VIRGINIA DEPARTMENT OF HEALTH

Office of Environmental Health
Lead Safe Virginia Program

Quality Assurance Project Plan

REVISED DECEMBER 9, 2015

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

Table of Contents

Section 1

Signature Page

REGION 3: THE MID-ATLANTIC STATES

SERVING THE DISTRICT OF COLUMBIA, DELAWARE, MARYLAND, PENNSYLVANIA, VIRGINIA AND WEST VIRGINIA
Environmental Science Center
701 Mapes Road
Fort Meade, Maryland 20755-5350

DATE: December 22, 2015

SUBJECT: Review of Revised Virginia Department of Health Office of Environmental Health Lead Safe Virginia Program Quality Assurance Project Plan [DCN140290]

FROM: Jarmael A. Burman, Chemist
OASQA/QAT (3EA22)

THRU: Fred Foreman, Chief, Technical Services Branch
OASQA (3EA22)

TO: Artencia Johnson, Project Manager
Toxics Program Branch (3LC61)

The Revised Virginia Department of Health Office of Environmental Health Lead Safe Virginia Program Quality Assurance Project Plan (QAPP), prepared by the Virginia Department of Health, was reviewed. The reviewer recommends that this QAPP be approved.

If you have any questions or comments regarding this document, please contact Jay Burman at burman.jarmael@epa.gov (410) 305-2743.

Lead Safe Virginia Program
December 9, 2015

Approval for:
Quality Assurance Project Plan

The Virginia Department of Health, Office of Environmental Health
Lead Safe Virginia Program

Allen L. Knapp
Authorized Certified Official

12/9/15
Date

Nancy K. Van Voorhis
Principal Investigator/QA Manager

12/9/15
Date

Environmental Protection Agency

Artencia Johnson
Region III Lead Program Project Officer

12/23/2015
Date

Section 2

Project Organization, Management Structure, Problem Definition and QA Statement

Project Management

1.1 Distribution List

Individuals who will receive copies of the approved QAPP and any subsequent revisions are listed in Table 1.1 Each individual's role on the project and the organization to which he/she belongs also are provided.

Individual	Organization	Project Responsibility/ Role
	EPA	EPA Approval
Allen L. Knapp	VDH	Authorized Certified Official/Director of Environmental Health
Nancy K. Van Voorhis	VDH	Principal Investigator/ QA Manager Director Lead-Safe Virginia
Trisha Henshaw	DPOR	Training & Certification Lead Workers Deputy Director

1.2 Project Organization and Management Structure

This grant is administered by the Lead Safe Virginia Program in the Division of Food and Environmental Services, Office of Environmental Health, Virginia Department of Health. Blood lead testing is performed by the child's primary care provider in most cases. Case Management of elevated levels is coordinated by the local health departments and the child's primary care provider. Environmental investigation into lead based paint hazards is conducted by the local health departments by environmental health specialists that are licensed risk assessors.

Laboratory analysis and reporting of blood lead levels is the responsibility of the CLIA-approved lab. Environmental samples are submitted to Schneider laboratories.

See organizational charts at end of this section.

1.3 Problem Definition:

Lead poisoning is a continuous environmental health concern in Virginia. Reductions in blood lead levels have been achieved through efforts to remove lead from gasoline, food cans, housing, and consumer products. However, the threat of lead poisoning still exists today through exposure to deteriorating lead-based paint. The primary concern with lead-based paint is that paint dust is harmful when swallowed by children under the age of six. When ingested, lead can affect children's developing nervous systems. The Virginia Department of Health has been awarded a grant from the United States Environmental Protection Agency (EPA) to enhance the efficiency and effectiveness of its Childhood Lead Poisoning Prevention Program (Lead Safe Virginia)

through compliance education and environmental lead exposure response activities in accordance with §402 and §404 of the Toxic Substances Control Act.

1.4 Project Description

Short-term objectives for the Lead-Safe Virginia Program

1. Provide requisite training for state agency employees

2. Provide capacity to test environmental samples on lead poisoned children

3. Continue to provide educational materials and compliance information through the program website with a reciprocal link to DPOR for licensed lead workers

4. Finalize reciprocity among states

5. Increase awareness of all lead-based paint regulations that impact contractors, real estate professionals, renovators, property managers, and maintenance personnel.

6. Keep current the certification/accreditation tests for lead-based paint abatement activities

7. Provide program administration

The long term goal of the program is to reduce the incidence of lead poisoning among children less than six years of age in Virginia. EPA uses the National Health and Nutrition Survey (NHANES) data to evaluate state programs. http://www.cdc.gov/nchs/nhanes.htm

1.5 QA/QC Statement

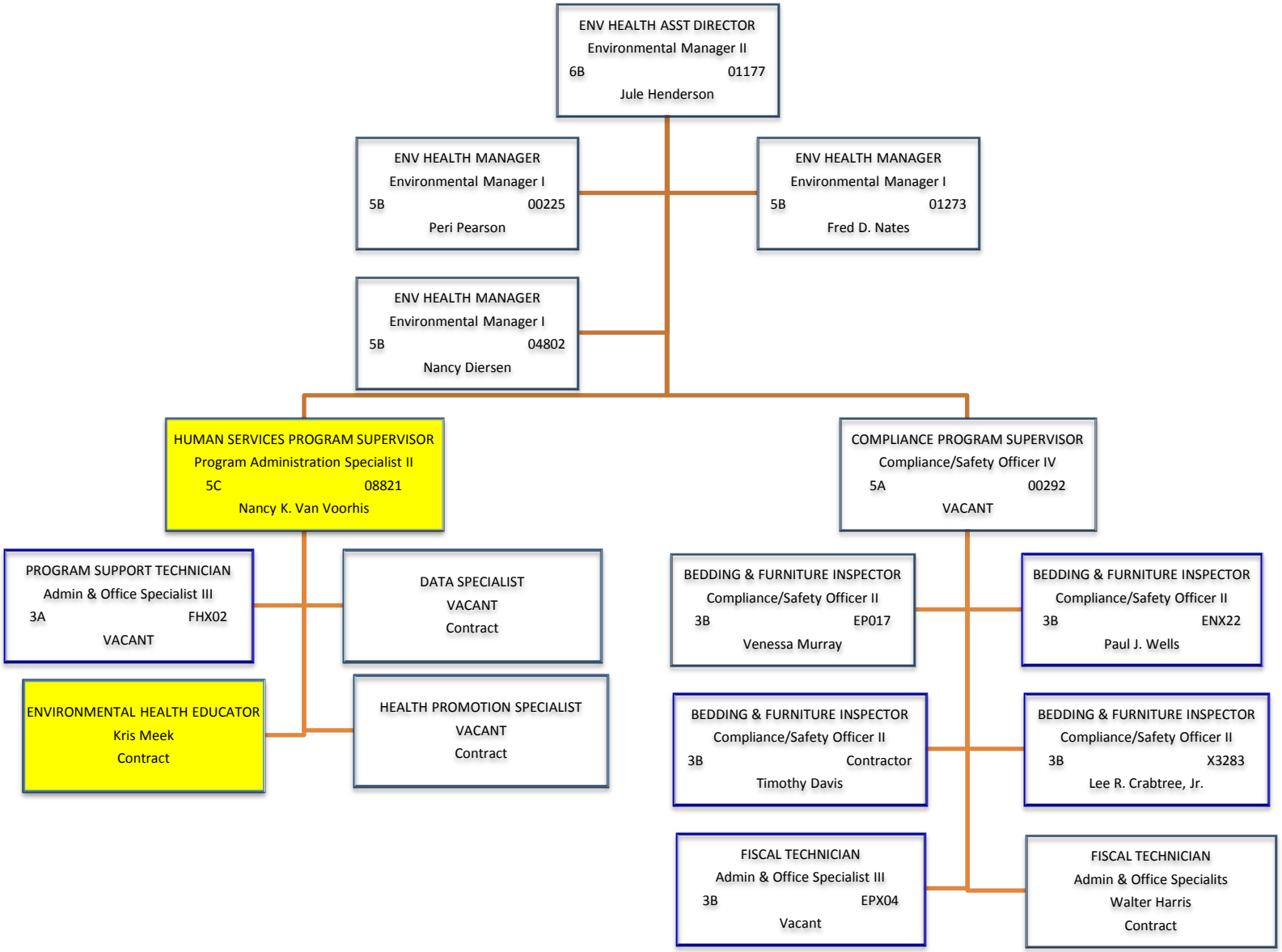
The Quality Assurance and Quality Control issues for this Quality Assurance Project Plan are addressed for five stages. Those stages are:

1. Follow-up referrals for environmental investigations.
2. Field sampling and onsite (XRF) field measurements
3. Laboratory analysis of environmental samples
4. Data review
5. Reporting

Referrals for an environmental investigation are made following a nursing assessment. Field sampling and onsite field measurements are conducted as a risk assessment and are performed in accordance with the guidelines provided in the Virginia Department of Health's "*Environmental Elevated Blood Lead Investigation*

Manual". Laboratory analysis of environmental samples is conducted by Schneider laboratories, an NLLAP certified lab. The QA/QC and SOPs for Schneider are included in this QAPP. Data review involves the assessment of compliance with the QAPP specific requirements for sampling methods and procedures specifically addressing the submittal of field blanks for sampling. Data is reviewed and the interpretation of the presence or absence of any lead hazards is reported to the owner of the residence, tenant, and local building code official. This report is to be in the form of a lead risk assessment report. An example of the report can be found in the VDH *Environmental Elevated Blood Lead Investigation Manual*.

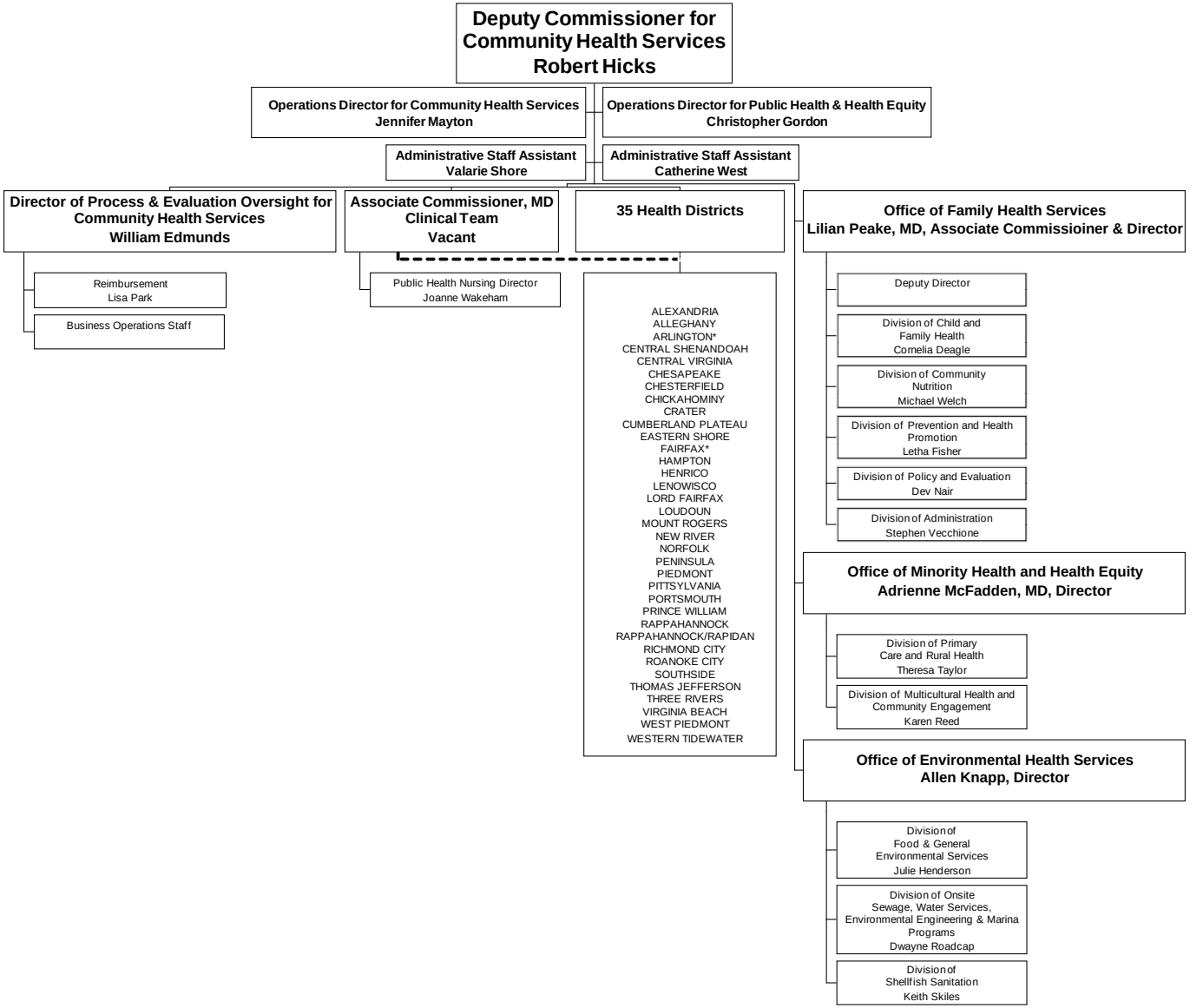
Division of Food and Environmental Services



