project based on manufacturer's claims or cited analytical methods are tabulated below:

Monitoring Parameter	Instrument	Range or Detection Limit
VOCs	MultiRAE/AreaRAE	0.1 – 200 ppm
H ₂ S	SPM	2 - 90 ppb (low range) 53 – 1500 ppb (MVIP range)
SO ₂	SPM	0.2 – 6.0 ppm
H ₂ SO ₄	SPM	26 – 750 ppb
Monitoring Parameter	Instrument	Range or Detection Limit

CO	Grey Wolf	0 – 500 ppm
CO2	Grey Wolf	0 – 10,000 ppm
Temperature	Grey Wolf	15 – 160°F (-10 - 70°C)
Humidity	Grey Wolf	0 – 100%

Sample Analysis	Reporting Limit	Matrix
VOCs (SUMMA canisters)	0.070 ppbv	Air
VOCs (Sorbent Tubes)	~2 to 10 µg/sample (volume dependent)	Air
PAHs (XAD Tubes)	~0.1 to 0.2 µg/sample (volume dependent)	Air
Inorganic Acids	~0.0005mg/sample (volume dependent)	Air
Aldehydes/Ketones	~0.1 ppbv (volume dependent)	Air
Sulfur Compounds	Compound specific	Air
Amines, Aliphatic	0.02 mg/sample (volume dependent)	Air
Amines, Aromatic	0.1 to 3 mg/sample (volume dependent)	Air

Data categories (DCs) corresponding to the data use objectives required for successful completion of this project are summarized in Table 1, *Field Sampling Summary* and Table 2, *QA/QC Analyses and Data Categories Summary*. These tables identify analytical parameters desired; type, volume and number of containers needed; preservation requirements; number of samples to be collected; and associated number and type of QA/QC samples based on the data category. Two of the three DCs based on the two Superfund Data Categories described in the 1993 Office of Solid Waste and Emergency Response (OSWER), Office of Emergency and Remedial Response (OERR) Directive, Screening Data (SD) and Definitive Data (DD), will be used for this project and are described below.

Screening data will be applicable to “real-time” air monitoring data for the preliminary identification and quantitation of contaminants. Screening data without definitive confirmation is not considered to be “data of known quality.” The following requirements for “SD” are applicable to all air monitoring activities:

1. Sample documentation in the form of field logbooks and appropriate field data sheets. Chain of custody (COC) records is optional for field screening locations.
2. All instrument calibration and/or performance check procedures/methods will be summarized and documented in the field/personal or instrument log notebook. The manufacturer’s instructions or standard operating procedures (SOPs) should specify the procedure and frequency for calibration during use.
3. Detection limit(s) will be determined and documented, along with the data, where appropriate.

Definitive data (DD) are used for all data collection activities that require a high level of accuracy using USEPA, National Institute of Occupational Safety and Health (NIOSH) and other industry-recognized methods. For the data to be definitive, either total measurement error or analytical error must be determined. Definitive data will be used to assess health risk or environmental impact and/or delineation of contaminants by ATSDR/FDOH. The following requirements for “DD” are applicable to all air samples:

1. Sample documentation in the form of field logbooks, the appropriate field data sheets, and COC forms will be provided
2. All instrument calibration and/or performance check procedures/methods will be summarized and documented in the field/personal or instrument log notebook.
3. Detection limit(s) will be determined and documented, along with the data, where appropriate
4. Sample holding times will be documented; this includes documentation of sample collection and analysis dates
5. Initial and continuing instrument calibration data will be provided.
6. For air samples, one trip blank will be included with each shipment of samples
7. Performance Evaluation (PE) samples are optional
8. Analyte identification will be confirmed on 100 percent of the samples by analytical methods associated with definitive data
9. Quantitation results for all samples will be provided
10. Analytical or total measurement error must be determined on 100 percent of the samples.
 - (a) Analytical error determination measures the precision of the analytical method. At a minimum, two replicate aliquots are taken from a thoroughly homogenized sample or two media blanks, prepared and analyzed in accordance with the method, calculated and compared to method-specific performance criteria.
 - (b) Total measurement error is determined from independently collected samples from the same location and analyzed by analytical methods associated with definitive data. Quality control parameters such as the mean, variance, and coefficient of variation is calculated and compared to established measurement criteria.

The data use categories are based on the Data Quality Indicators (DQIs) used to determine the acceptability or usability of the data. Two DQIs used in the laboratory measurement process are precision and accuracy

- Precision is a measure of agreement between replicate measurements under similar conditions and may be expressed as Relative Percent Difference (RPD). A Percent Difference (%D) or RPD may be calculated between the results of a sample and a field duplicate sample after the measurement process is complete.
- Accuracy is a measure of the agreement between an observed value and an accepted reference value. This will be determined by analyzing a known reference material or a sample to which a specific amount of a known reference material has been added. Accuracy will be expressed as Percent Recovery (%R). Since accuracy takes into account the effects of variability (precision), accuracy is a combination of bias and precision

A8 TRAINING AND CERTIFICATION

All field personnel involved with sampling activities will have the following documented training:

- Occupational Safety and Health Administration (OSHA) 40-hour and/or 8-hour refresher in Hazardous Waste Operations (29 CFR 1910.120)
- Department of Transportation (DOT) hazardous materials shipping
- First Aid and Cardiopulmonary Resuscitation (CPR) training (at least one team member)
- Demonstration of Capability per parameter per analyst and per matrix.

A9. DOCUMENTS AND RECORDS

Documents and records that will be generated during this project include:

- Sampling and Monitoring Protocols
- Analytical Reports
- Sample Labels
- COC Forms
- Custody Seals
- Air Sampling Work Sheets
- Air Monitoring Work Sheets
- Instrument Printouts
- Data Review Records
- Data Reduction Records
- Data Assessment Forms
- Data Validation Records
- Final Report

All documentation will be recorded in accordance with SOP #2002, *Sample Documentation*. This will include but is not limited to sample identification (ID), orifice and SUMMA[®] ID, identity of samplers, flow rate, vacuum before and after, and dates and times of sample collection. Analytical Reports will be prepared using SOP #4020, *Analytical Report Preparation*. The Final Report will provide a description of the project, field procedures, and laboratory procedures and will include final laboratory results with appropriate data validation report.

B. DATA GENERATION AND ACQUISITION

B1. SAMPLING/MONITORING PLAN DESIGN

Sufficient data should be obtained with the real-time instrument during the initial entry to screen the site for the appropriate contaminants. These gross measurements may be used on a preliminary basis to (1) determine levels of personal protection, (2) establish site work zones, and (3) map candidate areas for more thorough qualitative and quantitative studies involving air sampling.

Two homes with the imported drywall will be selected in both Florida and Louisiana. One home with US-manufactured drywall will be tested as a reference in conjunction with the selected homes in both Florida and Louisiana. One outdoor ambient air sample will be selected outside of each residence to evaluate the impact of ambient air on the indoor air. If the two homes are located within close proximity of each other, it may be feasible to select one ambient air location for both residences. Monitoring and sampling will not be conducted if there is a rainfall event. A rainfall event is defined as more than 5 minutes of precipitation. Samples taken outdoors during a rainfall event will be either analyzed and the results will be flagged or discarded altogether.

Air sampling will be performed for VOCs using SUMMA[®] canisters, VOCs in sorbent tubes, PAHs, inorganic acids, aldehydes/ketones and aliphatic and aromatic amines. Sulfur-containing compounds such as H₂S, carbonyl sulfide, carbon disulfide, dimethyl sulfide, dimethyl disulfide and mercaptans samples will be collected during each sampling event at one selected location. One sampling location in the living room area and one sampling location in the master bedroom or other sleeping area will be selected. Four sampling events will be conducted in unoccupied homes in each state of approximately 8-12 hour duration. Two sampling events will occur during the day and the other two during night time hours. Ambient air samples will be collected in conjunction with the indoor air samples outside of each home; the number of ambient air samples may vary depending upon the locations of the homes selected. Indoor air and ambient air samples will be collected at breathing height approximately 3 feet above the ground level. The summa grab sample will be taken once during every event for analysis for total VOCs (USEPA I0-15). Three air samples will be collected in each house using appropriate method for all events for each analysis and continuous reading instruments will be recorded throughout the sampling procedures at two locations.

Triplicate air samples from one selected wall cavity will be collected once a day from each house into appropriate bags, and analyzed for hydrogen sulfide, carbonyl sulfide, carbon disulfide, dimethylsulfide and dimethyldisulfide by the contract laboratory, using ASTM D5504-1

B2. SAMPLING/MONITORING METHODS

Toxic Gas Analyzer Monitoring. The toxic gas analyzer (MultiRAE/AreaRAE) is a compound-specific instrument designed and calibrated to identify and quantify a specific compound or class of compounds in either gaseous or vapor form. A data logger will be used to collect real-time data in 15-minute averages. Monitoring will be conducted in accordance with SOP #2139, *Operation of the MultiRAE Plus Multi Gas Monitor* and manufacturer's recommendations.