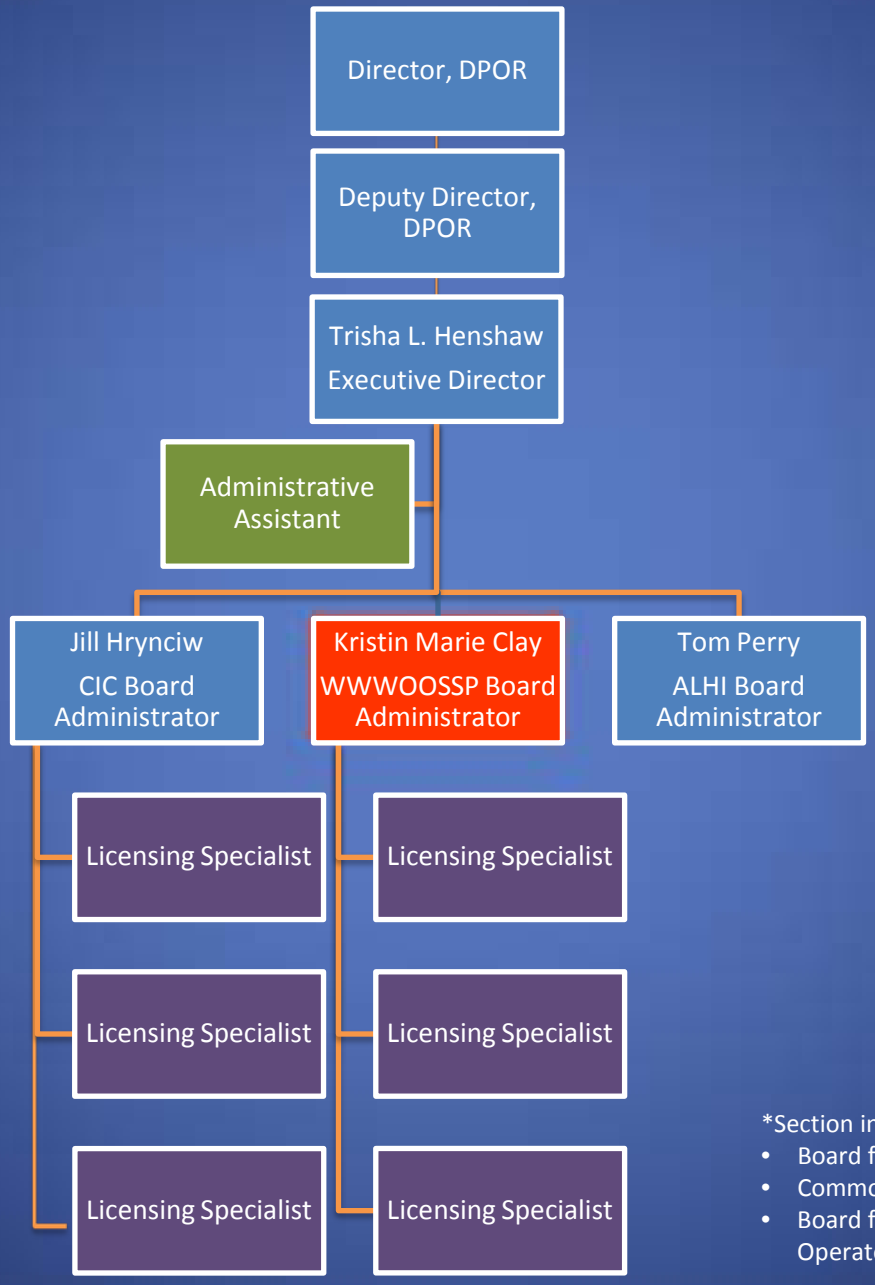
VIRGINIA DEPARTMENT OF HEALTH

Deputy Commissioner for Community Health Services

March 25, 2015



SECTION ORGANIZATION CHART*



*Section includes:

- Board for Asbestos, Lead, & Home Inspectors;
- Common Interest Community Board;
- Board for Waterworks & Wastewater Works Operators and Onsite Sewage System Professionals

Section 3

Nursing Assessment Form

NURSING ASSESSMENT

Check: _____Primary Address _____Related Date:_____

Child's Name:_____ DOB:_____

Parent's Name:_____ Test date:_____ BLL:_____

Address 1:_____

Address 2:_____

Telephone: Home:_____ Cell: _____ Work:_____

No. of children in home < 6 yrs.:_____ Child length of time at residence:_____

Recent immigrant, refugee, or adoptee from another country? ___Yes, ___No

Location if yes:_____

If < 6 months at this address, prior address(es):_____

Primary Care Provider (name and phone): _____

What other houses does your child visit? (include: home of relatives, friends, neighbors, babysitters)
Person Visited:_____Address:_____
Phone #:_____How often?_____
Person Visited:_____Address:_____
Phone #_____How often?_____
Name and address of child care center:_____

Symptoms?

_____None	_____Constipation	_____Hyperactivity	_____Convulsions
_____Nausea	_____Anorexia	_____Muscular Weakness	_____Restlessness
_____Vomiting	_____Lethargy	_____Irritability	_____Diarrhea
_____Anemia	_____Headaches	_____Unusual Behavior	_____Fainting
_____Other	_____Specify:_____		

Date symptoms first noticed:_____

Is child taking iron now? _____Yes _____No
Has he/she taken iron in the past? _____Yes _____No

Number of children in household:_____ Under six years old:_____

	NAME	DOB	TESTED FOR PB	RESULTS
1.	_____	_____	_____	_____
2.	_____	_____	_____	_____
3.	_____	_____	_____	_____

Any children with special needs (handicapped)?_____

Revised 9/16/15

General observation of dwelling unit:_____
Year dwelling was built: _____(if unknown check Trulia or Zillow)
Peeling paint: Yes_____ No_____ Interior_____ Exterior_____
Overall upkeep of interior: Good_____ Fair_____ Poor_____
Housekeeping practice: Good_____ Fair_____ Poor_____

1. Does the child eat, chew, suck on, or touch a lot:

____Plaster
____Paint chips
____Toys/jewelry
____Antique furniture
____Matches
____Mini-blinds
____Newspapers, comics, magazines
____Dirt
____Guard rails
____Other furniture (crib-bed)
____Thumb or fingernails
____ Pets that spend time outdoors
____Doors
____Moldings
____Window sill
____Metal objects, key chains, bullets, sinkers
____Cigarette butts/ashes

2. Where does child sleep?_____
   Is there chipping paint, broken plaster, peeling wallpaper, old window, or mini-blinds near the child's bed that can be easily reached or that can fall into bed.
   _____Yes _____No; If yes, specify_____

3. Does your child take painted or printed objects to bed with him/her?
   _____Yes _____No; If yes, specify:_____

4. Is there any area where the child is during the day or night where he/she could breathe car exhaust, other noticeable vapors, dust fumes or odors? i.e. (domestic trash burning, commercial, industrial exhaust fumes from stoves or fireplaces)(source of wood).
   _____Yes _____No; If yes, specify:_____

5. Live with an adult whose job of hobby involves exposure to lead (examples: highway construction, stained glass, smelting/refining, automotive repairs, pottery, house renovation, painting, or repairs, recycling, etc.)? Describe if yes. _____Yes _____No

6. What kind of pots, pans, and dishes do you use?_____
   i.e. (lead, soldered pots, pans, utensils, ceramics, pottery)
   What do you store food in? Cans – pewter?_____
   What kind of cup does you child drink from?_____
   Do you use kohl or other makeup on your child?_____
   Do you use any special ethnic medicines, spices, powders?_____

7. Do you have a garden?_____ Where located?_____
   Is your drinking water supply a private well? __Yes ___No
   Is there loose paint on wall/ceilings where food is prepared, the child eats, or where the child plays?
   _____Yes_____No; If yes, specify:_____

8. What is you child's favorite place to play or hide?
   Indoors? (ex. closets)_____
   Outdoors? (ex. porch, work shed)_____

9. Has this home or any address where significant time spent had any renovations in the last 6 months?
   _____Yes _____No

10. Is the child currently playing with or have played with any of the recent recalled toys?
    Check www.cspc.gov for a list of recalls ____Yes ___No

Nurses Signature:_____ Date:_____

Revised 9/16/15

Section 4

Follow-up Protocol

REFERRAL: Environmental Elevated Blood Lead Level Investigation Flow Chart

Referral for environmental investigation by case manager

Criteria to initiate an Environmental Investigation:

1. Venous blood lead level persistent or rising 15-19 µg/dL
2. Venous blood lead level ≥ 20 µg/dL
3. More than one child with an elevated blood lead level at a residence

Note: An elevated blood lead test must be a venous test performed by a CLIA approved laboratory

Response time for environmental investigations should occur following the guidance below:

- 15-19 µg/dL persistent-within 2 weeks of referral
- 20-44 µg/dL within on week of referral
- 45-70-44 µg/dL within 48 hours of referral
- ≥ 70 µg/dL within 24 hours of referral

Referral: The *Nursing Assessment Form* is received by risk assessor from the nurse case manager requesting an environmental investigation.

Note: This issue places the responsibility of initiating the environmental follow up in a timely manner on the nurse case manager who has access to the medical information.

Environmental investigation is performed in accordance with the *Environmental Elevated Blood Lead Level Investigation Manual*

The risk assessment report is to be completed one week after the sample results are received from Schneider Labs and the report is to be sent to the 1) owner, 2) tenant, and 3) local building code official.

Note: A copy of the report is to be given to the Case Manager and a copy sent to the Lead-Safe Virginia Program

Section 5

Environmental Investigation
Elevated Blood Lead Level Protocol

Environmental elevated Blood Lead level Investigation Manual

Performing A Risk Assessment For A Child With A Confirmed Environmental Elevated Blood Lead Level

Virginia Department of Health,
Office of Environmental Health
Lead Safe Virginia Program
Revised December 9, 2015

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

Table of Contents

Introduction

Childhood lead poisoning is a major, preventable environmental health problem. The persistence of lead poisoning, in light of present knowledge about the sources, pathways and prevention of lead exposure, continues to present a direct challenge to public health authorities and clinicians. As a result of industrialization, lead is common in the environment. Lead has no known physiological value and children are particularly susceptible to its toxic effects. There is no safe blood lead level. Most children poisoned have no apparent symptoms, and consequently, many cases go undiagnosed and untreated. Any blood lead level may be associated with harmful effects on children's learning and behavior. At higher levels exposure can have devastating health consequences including encephalopathy, seizures, coma and even death.

Lead figured prominently in the fall of the Roman Empire, and it continues to be a subject of vital interest in modern times. Lead is ubiquitous in the environment. Lead can be found in paint, dust, soil, air and water; however, the dust from lead based paint is the main source of lead poisoning in children. Lead poisoning is a silent disease that can cause serious health consequences for children because of its detrimental effects on both physical and mental development.