Single-Point Monitoring (SPM). The SPM or tapemeter employs a specially treated cloth tape reel called a "Chemcassette" and an electronic key called a "ChemKey" for the monitoring of H₂S, SO₂ and H₂SO₄. The ChemKey stores setup information and other functional information (i.e., flow rate, alarm levels and compound concentration times) needed for accurate detection of target gases. The Chemcassette is a medium onto which a known quantity of ambient air is concentrated. The use of the Chemcassette as a concentration media allows the instrument to monitor a variety of compounds in some cases down to the low parts per billion (ppb) ranges. When the tapemeter is monitoring, the tape from the Chemcassette is drawn into the "read head" where it is exposed to a predetermined amount of ambient air. If the target gas is present the tape responds with a color change in proportion to the concentration of the target gas present. The tapemeter reads this color change and through the ChemKey converts the observed color change into the concentration which is sent to the SPM light emitting diode (LED) display. The range and detection limits of the SPM are determined by the pre-programmed ChemKey specific for an analyte or a group of analytes. If monitoring is required, it will be performed in accordance with SOP #2115, *Single Point Monitor*.

Jerome H₂S Monitoring. Additional air monitoring may be conducted using the Jerome[®] 631-X. The Jerome[®] 631-X is a portable H₂S analyzer that displays low level concentrations with an analysis range of 0.003-50 ppm. When locked in survey mode, the 631-X automatically displays H₂S concentrations as quickly as every 3 seconds. The Jerome[®] 631-X utilizes a gold film sensor. The sensor's selectivity to H₂S eliminates interferences from sulfur dioxide, carbon dioxide, carbon monoxide, and water vapors. When the sample button is pressed, an internal pump draws air into the instrument. Any H₂S in the sample is absorbed by the sensor which registers a proportional change in electrical resistance. The H₂S concentration is displayed on the liquid crystal display (LCD), where it remains until the next sample is taken.

CO, CO₂, Relative Humidity (RH) and Temperature Monitoring. Air monitoring for CO, CO₂, RH and temperature will be performed utilizing the GreyWolf IQ410. CO₂ is measured using non dispersive infrared spectroscopy. CO is measured by an electrochemical sensor. Percent RH is measured by absorption or desorption of moisture by a thin polymeric film. For temperature, resistance over platinum element is measured. The Grey Wolf will be operated in accordance with SOP #1728, *Indoor Air Quality Monitoring Using the Wolfsense IAQ Probe*

Meteorological Monitoring. A Met One meteorological monitoring station will be set up to monitor wind speed, wind direction, barometric pressure, temperature, solar radiation, and rainfall. Operation of the Met One will be done in accordance with SOP #2129, *Met One Remote Meteorological Station*. Data will be processed using SOP #2138, *Installation and Use of the MicroMet Plus[®] Software*.

Digital photographs will be taken to identify the monitoring and sampling locations.

SUMMA[®] Canister Air Sampling. Grab air samples will be collected from each of the locations in SUMMA[®] canisters. Each SUMMA[®] canister for ambient air sampling will be opened for 30 seconds to collect 6 liters (L) of sample during the grab sampling period. SUMMA[®] canister sampling will be performed in accordance with SOP #1704, *SUMMA[®] Canister Sampling*

VOC Sampling. Ambient air sampling will be conducted following modified NIOSH Method 1500,

Hydrocarbons, BP 36-126 °C, Method 1501, Hydrocarbons, Aromatic and Method 1003, Hydrocarbons, Halogenated. The sampling train will consist of a 600-milligram (mg) charcoal solid sorbent tube connected to a low/high flow personal sampling pump (SKC). The sampling pump will be calibrated to collect approximately 1.0 liter per minute (L/min) of air through the sorbent tube for 8-12 hours for a total of 480-720 L.

PAH Sampling. Ambient air sampling for PAHs will be conducted following modified NIOSH Method 5515, *Polynuclear Aromatic Hydrocarbons*. The sampling train will consist of a 600-mg washed XAD-2 sorbent tube with 2-micron (um), 37-millimeter (mm) Teflon® (PTFE) filter connected to personal sampling pump (SKC). The sampling pumps will be calibrated to collect approximately 1.0 L/min of air through the sorbent tube and filter for approximately 8-12 hours for a total of 480 to 720 L.

Inorganic Acid Sampling. Ambient air sampling for inorganic acids will be conducted following NIOSH Method 7903, *Acids, Inorganic*. The sampling train consists of a 600-mg specially cleaned silica gel tube connected to a sampling pump. The SKC sampling pump will be calibrated to collect approximately 0.2 L/min of air through the tube for approximately 8-12 hours for a total of 96-144 L.

NOTE: For aldehydes/ketones, sulfur dioxide and aliphatic and aromatic amine sampling, high humidity may cause moisture buildup on the silica gel media; thereby reducing the total volume of air that may be drawn onto the sorbent tubes.

Aldehyde/Ketone Sampling. Ambient and indoor air sampling for aldehydes/ketones will be conducted using USEPA IO-11A, *Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Pressure Liquid Chromatography (HPLC)*. The sampling train consists of a 150/300 mg silica gel tube treated with 2, 4-dinitrophenylhydrazine (DNPH) connected to a personal sampling pump. The SKC sampling pump will be calibrated to collect approximately 1.0 L/min of air through the tube for approximately 8-12 hours for a total of 480 to 720 L.

Aliphatic and Aromatic Amine Sampling. Ambient and indoor air sampling for amines will be conducted following a NIOSH Method 2002, *Amines, Aromatic*, and NIOSH Method 2010, *Amines, Aliphatic*. Two separate sampling trains consisting of a 225-mg silica gel tube connected to a personal sampling pump. The sampling pump will be calibrated to collect approximately 0.2 L/min of air through the filter. Sampling will be conducted for 8-12 hours with air volume targeted to be between 96 and 144 L.

Sulfur Compounds: Ambient and indoor air samples will be collected into 1-L Tedlar® bags in accordance with SOP # 2102, *Tedlar Bag Sampling*. The Tedlar® bag is placed into the vacuum box and the fitting is attached to the sampling port and Teflon® tubing. The pump is attached to the Tygon® tubing, which is connected to the fitting on the vacuum box. The pump will evacuate the air in the vacuum box, creating a pressure differential that causes the sample to be drawn into the bag. The sample introduced into the Tedlar® bag never passes through the pump.

B3 SAMPLE HANDLING AND CUSTODY

COC records will be used to document all SUMMA® samples collected. All COC records will be peer reviewed in the field prior to release. At least two custody seals will be placed across the canister shipping containers to ensure sample integrity. The samples collected by field personnel will be shipped to the designated laboratories in Section A4 for analysis in accordance with SOP #2004, *Sample Packaging and Shipment*. Scriber will be used for overall sample management and for the preparation of COC records and sample labels.

B4 ANALYTICAL METHODS

The following methods will be used to analyze samples in the laboratory for this project:

Parameter	Method	Matrix
VOCs (SUMMA Canisters)	SOP #1814, <i>GC/MS Analysis of Sorbent Tubes and Canisters (Including up to 30 TICs)</i>	Air
VOCs (Sorbent Tubes)	SOP #1816, <i>Indoor Air Analysis of Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry (Including up to 30 TICs)</i>	Air
PAHs (Sorbent Tubes)	SOP #1817, <i>Analysis of Polynuclear Aromatic Hydrocarbons (PAHs) in Air by GC/MS(Including up to 30 TICs)</i>	Air
Inorganic Acids	NIOSH Method 7903, <i>Acids, Inorganic</i>	Air
Aldehydes/Ketones	USEPA Method TO-11A, <i>Determination of Formaldehyde in Ambient Air Using Adsorbent Cartridge Followed by High Pressure Liquid Chromatography (HPLC)</i>	Air
Sulfur Compounds	ASTM Method D-5504-01, <i>Determination of Sulfur Compounds in Natural Gas and Gaseous Fuels by Gas Chromatography and Chemiluminescence</i>	Air
Aliphatic Amines	NIOSH Method 2010, <i>Amines, Aliphatic</i>	Air
Aromatic Amines	NIOSH Method 2002, <i>Amines, Aromatic</i>	Air

TICs = Tentatively Identified Compounds

B5. QUALITY CONTROL

Appropriate QA/QC samples will be collected using the guidelines in SOP #2005, *Quality Assurance/Quality Control Samples*. Field QC samples are designed to assess the variability of the matrix or medium being sampled, and to detect contamination and sampling error in the field.