Lead-based paint was banned for residential use by the United States Consumer Product Safety Commission (CPSC) in 1978. Lead-based paint was used inside homes on woodwork, walls, floors, windows, doors, and stairs because it resisted wear and tear. It was also used on the outside of homes, porches, windows, and doors because it can withstand extreme weather changes. Even greater lead burdens are found in homes built before 1950, as the percent of lead in the paint was very high. Deteriorated paint and paint on friction and impact surfaces contribute to lead content in common household dust. As very young children crawl across floors, touch window sills and other horizontal surfaces, or play on porches or contaminated bare soil areas, they pick up lead dust on their hands, which is ingested when they eat without thoroughly washing their hands and through normal hand- to-mouth activity during play.

Renovation and remodeling activities which disturb lead-based paint by sanding or scraping also contribute significantly to the lead content in household dust. If airborne dust particles are inhaled, the amount of lead absorbed into the bloodstream is up to seven times greater than the amount absorbed by ingestion. Painted toys and non-paint sources such as imported lead-glazed pottery, imported plastic mini blinds, ethnic cosmetics, food and medicinal compounds are all potential sources of lead exposure. Some hobbies such as working on old cars, making stained glass or ammunition, are also potential sources of exposure. Family members can also bring lead into the home through contamination at work.

Remediation of lead poisoning involves both medical and environmental interventions. Lead poisoning is the number one environmental hazard for children and is totally preventable. The federal initiatives which promote primary prevention are grants awarded by the Department of Housing and Urban Development (HUD) for lead hazard reduction activities of privately owned properties, the Environmental Protection Agency's (EPA) development of standards for certification of supervisors, contractors, inspectors, risk assessors, project designers, and workers involved in lead-based paint activities, and the CDC's issuance of grants for support of state and local lead programs. In October 1992, the Residential Lead-Based Paint Hazard Reduction Act (Title X) was signed into law. This has prompted changes that affected property owners, landlords, lenders, realtors, insurers, parents, tenants, abatement contractors, inspectors, laboratories, trainers, home remodelers, and state and local government agencies.

Childhood Lead Poisoning Prevention Program (CLPPP)
Lead Safe *Virginia*

The Commonwealth of Virginia has established the regulatory structure necessary to conduct many types of activities in the prevention and identification of childhood lead poisoning. The Virginia CLPPP, operated through the Lead Safe Virginia Program at the Virginia Department of Health, provides services funded through EPA. Objectives include: 1) referrals for environmental investigations for all children under six years of age with an environmental elevated blood lead level; 2) educate realtors, landlords, renovators, painters, homeowners, property maintenance workers, child care centers, and others regarding lead-safe work practices, using licensed lead workers, and EPA regulations; and 3) implement primary prevention measures to reduce children's exposure to lead hazards through activities and collaboration.

Local health districts are generally responsible for environmental investigations of lead hazards for children with a confirmed venous concentration of lead in blood ≥20 μg/dL, two persistent or rising tests 15-19 μg/dL. These tests must be performed by a CLIA approved laboratory.

The Virginia Department of Health is committed to providing leadership in the development of these activities and to providing opportunities for training based on the latest research for public health officials in environmental investigation and remediation of lead poisoning. This manual should serve as a guide for performing risk assessments in housing where there are children with elevated blood lead levels.

Goal:
To provide public health officials, primarily Environmental Health Specialists (EHS) throughout the Commonwealth of Virginia with a manual that will enable them to:
1. Be informed and educated about the dangers of lead.
2. Be supportive of and committed to primary prevention efforts to eliminate childhood lead poisoning.
3. Identify environmental lead hazards.
4. Educate the public on how to remediate lead based paint hazards in the safest, most effective manner possible, using licensed lead workers.
5. To provide a tool to better assist families for resources to make their homes lead-safe.

History of Lead-Based Paint Regulation

Lead-based Paint Poisoning Prevention Act

The history of lead-based paint (LBP) regulations at the federal level began in 1971 when Congress passed the Lead-based Paint Poisoning Prevention Act (LBPPPA). This act was to provide federal financial assistance to help cities and communities to develop and function as intensive local programs to eliminate the causes of lead-based paint poisoning by detecting and addressing incidents of such poisoning. This act also established a federal demonstration and research program to study the extent of the lead-based paint poisoning problem and the methods available for lead-based paint removal, and prohibited future use of lead-based paint in federal or federally assisted construction or rehabilitation activities.

In 1973, amendments to the LBPPPA designated the Department of Housing and Urban

Development (HUD) as the lead agency in the federal effort to eliminate the hazard of LBP in housing. In that same year, 1973, the Consumer Products Safety Commission (CPSC) established a maximum lead content in paint of 0.5% by weight in a dry film of paint newly applied which was then lowered the allowable lead level in paint to 0.06% in 1978. In the 1980's, regulations addressing the LBP hazard in HUD housing were issued. In 1987 the Housing and Community Development Act changed the definition of the LBP hazard to include exterior as well as interior intact and non-intact painted surfaces. In 1989 HUD began to develop the first national compilation of technical protocols, practices and procedures on testing, abatement, worker protection, clean-up, and disposal of LBP in residential structures. HUD issued these guidelines on April 1, 1990, and revised them in September, 1990 and 1997. The HUD guidelines were revised again July 2012. ***HUD Guidelines, July 2012***

TITLE X

As awareness of the dangers of Lead based Paint hazards grew, Congress passed the "Residential Lead-Based Paint Hazard Reduction Act of 1992." This law was enacted as Title X of the Housing and Community Development Act of 1992 (P.L. 102-550), and was approved on October 28, 1992. It is commonly referred to as **"**Title X**".** This legislation is much more comprehensive and practical than previous laws in many ways. It focuses on the reduction of lead paint "hazards" rather than the removal or covering of all lead paint. It also commits the federal government to prevention by establishing public education and outreach activities to include a national hotline and information clearinghouse. The federal government also offers grant funds to cities and states for lead poisoning prevention activities. Title X also assures quality control and protection of occupants and workers through requirements for training and certification/licensure. It directs HUD to revise its guidelines to address risk assessments, inspections, interim controls, and abatement.

The most significant difference between Title X and previous federal legislation is its shift to reliance on market forces rather than government enforcement to achieve lead paint hazard reduction in private housing. The primary tool for this is the disclosure of information concerning lead upon transfer of residential property. In summary, the major legislative mandates of ***Title X*** are:

- ***Section 402 Rule,*** which established strict requirements for contractor and inspector certification and licensing;
- ***Section 403 Rule,*** which defines lead-based paint hazards and dangerous levels of lead in interior surface dust and bare soil;
- ***Section 1031 Rule,*** which required the **Occupational Safety and Health Administration (OSHA)** to issue final regulations on lead in the construction industry;
- ***Section 406, the Renovators' and Remodelers' Disclosure Rule,*** which requires disclosure of the potential for creating lead-based hazards during renovation and remodeling projects. This is also known as the Pre-Renovation Lead Hazard Education Rule (PRE Rule).
- **Section *1018, the Real Estate Notification and Disclosure Rule,*** which requires lead-based paint related disclosure and warning statements at the time of sale or rental of any pre-1978 housing unit.

Pre Renovation Education (PRE) Rule: Section 406

On June 1, 1999, an EPA rule went into effect that requires homeowners and renters be notified of the dangers of lead paint dust and debris during renovations. This regulation, the Lead Pre-Renovation Lead Hazard Education Rule (PRE Rule), requires painters, contractors, carpenters, property management companies and others involved in remodeling or renovation of pre-1978 housing (target housing) to notify homeowners and renters of the dangers of dust and debris from lead paint uncovered during this kind of work. Notification/education required by the PRE Rule was completed when anyone performing renovation for compensation distributes the pamphlet entitled, *Protect Your Family from Lead in Your Home* to their customers and receives verification of receipt. The rule also requires contractors to tell residents of the start and end dates of renovation and nature of the work being done, and to obtain written acknowledgment that notification was made. On March 31, 2008, EPA issued a rule, 40 CFR Part 745 that amended the PRE Rule and required the use of lead-safe practices and other actions aimed at preventing lead poisoning. This amendment is called the Renovation, Repair, and Painting Rule.

Renovation, Repair, and Painting Program (RRP) Rule

Common renovation activities like sanding, cutting and demolition can create hazardous lead dust and chips by disturbing lead-based paint, which can be harmful to adults and children. As discussed above under the PRE Rule amendment, EPA issued this rule requiring the use of lead-safe practices and other actions aimed at preventing lead poisoning. EPA's Renovation, Repair, and Painting Program (RRP) Rule update sections of the 1998 PRE Rule. Beginning April 22, 2010, contractors performing renovation repair, and painting projects that disturb lead-based paint in homes, child care facilities, and schools built before 1978 must be certified and must follow specific work practices to prevent lead contamination.

In December 2008, the RRP Rule started requiring that contractors performing renovation, repair and painting projects that disturb lead-based paint provide to owners and occupants of child care facilities and to parents and guardians of children under age six that attend child care facilities built prior to 1978, the lead hazard information pamphlet *Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools*. EPA's Renovation, Repair, and Painting Program Rule update sections of the 1998 PRE Rule. These amendments require that contractors disseminate the *Renovate Right: Important Lead Hazard Information for Families, Child Care Providers and Schools* **instead of** the *Protect Your Family from Lead in Your Home* pamphlet. The RRP Rule will affect paid renovators who work in pre-1978 housing and child-occupied facilities which include renovation contractors, maintenance workers in multi-family housing, painters, and other specialty trades. The RRP rule does not apply to minor maintenance or repair activities where less than six square feet of lead based paint is disturbed in a room or where less then 20 square feet of lead-based paint is disturbed on the exterior**. Under this new rule window replacement is not classed as minor maintenance or repair.** For additional information on the RRP rule or copies of the federal pamphlet Renovate Right: *Important Lead Hazard Information for Families, Child Care Providers and Schools* call 1-800-424-LEAD or via the Internet at ***The EPA Lead RRP Rules***

Real Estate Notification and Disclosure Rule: Section 1018

Section 1018 of Title X directed HUD and EPA to require the disclosure of known information on lead-based paint and lead-based paint "hazards" before the sale or lease of most housing built prior to 1978. Before ratification of a contract for housing sale or lease:

1. Sellers and landlords must disclose known lead-based paint and lead-based paint hazards and provide available reports to buyers or renters.
2. Sellers and landlords must give buyers and renters the pamphlet developed by EPA, HUD, and the Consumer Product Safety Commission (CPSC), titled *Protect Your Family from Lead in Your Home.*
3. Home buyers will get a 10-day period to conduct a lead-based paint inspection or risk assessment at their own expense. The rule gives the two parties flexibility to negotiate key terms of the evaluation.
4. Sales contracts and leasing agreements must include certain notification and disclosure language.
5. Sellers, lessors, and real estate agents share responsibility for ensuring compliance.

Disclosure of Lead-Based Paint Hazards

§ 36-107.1. Sale of residential structure with lead-based paint levels exceeding Code standards; penalty. Whenever any property owner has been notified by local building officials or representatives of local health departments that any residential premise has levels of lead-based paint in violation of the Uniform Statewide Building Code (§ 36.97 et seq.), or has received the results of a lead inspection and/or risk assessment, such property owner shall notify prospective purchasers in writing of the presence of unacceptable levels of lead-based paint in such premises and the requirements concerning the removal of the same. Such notification shall include a copy of any notice the property owner received from local building officials or representative of local health departments advising of the presence of unacceptable levels of lead-based paint in such premises.

The notice required shall be provided to prospective purchasers prior to the signing of a purchase and sales agreement or, if there is no purchase or sales agreement, prior to the signing of a deed. The requirements shall not apply to purchase and sales agreements or deed signed prior to July 1, 1991. Transactions in which sellers have accepted written offers prior to July 1, 1991, but have not signed a purchase or sales agreement or a deed prior to July 1, 1991, shall be subject to the notice requirements.