The following field QC samples will be collected during sampling:

- For VOCs, trip blanks will be collected at the frequency of one per shipment,
- For all sampling media, with the exception of SUMMA[®] canisters, a field blank will be collected for each day of sampling,
- For all sampling media, with the exception of SUMMA[®] canisters, a lot blank will be collected for each used during sampling, and
- For all sampling media, with the exception of SUMMA[®] canisters, two sorbent tubes will be submitted to be used as a blank spike/blank spike duplicate.

Laboratory QC samples are analyzed in the laboratory and are used to determine any matrix effects and to assess the performance of the laboratory. The following QC samples will be run for the VOC air analysis of SUMMA[®] canisters:

- System blanks for VOC gas chromatography/mass spectrometry (GC/MS) analyses,
- Replicate analysis at the frequency of 5 percent,
- Laboratory Control Sample (LCS) at the frequency of 5 percent.

The following QC samples will be run for VOCs (sorbent tubes), PAHs, aldehydes/ketones, aliphatic and aromatic amines, inorganic acids and sulfur compounds in air:

- One method blank must be prepared for each batch of 20 samples
- One BS/BSD must be prepared every 20 samples or per project.
- One lot blank must be extracted and analyzed for each tube and filter lot represented in the sampling event.

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

The ability to generate data of known quality is dependent on the maintenance of equipment and analytical instrumentation on a routine and as needed basis. Preventive maintenance actions are taken to prevent instruments from failing during use, to ensure proper instrument performance, and to increase the reliability of the measurement system. Typically, maintenance is initiated when the QC requirements of the method are not met, previous experience with the instrument indicates maintenance should be performed, manufacturer's recommendations, a schedule determined by each group, or prior to and after monitoring and sampling. Each piece of equipment and analytical instrument is assigned a preventive maintenance logbook. All maintenance activities are recorded in this logbook and include the following information: date of service, person/vendor performing the service, type of maintenance performed and the reason, parts replaced, and any other pertinent information. In addition, an ample supply of spare parts is maintained by each group to minimize downtime of the equipment/instruments. Repairs are defined as any unscheduled service or maintenance required on equipment or instrumentation that cannot be handled by field or laboratory personnel. Any repairs made on equipment or instrumentation is also documented in the preventive maintenance log. The service or work orders should be taped in the logbook, and signed and dated across the tape.

Contractor personnel will be responsible for conducting preventive maintenance on a routine and on an as-needed basis to prevent instruments/equipment from failing during use, ensure proper performance and increase the reliability of the system. Each piece of equipment will be checked operationally prior to deployment.

On a monthly basis, the following maintenance is conducted on the SPM, as required:

- Verify system response including electronics and optical system,
- Perform leak test,
- Perform gross alarm simulation,
- Replace acid scrubber and particulate filters,
- Conduct full alarm simulation,
- Conduct inventory of appropriate Chemcassette® checking expiration dates.

On a quarterly basis, the following maintenance is conducted on the Jerome® 631x, as required:

- Perform heat sensor regeneration,
- Zero the instrument,
- Check air intake,
- Change desiccant.
- Charge/change batteries,
- Change zero air or mercury exhaust filters,
- Change internal filters and/or intake filter disc,
- Perform functionality check.

The MultiRAE/AreaRAE are maintained on a monthly basis and checked prior to use in the field. All maintenance activities are documented within instrument/equipment-specific maintenance logbooks. Maintenance includes but is not limited to cleaning the unit and the PID, verifying date and time set, and changing particulate/water trap filters.

The ERT/REAC Laboratory and the outside laboratories will be responsible for maintaining laboratory equipment.

B7. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Operational calibration is generally performed as part of the analytical procedure and is dependent upon the type of instrumentation. Typically, certified standards with certificates of analysis are used to prepare calibration standards for analytical instruments. Preparation of a standard curve is accomplished by using calibration standards containing the species to be analyzed into a specific solvent mixture to be introduced into the instrument. The concentrations of the working standards are chosen to cover the working range of the instrument. The calibration curve is prepared by plotting instrument response versus the concentration of the standards. Concentrations of the samples analyzed are read directly from the calibration curve or determined by interpolation.

Instrument calibration typically consists of two types: initial calibration and continuing calibration. Initial calibration procedures establish the calibration range of the instrument and determine the instrument response over that range. The instrument response may be area counts, peak height, or absorbance, and is expressed as a percentage relative standard deviation (RSD) or a correlation coefficient. Continuing calibration measures the instrument response to a single calibration standard, and the response is compared with the initial calibration. Continuing calibration may be used as a single point within a 12-hour period, or every 10 samples, depending on the analyte to be measured.

Calibration of flow rate for air sampling will be performed before sampling is initiated and after sampling is completed. A secondary calibration device that has been calibrated against a primary calibrator will be used to determine the initial and final flow rates. The flow rate used to determine the volume of air sampled will be the average of the initial and final flow rates. All information will be recorded on the air sampling worksheets.

The Jerome® 631-X H₂S monitor is factory calibrated on an annual basis and a functionality check is conducted on a monthly basis.

The SPM units do not require annual calibration. The functionality test of the SPM optics is performed on a monthly basis to verify the system response, using an optical test card. An additional leak test of the unit is performed to ensure that no leaks are present between the sampling point and the SPM. A visual and audible alarm test is also performed to simulate four gas conditions: sub-alarm concentration, above alarm level 1, above alarm level 2, above full scale. MultiRAE calibration is performed on a monthly basis or more frequently if necessary.

The PID used to measure total VOCs will be calibrated using isobutylene as the calibration gas on a monthly basis and prior to use. Each of the toxic gas sensors will be checked using a certified gas specific to the sensors installed in the instrument.

For VOCs in SUMMA® canisters and charcoal tubes and PAHs in XAD tubes, the GC/MS must meet the ion abundance tune criteria before initiating acquisition activities involving samples, blanks, or standards every 24 hours during sample analysis. Once the tune criteria have been met, the GC/MS system must be initially calibrated using a minimum of five concentrations to determine the linear response of the target analytes. After 24 hours of sample acquisition have passed, the GC/MS must be re-tuned and the initial calibration curve verified by the mid-level calibration standard.

Any calibrations conducted by an outside laboratory for inorganic acids, aliphatic and aromatic amines and sulfur-containing compounds will be done in accordance with the cited analytical methods or the laboratory's SOPs and its Quality Assurance (QA) Manual.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Contractor personnel will have the responsibility for the inspection and acceptance of supplies and consumables. It is the responsibility of the USEPA/ERT to provide adequate facilities, equipment and supplies for the contractor to perform all field-related tasks for this Work Assignment. The ERT contractor is responsible for the procurement, inspection, and acceptance of supplies and consumables for this Work.

Assignment The outside laboratories will be responsible for the inspection and acceptance of supplies and consumables for the analytical activities subcontracted to them.

B9. NON-DIRECT MEASUREMENTS

This section is not applicable to this QAPP.

B10 DATA MANAGEMENT

Samples will be delivered under COC to the specified laboratories. Samples will be identified by the field assigned number. The incoming samples will be checked against the COC for accuracy and assigned a unique laboratory number, which identifies the sample to the laboratory personnel. This number can later be cross-referenced to the field number. All laboratory procedures will be reviewed and the data verified for the appropriate QA objectives. Any problems identified will be brought to the attention of the USEPA/ERT Project Lead for resolution before release of the Final Report. Hard copies and electronic copies of all deliverables will be stored by the contractor in Central Files and on archive drive. All data deliverables for this Work Assignment will be posted to the ERI-Information Management System (IMS) website either as a Scribe electronic data deliverable (EDD) or in portable document format (.pdf). Any SOPs or APs referenced in this QAPP are available as uncontrolled copies. Site logbooks and field sampling worksheets will also be archived once the project has been completed.

C. ASSESSMENT/OVERSIGHT

C1. ASSESSMENT AND RESPONSE ACTIONS

The ERI Technical Lead, ERI Project Lead, USEPA Project Lead, and the OSRTI QA Manager are responsible for QC assessments and corrective action for this project. The tasks associated with this QAPP are assessed through the use of peer reviews and management system reviews. Peer review enables the reviewers to identify and correct reporting errors before reports are submitted. Management system reviews establish compliance with prevailing management structure, policies and procedures, and ensures that the required data are obtained.

The USEPA/ERT Technical Lead will have the responsibility for verifying that the proper SOPs and sampling procedures are followed. If any technical issues or deficiencies are identified, the USEPA/ERT Project Lead will be notified and will pursue immediate resolution or corrective action. Any changes in scope of work will be documented and approved by the USEPA Project Lead.

C2 REPORTS TO MANAGEMENT

The ERI Technical Lead will issue weekly status report to the ERI Director, ATSDR, and the States Department of Health. The ERI Director will update the senior EPA management on a weekly basis.