Any person who fails to comply with the provisions of this section shall be liable for all damages caused by the failure to comply and shall, in addition, be liable for a civil penalty not to exceed $1,000. (1991, c. 266)

The following language is to be included in all inspections and/or risk assessment reports, or other correspondence with the building owners or other responsible parties:

The Federal Residential Lead-Based Paint Hazard Reduction Act of 1992, 42 U.S.C. 4852d, requires sellers and landlords of most residential housing built before 1978 to disclose all available reports concerning lead-based paint and/or lead-based paint hazards, ***<u>including the test results contained in this notice</u>****, to purchasers and tenants at the time of sale or lease or upon lease renewal. This disclosure must occur even if the hazard reduction or abatement has been completed. Failure to disclose these test results*

is a violation of the U.S. Department of Housing and Urban Development and the U.S. Environmental Protection Agency regulations at 24 CFR Part 35 and 40 CFR Part 745 and can result in a fine of up to $11,000 per violation. To find out more information about your obligations under federal lead-based paint requirements, call 1-800-424-LEAD.

Role of the Environmental Health Specialist (Health Department):

- Obtain licensure from DPOR to conduct lead-based paint risk assessments and submit detailed reports to property owners, physicians, local building officials, and the Lead-Safe Virginia Program.
- Educate the property owners on the public health significance of lead-based paint exposure hazards and recommend specific remediation options.
- Assure or conduct post-remediation inspection and clearance testing.
- Appear in administrative hearings and in court as an expert witness where required.

Legal Considerations for Environmental Health Specialists (Health Department)

Upon notification of a child with a confirmed elevated blood lead level where further investigation is required, the local health district conducts an environmental investigation to determine the sources of the lead exposure. If a "risk assessment" for lead paint hazards in the housing is required, the individual conducting the risk assessment, including health department officials, **must** be licensed by the Virginia Department of Professional and Occupational Regulation (DPOR)**.**

DPOR has issued *Virginia Lead-Based Paint Activities Regulations* which contain the standards for performing lead-based paint activities in Virginia, the information and procedures necessary to obtain a certification for individuals and firms that wish to perform such activities, and the accreditation requirements and process for lead-based activity training programs. The law that governs these activities is also found in Title 54.1, Chapter 5 of the Code of Virginia**.** More information can be found on the DPOR Web site at ***www.dpor.virginia.gov/***. Each state is required to have similar regulations, in accordance with the U. S. Environmental Protection Agency's Final Rule in the Code of Federal Regulations (CFR), August 29, 1996.

The EHS and health district are responsible for supporting § 36-106 Code of Virginia, by providing a copy of any risk assessment that identifies a lead hazard to the local building code official for follow up.

Trial Issues

What is "proof"? Generally, proof is any information that will assist the finder of fact in its deliberation. Photographs of the scene, with paint flaking on the ground, are excellent examples of proof. A simple narrative of observations is proof that those events did in fact occur. Physical samples of paint chip, dust, soil and water samples taken from the scene are highly persuasive, but to be admissible, chain of custody must be maintained. Establishing the chain of custody is a prerequisite to the admission of testimony. With the chain of custody established for samples submitted to the lab the laboratory expert who analyzed the sample can accurately testify to its lead content.

A chain of custody form should be used in order to admit into evidence any physical item, e.g., paint samples; so that the court can be assured that the integrity of the evidence has been secured. This means that the chain of custody must identify each person who had physical possession of the evidence, and each individual must be available to testify that there was no tampering of the evidence while it was in their possession. This also means that the evidence must be kept in a secure location, such as a locked file cabinet, so that the possibility of anyone else tampering with it is reduced. If the chain of custody is properly maintained in accordance with EPA protocols, the chemist will be able to testify as to the veracity of the analytical results. Otherwise, with improper chain of custody, the test results will be inadmissible as court evidence. Any questions concerning establishment of proper chain of custody can be referred to the QA/QC officer at the NLLAP accredited laboratory.

A chain of custody is not needed for paint concentrations measured by X-Ray Fluorescence (XRF). In order to be admissible, the person operating the XRF unit must be able to testify that: (1) the instrument was working properly at the time of the field test; and (2) the person knew how to operate the instrument properly. Note: it is very helpful if the instrument has a read-out that corresponds to the legal standards directly, without requiring a conversion to a different unit. The operator of the XRF is required to perform a Demonstration of Capacity (DOC) which consists of using the XRF to detect lead in a quality control (QC) sample. The yellow "1.9 mg/cm^2 NIST traceable standard paint film" used to check the instruments calibration could also be used as the QC sample. This test should be repeated seven time over the course of three non-consecutive days e.g., analyze the QC sample three times the first day, twice the second day, and twice on the third day). The results of each of the analyses should not vary by more than ± 10% from the true value of the QC sample. In addition, the XRF operator should also analyze the QC sample before analyzing any field samples and again at the end of the sample screening sequence to demonstrate the instrument has maintained its calibration. A logbook containing the QC sample analysis results and all maintenance records should be maintained for each instrument. Incorporation of the QC standard and demonstration of capability provides a basis that would make the data more legally defensible. **Note that XRF readings are only indicative of the presence/absence of lead paint as part of a lead inspection and do not provide information for identifying the immediate lead hazard which is usually lead dust.**

A full understanding of legal liability requires an understanding of the background of legal considerations regarding lead poisoning. Childhood lead poisoning is an arena fraught with many complexities, both legal and technical. Due to heightened public awareness and litigation of cases of lead poisoning, the still-evolving standard of care for risk assessment, the developing nature of risk assessment, and heavy reliance upon the judgment, knowledge, and skill of the risk assessor, potential legal liabilities exist for the individual performing lead hazard evaluations. Avoidance of legal liability turns on those professionals fulfilling four legal duties owed to society. The four legal obligations are: 1) **"**the duty of reasonable care**"** which is the ability to foresee harm to others that arises from a consultant's or contractor's activities, the legal obligation is to protect others from such harm; 2) the "duty to warn**"** requires that others be adequately advised of potential hazards that can cause injury or damage; 3) the "duty to be informed**"** refers to the need to keep abreast of the latest scientific information, discoveries, procedures, products, and regulations that affect or govern one's chosen field.; and 4) the "duty to test**"** requires that one evaluate and ascertain potential hazards to which third parties can be exposed."

Risk assessment for identifying lead hazards is a discipline which characterizes the relative safety of a dwelling in terms of lead hazards associated with the residence, and

identifying lead hazard reduction measures suitable for the residence. This involves consideration of the condition and location of lead-based paint, occupancy use patterns, and other building conditions which cause the failure of paint.

Upon notification of a child with a confirmed environmental elevated blood lead level (EEBLL), the local health district conducts an environmental investigation to determine the source of the lead exposure through an environmental risk assessment. The environmental risk assessment will usually be performed by an Environmental Health Specialist (EHS), who is a licensed risk assessor, following the Virginia Lead-based Paint Regulations (DPOR).

The EHS and health district are responsible for maintaining complete records for potential legal requests or subpoenas.

Lead Based Paint Inspection vs. Risk Assessment

Although an inspection may locate and identify the presence of lead based paint, an inspection does not identify hazards or provide hazard reduction protocols for lead based paint hazards. As a licensed risk assessor, it is the role of the Environmental Health Specialist (EHS) to address the lead hazards and to offer a lead hazard control plan.

When performing a risk assessment in response to an environmental elevated blood lead level, the public health official should follow the written policy and standard operating procedures described within this manual to ensure that all quality assurance/quality control protocols are followed. While completing a lead risk assessment the licensed risk assessor must provide complete and comprehensive explanations of work in written form, including all possible hazards, to the client. An example of an investigation report, including a lead hazard control plan, may be found in the appendices. **Copies of these reports must be maintained indefinitely**.

Each health district is encouraged to have at least one licensed lead-based paint risk assessor on staff. Funds for fees associated with training health department employees are available through the Lead-Safe Virginia Program. If your district does not have a licensed lead-based paint inspector or you have questions about becoming licensed in please contact the Lead-Safe Virginia Program Director at 804-865-7694.

Medicaid Reimbursement for Environmental Investigation of Lead Hazards

Health districts may obtain Medicaid reimbursement ($150.00) for an environmental investigation of the child's home to identify the source or sources of lead exposure for a child enrolled in Medicaid with an elevated blood lead. For reimbursement, the child must have a venous blood lead with a confirmed concentration of lead in blood ≥ 20 μg/dL for a single test, or 15-19 μg/dL in two tests taken at least 3 months apart. Only one billing is authorized per household, regardless of the number of visits. Use billing code T1029 for the environmental investigation.

Environmental Health Protocol for an Investigation

The purpose of an elevated blood lead level investigation is to determine and report the existence, nature, severity, and location of lead hazards in a dwelling through an on-site investigation. After conducting the investigation, the EHS should provide a lead hazard control

plan on possible solutions to address the hazards identified. Procedures should be done in accordance with the EPA 403 Rule and Virginia regulations through DPOR. The standard operating procedures for sampling and the guidance information on completing an investigation, both of which are included in this document, will guide the risk assessor through the process. The risk assessor is responsible for identifying lead hazards in the environment of a child/children under six that has/have been identified as lead poisoned; informing the owner and the tenants of an appropriate course of action to remediate/abate the lead hazards; and depending on the locality, enforcement of the code of action.

Upon receiving a referral, the risk assessor shall obtain a copy of the nurse's assessment and then complete the resident questionnaire (Appendix B). Depending on the blood lead level and assessment/questionnaire (i.e. age of housing), schedule a time for a risk assessment. If an initial home visit can be completed by the nurse or outreach worker, this can be most beneficial for educational purposes as well as planning for the risk assessment if the risk assessment is not scheduled the same day. **In the case of a rental property, permission is not required from the property owner to perform the risk assessment.**

EHS Response Time

BLOOD LEAD LEVEL	RESPONSE TIME
10-14	MAY BE REQUIRED BY LOCAL LEAD ORDINANCE (RICHMOND CITY)
15-19 (PERSISTENT OR RISING)	WITHIN TWO WEEKS OF REFERRAL
20-44	WITHIN ONE WEEK OF REFERRAL
45-70	WITHIN 48 HOURS OF REFERRAL
≥ 70	WITHIN 24 HOURS OF REFERRAL

Important points to Remember:

✓ Throughout the process of an investigation, always follow HIPPA regulations.
✓ All risk assessors should be properly trained and licensed in accordance with DPOR regulations. **You may not conduct a risk assessment if your license has expired.**
✓ As a general rule, the person with possessory interest in the dwelling unit has authority to allow the public health official on the premises to conduct a risk assessment. The tenant **does** have the authority to let you inside their own dwelling unit without the need for the landlord's consent. Always obtain consent to enter from an adult. Any adult member of the immediate household will suffice; it would not be proper to rely on the consent of a minor. Adult babysitters pose something of a special circumstance, and common sense will help identify those situations when it would be advisable to return another time. The EHS should attempt to set up a time and date with the tenant for the risk assessment prior to visiting the residence.

Laboratory Submission

All environmental samples are to be sent to Schneider Laboratories in Richmond. Schneider is recognized by EPA's National Lead Laboratory Accreditation Program (NLLAP),

which currently is administered by the American Association for Laboratory Accreditation (AALA) and the American Industrial Hygiene Association (AIHA). Schneider is accredited to analyze lead in soil, dust wipes, paint, and water. All samples sent to the laboratory for analysis MUST be sufficiently labeled with a unique sample number, date, sampler's initials, time sample was collected, and the address or a case file number. An example of a unique sample number may include the sample type, date and sampler's initials: DW1-08/07/04 JH-13:15. This represents dust wipe #1 collected on August 8, 2004 by John Henry at 1:15 PM. Be sure to include and complete appropriate laboratory and chain of custody form. A sample form and chain of custody form from Schneider can be found in Appendix H. The chain of custody form is important to ensure that the samples are traceable. Appropriate sampling and shipping packaging criteria should be verified with the laboratory. Please call Schneider Laboratory and request sampling supplies under the Lead Safe Virginia account. Samples to be submitted to Schneider can be sent to:

Schneider Laboratories
2512 West Cary Street
Richmond, VA 23220-5117

Standard Operating Procedures for Environmental Sampling

*Note: Sampling forms for environmental sampling can be found in Appendices C, D, E, F, and G.

The goal of these standard operating procedures is to provide guidance for risk assessors in investigating the environments in which a lead poisoned child resides and/or routinely spends time. Following Virginia Lead Paint Regulations, and using references such as the *EPA Risk Assessment Model Curriculum Section 13: Performing Risk Assessments for Housing with Children Who Have Elevated Blood Lead Levels* and the *HUD Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing.*

Regulations included in the EPA 403 Rule: Lead: Identification of Dangerous Levels of Lead, 2001, 40 CFR Part 745 specify the areas which must be sampled and the minimum number of samples to take for a routine risk assessment; citing ASTM Methods E-1727-04 Standard Practice for Field Collection of Soil Samples for Subsequent Lead Determination; E-1728-03 Standard Practice for Collection of Settled Dust Samples Using Wipe Sampling Methods for Subsequent Lead Determination and; E-1792-03 Standard Specification for Wipe Sampling Materials for Lead in Surface Dust for sample collection techniques.

The EPA Risk Assessment Model Curriculum states that the purpose of an environmental investigation involving a child with an elevated blood lead level (what all EHS will be performing) is to **identify a cause or causes for the lead poisoning of a child.** Whereas a standard risk assessment attempts to identify basic lead-based paint hazards in a dwelling, regardless of whether or not a child is poisoned. In addition to the sampling protocol necessary to meet the legal requirements specified in the EPA 403 Rule, many other sources of lead may be present and the possibility of these must be considered, and non-routine samples collected, if necessary.

The EPA 403 Rule clearly defines what constitutes lead hazards:

> *(a) Paint-lead hazard*: "A paint-lead hazard is any of the following: (1) Any lead-based paint on a friction surface that is subject to abrasion and where the lead dust levels on the nearest horizontal surface underneath the friction surface (e.g., the window sill, or floor)

are equal to or greater than the dust-lead hazard levels identified in paragraph (b) of this section. (2) Any damaged or otherwise deteriorated lead-based paint on an impact surface that is caused by impact from a related building component (such as a door knob that knocks into a wall or a door that knocks against its door frame. (3) Any chewable lead-based painted surface on which there is evidence of teeth marks. (4) Any other deteriorated lead-based paint in any residential building or child-occupied facility or on the exterior of any residential building or child-occupied facility.

(b) *Dust-lead hazard*. A dust-lead hazard is surface dust in a residential dwelling or child-occupied facility that contains a mass-per-area concentration of lead equal to or exceeding 40 ug/ft^2 on floors or 250 ug/ft^2 on interior window sills based on wipe samples.

(c) *Soil-lead hazard*. A soil-lead hazard is bare soil on residential real property or on the property of a child-occupied facility that contains total lead equal to or exceeding 400 parts per million (mg/kg) in a play area or average of 1,200 parts per million of bare soil in the rest of the yard based on soil samples.

ROUTINE RISK ASSESSMENT REQUIREMENTS

Virginia lead paint regulations mirror EPA regulations for the most part. Virginia licensed risk assessors must follow:
DPOR Lead-Based Paint Activities, August 1, 2015

Paint Chip Sampling (Appendix C)

A routine risk assessment requires sampling of all deteriorated paint in, outside and on other surfaces such as fencing, associated with the dwelling. Any paint chip samples must be obtained according to the protocol described herein so that sample results will be reported in mg/cm^2 . Additionally, all samples will be analyzed by a laboratory which participates in the National Lead Laboratory Accreditation Program (NLLAP). Currently, no spot test kits or on-site wipe analysis kits have been approved by the EPA. Therefore, until such time as the EPA and DPOR approves them for use as part of an assessment, they are unacceptable legally as part of any sampling protocol for risk assessments, including investigations.

Dust Wipe Sampling (Appendix D)

The EPA 403 Rule requires:

"(5) In residential dwellings, dust samples (either composite or single surface samples) from the interior window sill(s) and floor shall be collected and analyzed for lead concentration in all living areas where one or more children, age 6 and under, are most likely to come into contact with dust. (6) For multi-family dwellings and child-occupied facilities, the samples required in paragraph (d) (4) of this section shall be taken. In addition, interior window sill and floor dust samples (either composite or single surface samples) shall be collected and analyzed for lead concentration in the following locations:

(7) For child-occupied facilities, interior window sill and floor dust samples (either composite or

single surface samples) shall be collected and analyzed for lead concentration in each room, hallway or stairwell utilized by one or more children, age 6 and under, and in other common areas in the child occupied facility where one or more children, age 6 and under, are likely to come into contact with dust.

In summary, the risk assessor ***MUST*** collect a floor dust wipe and a window sill dust wipe in every room where children 6 years and younger are likely to spend time. In multiple family dwellings, the above samples must be collected as well as a floor dust wipe sample and a window sill dust wipe sample "*in each room, hallway or stairwell utilized by one or more children, age 6 and under, and in other common areas in the child occupied facility where one or more children, age 6 and under, are likely to come into contact with dust"*.

Soil Sampling (Appendix E)

A risk assessor must also collect soil samples for all bare soil areas. The bare soil areas must be divided into child play areas and other bare areas of the yard. The protocol for soil sampling is also included in this document. The EPA 403 Rule specifically identifies bare soil as a hazard when the following conditions are met:

> *A soil-lead hazard is bare soil on residential real property or on the property of a child occupied facility that contains total lead equal to or exceeding 400 parts per million (mg/kg) in a play area or average of 1,200 parts per million of bare soil in the rest of the yard based on soil samples.*

Water Sampling (Appendix F)

Water testing is a routine part of an elevated blood lead level investigation. The water samples must be collected in accordance with the sampling protocol included herein. This protocol combines the requirements of the EPA Risk Assessment Model Curriculum and the EPA Safe Drinking Water Act.

Starting Point: Elevated Blood Lead Level Environmental Investigation

Whether or not an inspection, risk assessment, or any sampling has previously been completed, the first step in an environmental elevated blood lead investigation is completion of an approved resident questionnaire. The risk assessor will then perform a visual assessment of the dwelling to determine overall building condition and the condition of all painted surfaces. The dwelling is visually assessed by drawing a diagram of the unit, labeling rooms, and identifying doors and windows and other relevant information. Each wall should be identified as wall A, B, C, or D. Standing inside of the unit, wall A is the wall that faces the street address for a single family residence or front entrance of the unit for multi-family housing. Walls B, C, & D are then identified clockwise from wall A. (See Diagram 1 below)

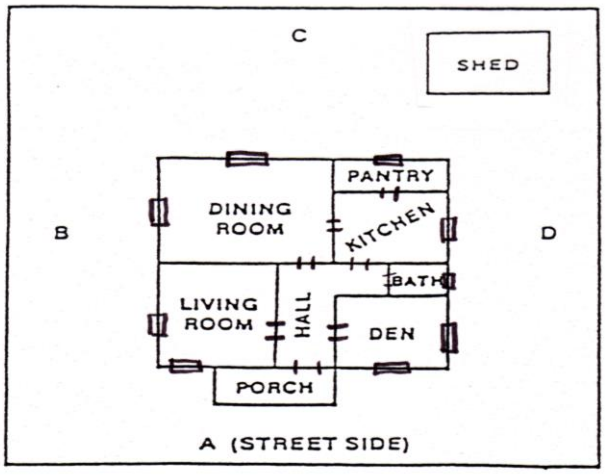


Diagram 1

Following the initial survey of the property, the risk assessor must examine painted surfaces both inside and outside to locate those surfaces showing deterioration, friction points, impact points, or evidence of chewing or mouthing. When the assessor visually evaluates the painted surfaces, he/she should address two issues: (1) the extent of deterioration (how large an area is deteriorated) and (2) the type of deterioration. This information may be relevant when developing hazards control options. A visual assessment of all paint surface conditions is to be completed on a room by room basis noting all deteriorated surfaces, both interior and exterior. Particular attention should be paid to friction (ex. windows) and impact surfaces (ex. steps, floors) and surfaces accessible and chewable to a young child (ex. window sills). After the completion of the questionnaire and the visual assessment, environmental sampling can then be completed. It is important to note that different media (dust, paint, soil) sampling should be conducted in a specific sequence with dust wipe samples collected first. This prevents the risk assessor from contaminating the horizontal surfaces to be wiped with debris from collecting chipping paint samples. After dust wipe sampling has been completed, all other environmental samples should be taken. In addition to risk assessment required samples (deteriorated paint, dust, soil), water samples must be collected and additional samples of other materials and surfaces may be required, dependent upon information collected during the questionnaire and subject to the risk assessor's professional judgment. The investigator is obligated, as described in the EPA Risk Assessment Model Curriculum, to conduct a comprehensive investigation of **all** sources of lead in the child's environment, not just those lead exposures directly related to the child's housing. This investigation includes studying other dwellings frequented by the child and relatively uncommon sources of lead, such as glazed pottery and traditional medicines or remedies. Some of these sources may be discovered by the results of the questionnaire or *Nurses Assessment Form.*

Deteriorated Paint Sampling

Methods of Measuring Lead in Deteriorated Paint Films for Elevated Blood Lead Level Inspection

This section reviews issues related to deteriorated paint films only. The assumption is that

the risk assessor has been previously trained in paint film sampling and measurement procedures in the EPA inspector/risk assessor course. All sampling records must be maintained in accordance with EPA, DPOR, and ASTM protocols.

The lead content in deteriorated paint films will be determined by laboratory analysis as required per the environmental elevated blood lead investigation protocol. The American Society of Testing and Materials (ASTM) developed standards addressing the collection, preparation, and analysis of paint samples for lead determination.

ASTM standards include:

- E 1729 Field Collection of Dried Paint Samples for Lead Determination
- E 1645 Preparation of Dried Paint Samples for Laboratory Analysis
- E 1613 Standard Test Method for Analysis for Digested Samples
- E 1979-98 Standard Practice for Ultrasonic Extraction of Paint, Dust, Soil and Air Samples for Subsequent Determination of Lead
- E 1775-96 Standard Guide for Evaluation Performance of On-Site Extraction and Filed-Portable Electrochemical or Spectrophotometer Analysis for Lead

Selecting the Area for Analysis for Environmental Elevated Blood Lead Level Inspection

When examining an area for analysis of deteriorated paint films, proper selection is essential. Spatial variation (how much the lead content changes across a given surface) on intact surfaces is known to be considerable. Across a surface with deteriorated films, the variation may be even larger, since some areas may not contain all layers. The risk assessor should make a visual inspection to select an area in which all layers of paint film are present and in which the least amount of deterioration is apparent.

Testing Locations/Components for Environmental Elevated Blood Lead Level Inspection

For each home to be inspected, all surfaces with deteriorated paint in interior rooms, common areas, and exterior areas must be tested. This includes, but is not limited to hallways, foyers, stairwells, enclosed porches, outbuildings, and fences. Attics and basements are to be included if they are frequented by children. Inspecting all rooms will be beneficial for developing a hazard control plan or abatement scope of work. An example of an Abatement Scope of Work can be found in Appendix M. The following descriptions are for testing combinations of building components that may be sampled should deteriorated paint be observed.

A. Doors (see Diagram 2 below)

- Door jambs, stops, casings, and transoms are tested as a single combination. Testing one of these will represent all.
- The door itself is separate from the other components and should be tested separately. For doors that separate rooms, each side of the door will need to be tested. The same is true for door casings and trim.
- Door thresholds should also be tested separately.
- All doors in a room may not need to be tested. If all appear to be the same in nature (e.g., size, material, look, etc.) select one to represent all. If there is reason to believe that each

door has a different paint history or is completely different in nature, then each door should be tested separately.