D DATA VALIDATION AND USABILITY

D1 DATA REVIEW, VERIFICATION AND VALIDATION

All data produced under this QAPP will be evaluated to determine compliance with the stated collection methods, type, and number of samples collected, sample handling, and correct analytical procedures. Data review will be conducted in the laboratory prior to data release to evaluate the validity of the sample batch. Two data quality indicators, precision and accuracy, will be used to assess the batch. Data verification is the steps taken to determine whether the quality requirements specified in the "B" elements of this QAPP have been met. For field activities, it is necessary to determine whether the samples were collected using the sampling design specified in element B1, whether the samples were collected according to a specific method or SOP as specified in element B2, whether the collected samples have been recorded and handled properly as in element B3, and whether the proper amount of QC samples were taken to satisfy the QC requirements specified in element B5. For analytical activities, each sample should be verified to ensure that the procedures

used to generate the data (as specified in element B4) were performed as specified. The proper amount of QC checks (as specified in element B5) that were prepared and analyzed during the actual analysis provide an indication of the quality of the data. Instrument calibrations (as specified in element B7) are evaluated to determine whether the correct number of calibration standards were used and the range of the analysis, whether standards were analyzed in an appropriate sequence specific to the methods used, and were performed prior to the analysis of samples, blanks and QC samples in an appropriate time frame.

The Contractor's DV&RW Group is responsible for reviewing the data against a set of criteria to verify its validity prior to use. The data validation process summarizes the data and QC deficiencies, and determines the impact on the overall data quality. Data validation qualifiers are assigned in the data assessment records, flagged on the results tables and are noted in the case narrative of the final analytical report.

D2. VERIFICATION AND VALIDATION METHODS

Data verification occurs at each level in the field and in the laboratory to ensure that appropriate outputs are being generated routinely. Records produced electronically or maintained as hard copies are subject to data verification. During field activities, records associated with sample collection such as field data sheets, COC records, shipper's air bills, logbook documentation, or electronic devices to log samples or print sample labels are verified against approved SOPs or procedures. At sample receipt, COC records are verified along with refrigerator and freezer logs to ensure the integrity of the samples. During sample preparation, digestion/extraction logs, certificates of analysis for surrogates and spiking compounds, refrigerator and freezer logs, analytical requests and standard preparation logs are verified. Manufacturer's certificates for calibration and/or internal standards, instrument run or injection logs, standard preparation logs, calculation worksheets, and QC sample results are verified during the analysis of the sample set. Review of data package or client deliverables are verified for compliance with peer review procedures.

Data validation will be conducted on all of the analytical data packages to determine how seriously the sample data deviate from acceptance limits and the potential effect on the data. All anomalies will be documented in the case narrative of the final analytical report. Data will be validated in accordance with National Functional Guidelines or contractor data validation SOPs.

D3. RECONCILIATION WITH USER REQUIREMENTS

Responsibility lies with the USEPA.

REFERENCES

U.S. Environmental Protection Agency. 2001. USEPA Requirements for *Quality Assurance Project Plans* (EPA QA/R-5), EPA/240/B-01/003, Office of Environmental Information.

U.S. Environmental Protection Agency. 1990. *Quality Assurance/Quality Control Guidance for Removal Activities*, EPA/540/G-90/004, Office of Emergency and Remedial Response.

Response, Engineering and Analytical Contract. 2003. *Quality Assurance Project Plan for the Response Engineering and Analytical Contract*.

United States Environmental Protection Agency. 2005. *Uniform Federal Policy for Quality Assurance Project Plans*, EPA-505-B-04-900A, Version 1.

WWW.EPA.ORG/SOP

TABLE 1. Field Sampling Summary - Air
Drywall Investigation
May 2009

Analytical Parameter	Action Level	Sampling Media	Suggested Holding Times	Flow Rate	Volume Min - Max	Subtotal Number
VOCs	TBD	SUMMA [®] Canisters	30 days	Grab	6 L	36
VOCs	TBD	600 mg Carbon Tube	14 days at 4°C	1 L/min	480 to 720 L	60
PAHs	TBD	XAD-2 Tube/ PTFE Filter	14 days at 4°C	1 L/min	480 to 720 L	60
Inorganic Acids	TBD	600 mg Silica Gel Tube	21 days	0.3 L/min	96 to 144 L	60
Aldehydes/Ketones	TBD	150/300 mg silica gel tube w/DNPH	14 days at 4°C	1 L/min	480 to 720 L	60
Sulfur Compounds	TBD	1-L Tedlar Bag	24 hours	Grab	1.0 L	54
Amines, Aliphatic	TBD	225 mg silica gel tube	14 days at 4°C	0.2 L/min	96 to 144 L	60
Amines, Aromatic	TBD	225 mg silica gel tube	7 days at 4°C	0.2 L/min	96 to 144 L	60

NOTES: L = liters, TBD = To be determined, VOCs = volatile organic compounds, SO₂ = sulfur dioxide, H₂SO₃ = Sulfurous acid, CO = Carbon monoxide, CO₂ = Carbon dioxide, L/min = liters per minute, mg = milligrams, PAH = Polycyclic aromatic hydrocarbons

- The concentration level, specific or generic, which is needed in order to make an evaluation. This level will provide a basis for determining the analytical method to be used in consultation with ATSDR, and State of Florida and Louisiana.