Doors

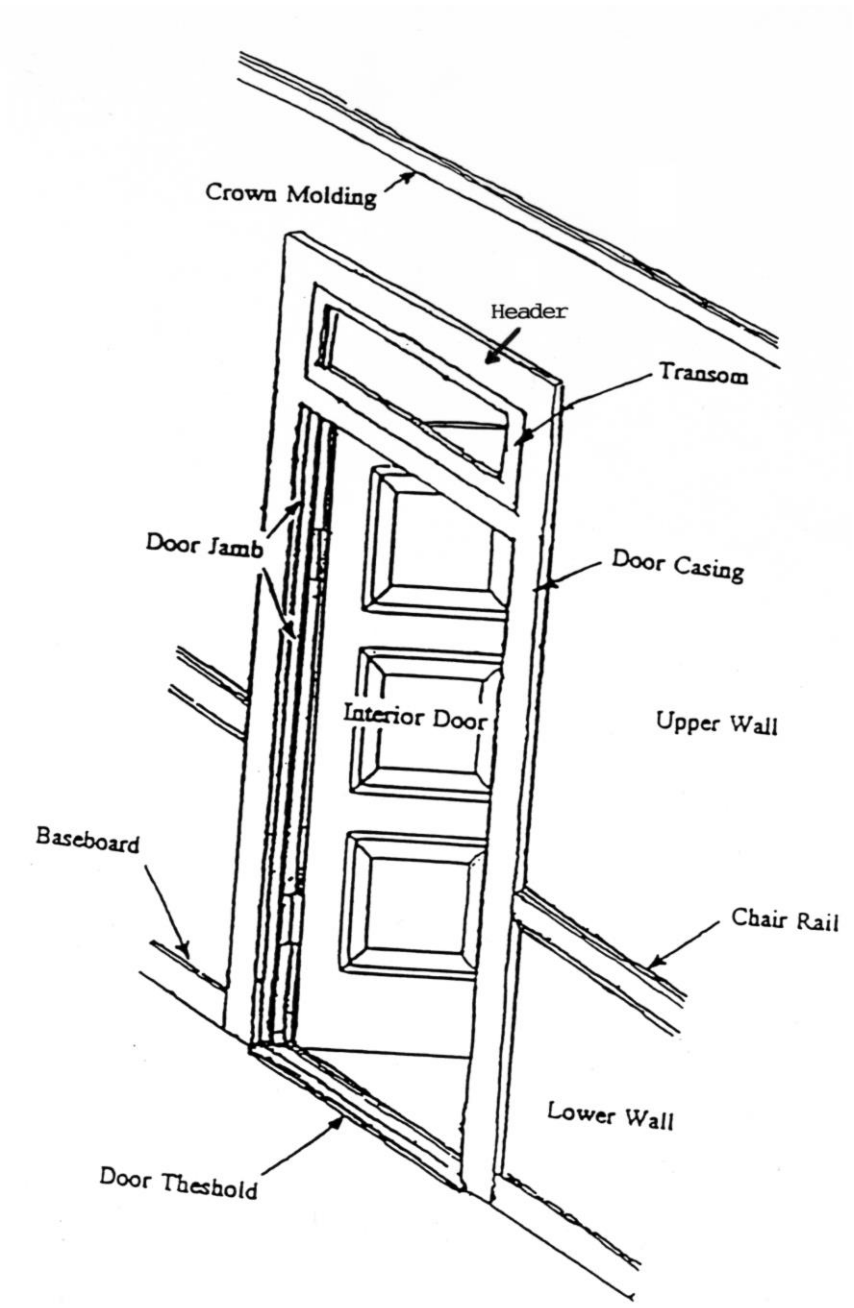
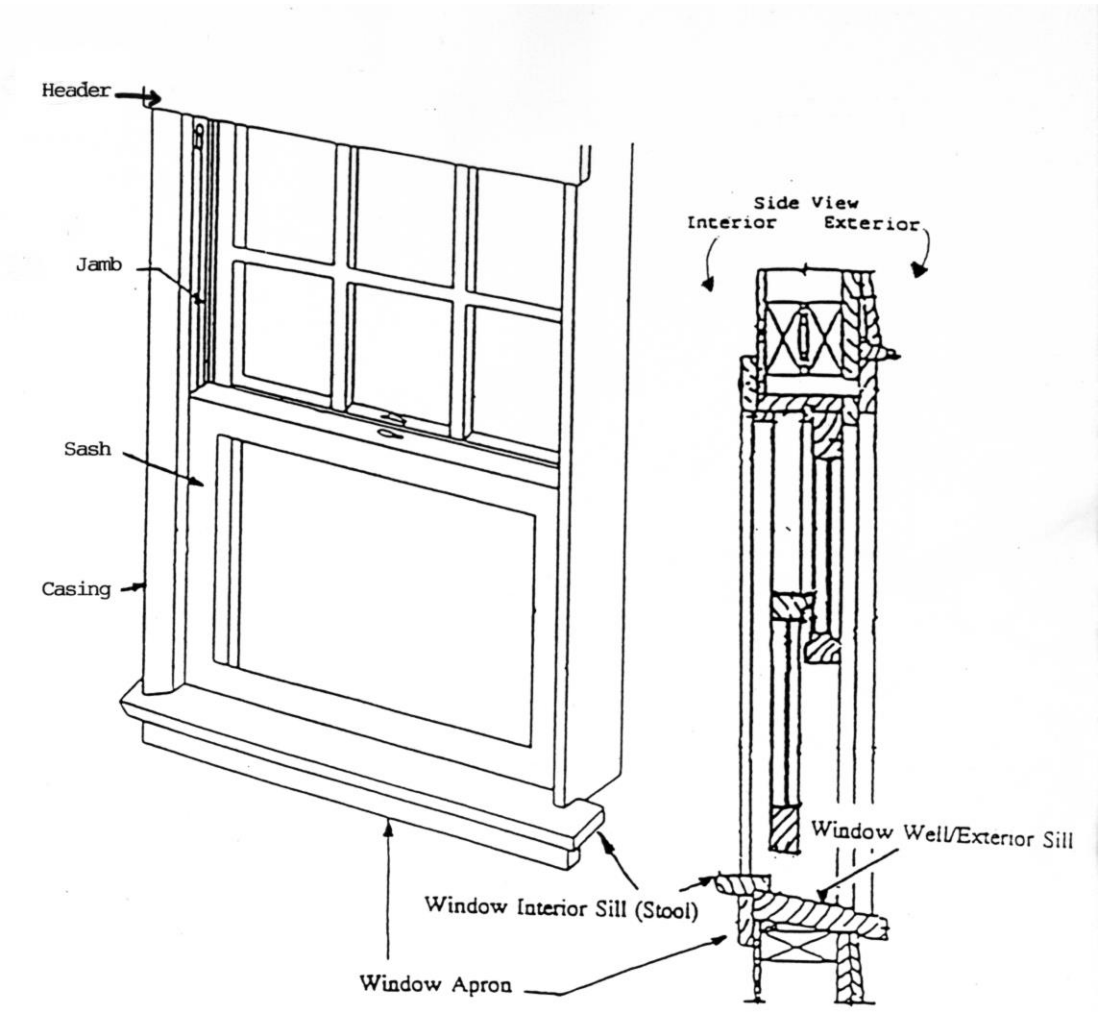


Diagram 2

B. Windows (see Diagram 3 below)

- Interior window casings, stops, jambs, sills, and aprons (all trim) are a single testing combination.
- Interior window sashes (the window portion) are separate from the other components and should be tested separately. The exterior sides of the sashes are also treated separately and should be tested with the exterior.
- All windows in a room may not need to be tested. If all appear to be the same in nature (e.g., size, material, look, etc.) select one to represent all. If there is reason to believe that each window has a different paint history or is a completely different in nature, then each window with deteriorated paint should be tested separately.

Windows



Diagram

C. Interior Trim

- For each room, baseboards, chair rails, crown molding, etc. should all be tested separately. However, each component will only need to be tested once, as opposed to on every wall. The only exception is if there is reason to believe that each baseboard, chair rail, or crown molding on each wall has a different paint history or is a completely different in nature, then each component should be tested separately.

D. Interior Walls

- If four walls of a room have deteriorated paint then each should be tested individually. According the Chapter 7 of the HUD Guidelines, if there are more than 4 walls within a room with the same substrate, the four readings should be averaged and the average assigned as the concentration for the rest of the walls. If the risk assessor is in doubt as to the construction dates of the different walls (when there are more than four), all walls should be tested.
- For walls that have two different types of covering, such as the upper walls having plaster and the lower walls having wood, each wall type should be tested on each wall. (Therefore, at least 8 wall readings will be taken in that room.)
- Electrical sockets, switches, and/or plates can be included as part of the wall and need not be tested individually.
- Walls covered by wallpaper can also be tested, especially if the wallpaper is in poor condition. (property owner may be planning to take it down.) If available, the XRF should have the capability of reading the underlying paint.
- Walls with ceramic tiles can also be tested. Some ceramic tiles have been found to contain lead. The tiles are not considered a hazard as along as they are intact.

E. Floors

- Painted, shellacked, varnished, or stained floors should be tested. If the floors appear to have the same coating through out the dwelling, testing in one room can be representative of the remaining floors. If the floor coatings are different from room to room, each floor should be tested separately. If the dwelling is more than one story high, at least one floor, per coating, should be tested per story.
- Floors should be tested in areas where the coating is apparent as opposed to a more worn area such as in front of a door. Testing areas closer to walls as opposed to in the middle of the room give more accurate results of the paint history.
- Thresholds can be considered part of the door as well as the floor. It is suggested to test the thresholds separately from the floor.
- Floor coverings such as linoleum need not be tested.

F. Ceilings

- Ceilings are usually inaccessible and not tested, unless the ceiling is deteriorated and does not fit the testing combination assigned to the walls (different texture, different material or different substrate). Otherwise, it will be assumed that the ceilings are of the same

nature as the walls; however, the condition of the ceiling should also be noted (e.g., deteriorated paint, water damage, etc.).

G. Stairwell Components (See Diagram 4 below)

- Most of the time different stairwell components will have different paint coatings. For example, the treads are likely to be painted differently than the risers. It is recommended that at least one of each component type if deteriorated paint exists be tested. These components include railing caps, lower railings, balusters, newel post, stringers, baseboards, treads, and risers.

Stairwell Components

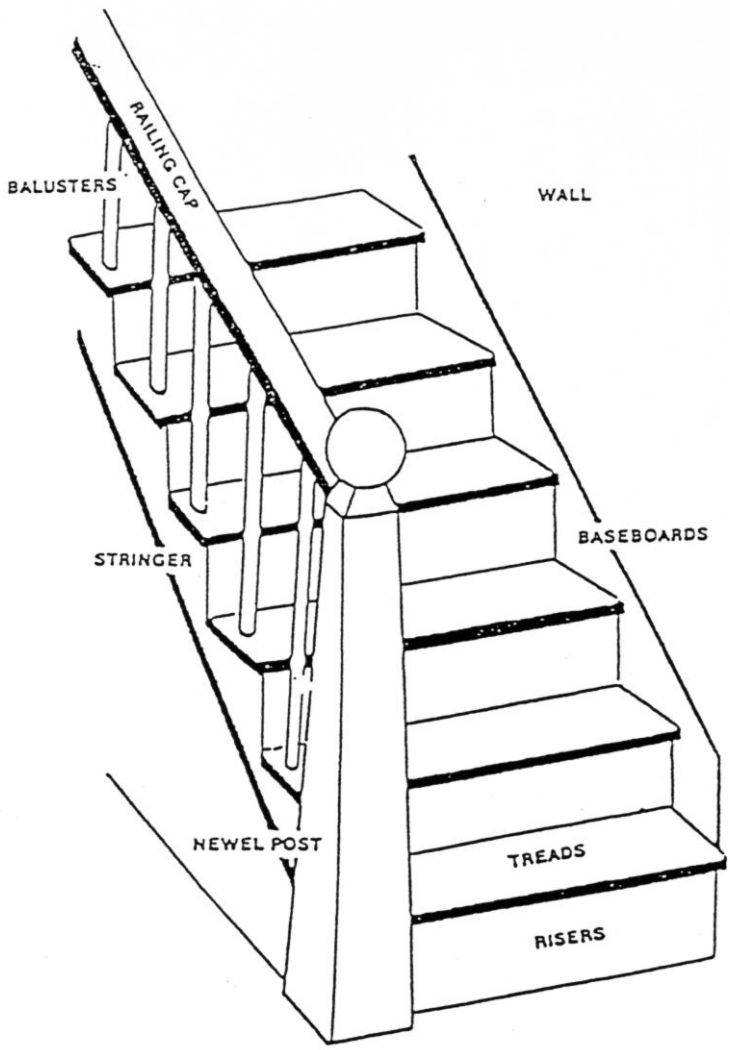


Diagram 4

H. Closets (See Diagram 5 below)

- Closets should be taken into consideration when there is a child involved. This may be the area where toys are stored or even where a child plays.
- The walls, floor, or ceiling of the closet do not need to be tested unless they are obviously dissimilar from the adjoining room, or appear to be a likely exposure scenario for children. However; there may be some other components within the closet, like a lower shelf that may be accessible /chewable to a child, which should be tested if deteriorated paint exists and it is a chewable surface.

Closets

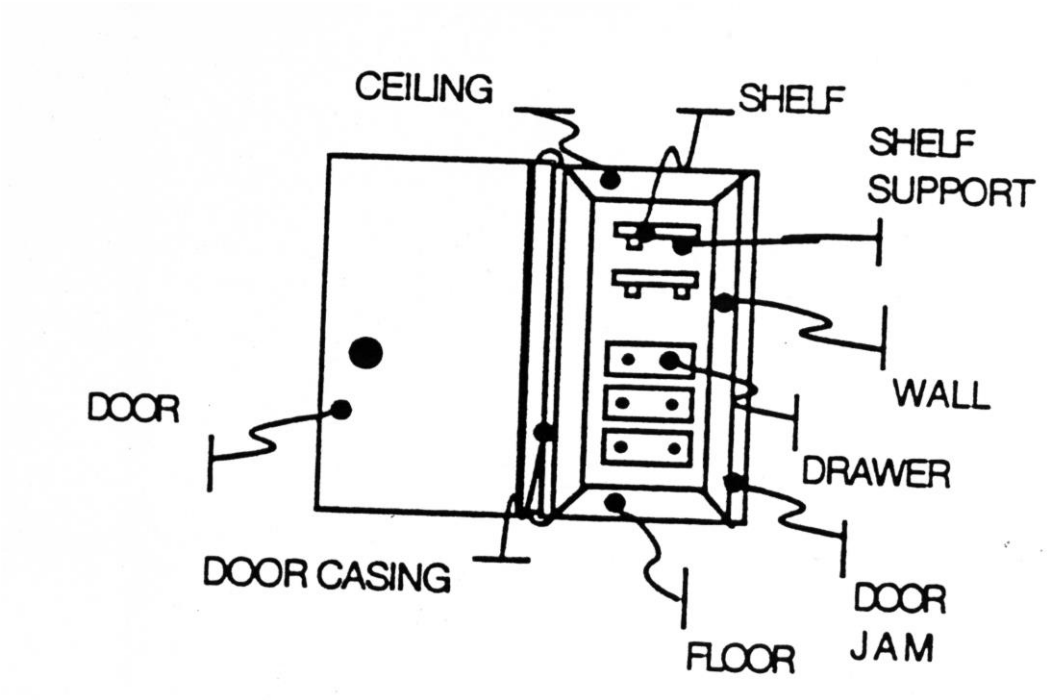


Diagram 5

I. Furniture (See Diagram 6 below)

- Painted or varnished furniture that is physically attached to the unit (e.g., built in cabinets, bookshelf, desk, etc.) should be tested as separate components. Unattached children's furniture, especially if built before 1978, may contain lead and should be tested if deteriorated paint exists or the surface is a chewable surface.

Furniture

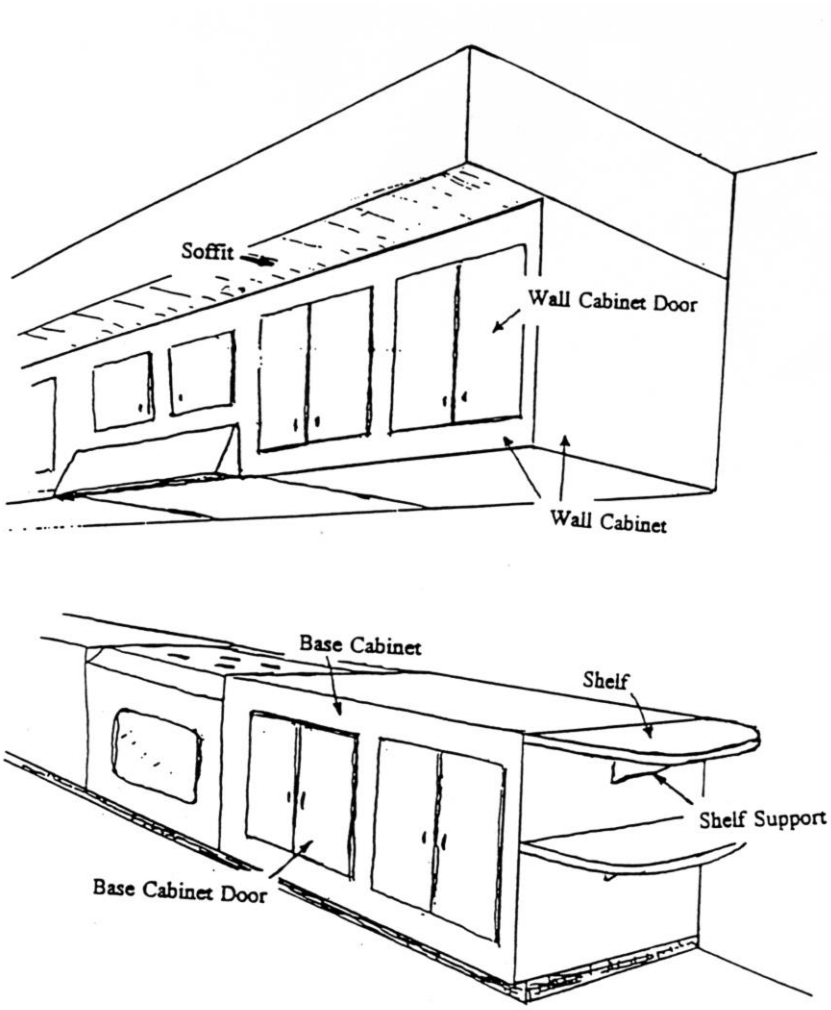


Diagram 6

J. Miscellaneous Interior Items

Other items that should also be tested if deteriorated paint is observed and/or the child has access to these items are:

- Fireplaces, cabinets, radiators, heating units, mini-blinds, dishes, etc.

K. Exterior (see Diagram 7-A, 7-B, & 7-C)

- Walls on all sides of the dwelling, if the surface is deteriorated, should be tested. (e.g., four for a freestanding dwelling or two for a row house) The foundation and any corner boards should also be tested, if deteriorated paint is observed.
- The exterior is considered a "room equivalent" and, if deteriorated, can be tested as such. Testing combination for windows, doors, window trim, door trim, staircases, etc. should be developed for all deteriorated surfaces..
- Porches: At least one of each component type should be tested. These components include the ceiling, soffits, fascias, gutters, down spouts, floor, railings, balusters, columns, steps, etc. For those components that are inaccessible (e.g., ceiling, soffit, etc.), the paint condition and any visible characteristics should be noted. If the surfaces are deteriorated, they must be sampled.

Exterior

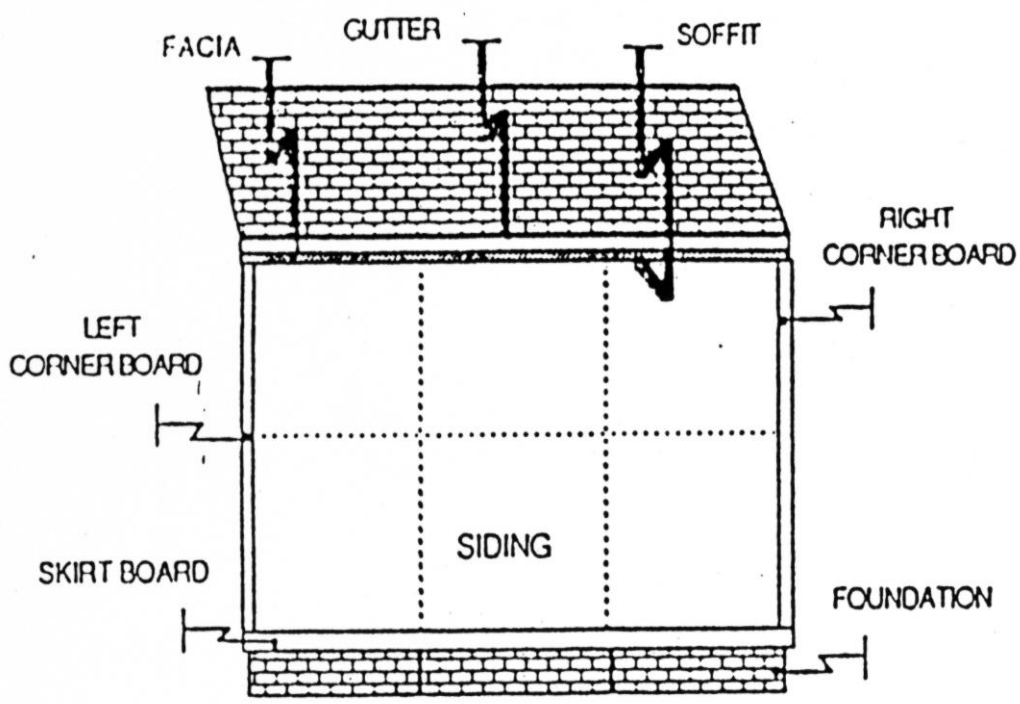


Diagram 7-A

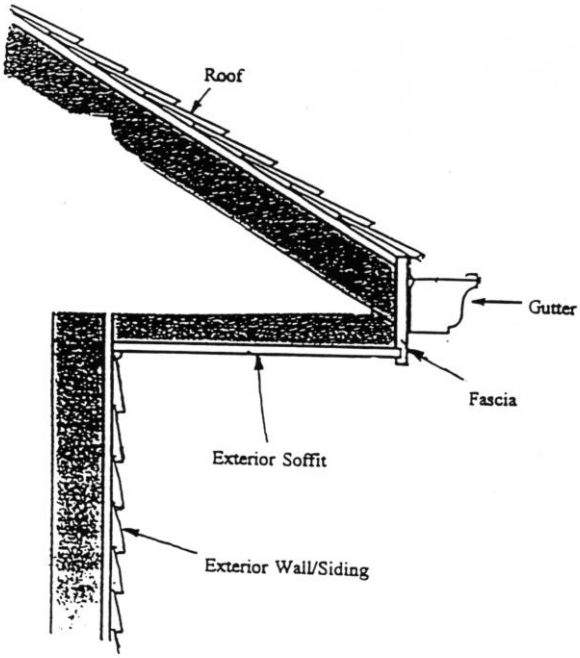


Diagram 7-B

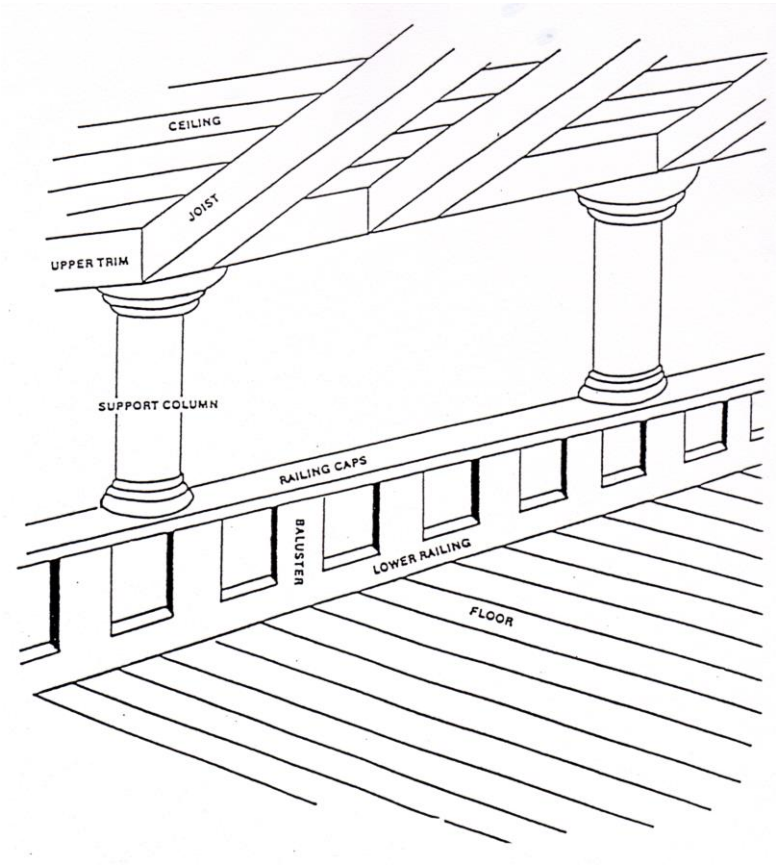


Diagram 7-C

L. Miscellaneous Exterior Items

Other items that may also be tested are:

- Fences, swing sets, laundry line post, storage sheds and garages, dog houses (if the pet comes into the house), fuel tanks, etc.