TABLE 2. QA/QC Analyses and Data Categories Summary - Air
 Drywall Investigation
 May 2009

Analytical Parameter	Analytical Method	Estimated Limit of Detection ¹	Lot Blanks ²	Ambient Air Samples ³	Collocated Samples ⁴	Trip Blanks ⁵	Breakthrough ⁶	PE Samples ⁷	Data Category ⁸
VOCs	REAC SOP #1814	0.070 ppbv	NA	1/home	NA	1/shipment	NA	NA	DD
VOCs	REAC SOP #1816	~2 to 10 µg/sample	1	1/home	NA	1/shipment	NA	NA	DD
PAHs	REAC SOP #1817	0.1 to 0.2 µg/sample	1	1/home	NA	NA	NA	NA	DD
Inorganic Acids	NIOSH 7903	~0.0005 mg/sample	1	1/home	NA	NA	NA	NA	DD
Aldehydes/Ketones	EPA Method TO-11A	~0.1 ppbv (volume dependent)	1	1/home	NA	NA	NA	NA	DD
Sulfur Compounds	ASTM D5504-01	Compound Specific	1	1/home	NA	NA	NA	NA	DD
Amines, Aliphatic	NIOSH Method 2010	0.02 mg/sample	1	1/home	NA	NA	NA	NA	DD
Amines, Aromatic	NIOSH Method 2002	0.1 to 3 mg/sample	1	1/home	NA	NA	NA	NA	DD

Analytical Parameter	Analytical Method	Estimated Limit of Detection ¹	Lot Blanks ²	Ambient Air Samples ³	Collocated Samples ⁴	Trip Blanks ⁵	Breakthrough ⁶	PE Samples ⁷	Data Category ⁸
VOCs	MultiRAE	0.1 ppm	NA	NA	NA	NA	NA	NA	SD
H ₂ S	SPM	1 ppb	NA	NA	NA	NA	NA	NA	SD
SO ₂	SPM	0.2 ppm	NA	NA	NA	NA	NA	NA	SD
SO ₂	MultiRAE	0.1 ppm	NA	NA	NA	NA	NA	NA	SD
H ₂ SO ₄	SPM	26 ppb	NA	NA	NA	NA	NA	NA	SD
CO	Grey Wolf	1 ppm	NA	NA	NA	NA	NA	NA	SD
CO ₂	Grey Wolf	1 ppm	NA	NA	NA	NA	NA	NA	SD
Temperature	Grey Wolf	15°F	NA	NA	NA	NA	NA	NA	SD
Humidity	Grey Wolf	1%	NA	NA	NA	NA	NA	NA	SD

NOTES: DD = Definitive Data, VOCs = Volatile Organic Compounds, H₂S = Hydrogen sulfide, SO₂ = Sulfur Dioxide, H₂SO₄ = Sulfuric Acid, CS₂ = Carbon disulfide, COS = Carbonyl sulfide, DMS = Dimethylsulfide, DMDS = Dimethyldisulfide, CO = Carbon monoxide, CO₂ = Carbon Dioxide

- i. To be determined by the person arranging the analysis. Should be equal to or less than the action level.

2. Required for all data categories at a minimum rate of 10 percent of the total sample or one per sampling event per lot.
3. Mandatory for Definitive Data at a minimum rate of 5 percent of the total sample or one per sampling event. Certain methods may require a greater frequency.
4. Required for all data categories at a minimum rate of 5 percent of the total sample or one per sampling event.
5. Optional for SD/DC and mandatory for DD at a minimum rate of 5 percent of the total sample or one per sampling event.
6. Recommended for SD/DC and DD. Rate is method dependent. Requirement for use is based on deviations from accepted protocol and atmospheric conditions.
7. Performance evaluation samples are optional for SD/DC and DD at one per parameter per matrix. For SD, enter "NA."
8. Enter QA objective desired: SD, SD/DC, DD