Paint Chip Collection

Prior to testing deteriorated surfaces by paint chip collection, it is prudent to collect the necessary dust wipes in the areas with deteriorated paint so that the risk assessor can avoid the possibility of further contamination of horizontal surfaces which will be sampled for leaded dust.

Sampling Materials

The following materials might be useful to prepare the samples:

- ✓ Heat gun with a setting below 1,100^{o} F.
- ✓ 3' x 3' piece of 6 mil poly sheeting
- ✓ Role of ¾ or 1 inch quick release masking tape
- ✓ 4 x 3 index cards or larger
- ✓ Utility knife
- ✓ Variety of 2" scrapers including one with replaceable blade
- ✓ Pencil
- ✓ Template with 2" x 2" square cut out of center
- ✓ Hard shell containers such as plastic or glass vials for sample collection
- ✓ Indelible marker for labeling vial
- ✓ Box of wipes for cleaning scrapers, templates, hands as necessary
- ✓ Thin powder-free gloves
- ✓ Trash bags
- ✓ Sample collection forms
- ✓ Laboratory Chain of Custody forms
- ✓ Gallon size plastic baggies
- ✓ Clear quick dry spray sealant
- ✓ Extension cord and Portable Ground Fault Circuit Interrupter
- ✓ Pen
- ✓ Field log notebook {all field sampling notes (including collection forms), diagrams, questionnaires, site information should be inserted into the logbook so that the logbook contains all notes, results, etc as one comprehensive file for all information concerning the site}
- ✓ Canvas bag, box or other container for sampling supplies: "Sampling Kit"

Paint Chip Sampling Protocol for Elevated Blood Lead Level Inspection:

1) Draw a diagram of the dwelling, both interior and exterior
2) Choose the sample collection locations as described above
3) Place poly under the area to be sampled and secure it at corners with masking tape

4) Place template on wall and, using pencil, outline area of sample (using a template is optional, a measured area can just be marked with tape)
5) If template used, then wipe clean template before placing back in collection bag
6) Place masking tape around the penciled sample area on all sides
7) Slightly bend an index card along the long edge and tape it directly under the taped area to serve as a "collection shelf" for any paint which falls during sampling
8) Label sample vial with date, unique sample number and sampler's initials, (time will be added later), and record in field logbook
9) Plug in heat gun, choose scraper, put on gloves (Be careful not to touch any potentially contaminated surface after gloves are on hands)
10) Using heat gun and scraper, remove the paint from within the taped area only, taking care not to loose any of the sample (Note: If more than $1/16^{th}$ of the sample is lost, or more than $1/16^{th}$ extra is scraped, the sample area is invalid and a new area must be chosen for collection)
11) Carefully place all scraped paint into the sample vial. If the paint falls onto the card, carefully bend the card to contain the sample and remove the card so that the paint can be put into the vial. **ALL LAYERS OF PAINT MUST BE INCLUDED. BECAUSE THE SAMPLE WILL BE ANALYZED FOR MG/CM^2, SUBSTRATE IN THE SAMPLE WILL NOT BIAS SAMPLE RESULTS.**
12) Put time collected on vial and seal vial, place vial in labeled gallon baggie (all vials will go into this baggie)
13) Record time in logbook.
14) Remove tape from wall and wipe wall
15) Place wipe and tape into trash bag
16) Wipe tools, allow heat gun to cool, place tools and supplies(except poly) in collection bag
17) Spray sealant onto scraped area
18) Wipe poly, fold and place in sampling kit
19) Discard gloves, place in trash bag
20) Move to next sampling location and repeat
21) Record sample location and number on diagram
22) AFTER ALL DETERIORATED PAINT CHIPS ARE COLLECTED, fill out Chain of Custody sheet, taking care to specify area included in sample (2" x 2") and request results in mg/cm2
23) Remove all sampling trash from property

Note: If sample size cannot be 2" x 2", risk assessor may collect 1" x 4". Some samples may be able to analyze smaller samples as long as the exact area scraped is reported. Please check with the laboratory. However, the method includes collection of 4 square inches for best results.

XRF Analysis (not required for Elevated Blood Lead Level Inspection):

If using an XRF please refer to the *Commonwealth of Virginia Radiation Protection Regulatory Guide: Guidance for Portable Gauges or XRF Devices* (Appendix O)

The X-ray fluorescence (XRF) Lead-in-Paint analyzer is a portable, hand-held instrument that immediately measures the lead content of painted surfaces without removing or damaging

the paint or substrate. Some units can detect lead through as many as 25 layers of paint. To accomplish these results the instrument utilizes a gamma radiation source (or sources), usually Cobalt-57 or cadmium-109. The paint to be analyzed is exposed to gamma rays from the source in the XRF instrument and atoms of the lead in the paint are "excited," causing them to generate X-rays. The occurrences of these X-rays are detected and translated by the instrument electronics to indicate the concentration of lead in the paint. Lead concentration readings, in milligrams of lead per square centimeter of surface analyzed (mg/cm^2), appear in a few seconds on a digital display window.

License Required

Applicants wishing to possess or use radioactive material in the Commonwealth of Virginia are subject to the requirements of **12VAC5-481** 'Virginia Radiation Protection Regulations' and must file a license application with the Virginia Department of Health, Radioactive Materials Program.

In order for a licensed risk assessor to obtain a license and use an XRF device during an investigation applicants are first encouraged to study the *Commonwealth of Virginia Radiation Protection Regulatory Guide: Guidance for Portable Gauges or XRF Devices* before completing the VDH form, *Application for Radioactive Material License Authorizing the Use of Sealed Sources in Portable Gauges or XRF Devices.* VDH expects licensees to provide requesting information on specific aspects of their proposed radiation protection program in attachments to the application. When necessary, VDH may ask the applicant for additional information to gain reasonable assurance that an adequate radiation protection program has been established. After a license is issued, the licensee must perform in accordance with the following:

- All statements, representations, and procedures contained in the application and in correspondence with VDH;
- All terms and conditions of the license; and
- Follow 12VAC5-481 'Virginia Radiation Protection Regulations.'

It is the applicant's and/or licensee's responsibilities to obtain, read, and follow **12 VAC 5-481** 'Virginia Radiation Protection Regulations' Applicants can request single copies of the regulations by contacting the Virginia Department of Health, Radioactive Materials Program. The following parts to **12 VAC 5-481** Virginia Radiation Protection Regulations contain requirements applicable to Portable Gauge Devices or XRF licensees:

- Part I, General Provisions
- Part II, Licensing of Radioactive Materials
- Part IV, Standards for Protection Against Radiation
- Part X, Notices, Instructions and Reports to Workers; Inspections
- Part XIII, Transportation of Radioactive Material

Training

In order to obtain a license to operate an XRF device, VDH requires the completion of one of the following as evidence of adequate training and experience to operate an XRF:

- Portable gauge manufacture's course for users
- Equivalent course that meets VDH requirements for the competent operation of portable gages and XRF devices using sealed sources of radioactive material.

*VDH requires that the course shall be at lead 8 hours in length. Refer to *Commonwealth of Virginia Radiation Protection Regulatory Guide: Guidance for Portable Gauges or XRF Devices* (Appendix O) for details on the criteria for acceptable training courses for portable Gauge Users.

Radiation Safety Officer

The Radiation Safety Officer (RSO) is the person responsible for the radiation protection program. The RSO must have adequate training and experience. VDH will accept successful completion of one of the following as evidence of adequate training and experience:

- Portable gauge manufacture's course for users or for RSOs.
- Equivalent course that meets VDH requirements for the competent operation of portable gages and XRF devices using sealed sources of radioactive material.

*Refer to *Commonwealth of Virginia Radiation Protection Regulatory Guide: Guidance for Portable Gauges or XRF Devices* for details on the criteria for acceptable training courses for portable Gauge Users.

The RSOs duties and responsibilities include the following:

- Stop licensed activities that the RSO considers unsafe.
- Assure that possession, use, storage, and maintenance of sources and gauges or XRFs are consistent with the limitations in the license, the sealed source and device registration sheet(s), and manufacturer's recommendations and instructions.
- Assure that all individuals using gauges are properly trained.
- Assure when necessary, that 'personnel monitoring devices' are used and exchanged at the proper intervals; records of the results of such monitoring are maintained.
- Assure all gauges or XRFs are properly secured.
- Notify proper authorities in cases of accident, damage to gauges, fire, or theft.
- Investigate unusual occurrences involving the gauge (e.g., accident, damage), determine cause(s) and identify appropriate corrective action, and assure corrective action is taken.
- Assure audits are performed at least annually and documented, and corrective actions taken.
- Assure licensed material is transported in accordance with all applicable Department of Transportation requirements.
- Assure all licensed material is disposed of properly.
- Maintain all appropriate records.
- An up-to-date license is maintained and all amendment and renewal requests submitted in a timely manner.
- Assure that two independent physical barriers are used for portable gauges not under constant supervision.

Transfer of Control Application

Licensees must provide full information and obtain VDH's **prior written consent** before transferring ownership or control of the license. Changes in ownership may be the results of stock transfers, employee turnover, etc. Obtaining written consent from VDH prior to the change is to ensure the following:

- Radioactive materials are possessed, used, or controlled only by persons who have valid VDH licenses.

- Materials are properly handled and secured.
- Persons using these materials are competent and committed to implementing appropriate radiological controls.
- A clear chain of custody is established to identify who is responsible for final disposal of XRF.
- Public health and safety are not compromised by the use of such materials.

XRF manufacturers offer one-day courses teaching the use, care and precautions to be taken for their specific instruments, including packaging and transportation requirements. Anyone who plans to use an XRF machine, even a rented or borrowed one, must attend the course offered for the machine involved. The Virginia Department of Health - Radiological Health Program (VDH-RHP) XRF Regulatory Guide relates this and other requirements, which all users of XRF instruments must meet prior to operating an XRF unit.

XRF Safety

XRF instruments are constructed in a manner that enhances the safety of their use of radiation sources. Manufacturers' instructions should be followed carefully to assure their safe use.

Radiation Safety

The three main methods for controlling exposure to radiation are time, distance and shielding. Simply put; the time control means that the shorter the time of exposure to a radiation source, the smaller the dose of radiation received and therefore, the less chance of damage to human tissues. The distance factor considers that the more distance afforded between a radiation source and a person, the less intense the dose of radiation will be. Shielding is used between the radiation source and a person so that the energy from the source can either be absorbed by the shielding or deflected away from areas where it could be harmful. The XRF operator must always be conscious of, and use these exposure control mechanisms.

Because of the characteristic surface penetration capability of the energy emitted from the radioactive material in the XRF instrument, the operator must be aware of any people who might be in rooms or areas adjoining the area of operations.

A radiation beam is emitted from the XRF unit to accomplish the intended operation. The direction that the beam travels is dependent upon the type of instrument being used. The instrument operator must be conscious of this direction to assure the safety of people in areas adjoining the survey operation area. This and other safety considerations will be discussed in the required instrument manufacturer's training program.

Because the radiation source emits radioactive energy all of the time (even when the instrument shutter is closed), if the operator needs to use both hands, the XRF unit should be placed onto the ground or another safe, flat surface. It should never be held under the arm, between the legs or otherwise against the body.

Security

VDH regulations require a portable gauge license to use a minimum of two independent physical controls that form tangible barriers to secure portable gauges from unauthorized removal whenever the portable gauge is not under the control and constant surveillance by the

licensee. "Control and maintain constant surveillance" of portable gauges means being immediately present or remaining in close proximity to the portable gauge to prevent unauthorized removal of the portable gauge.

When a portable gauge is stored at a licensed facility, the licensee is required to use two independent physical controls to secure the gauge. Examples include:

- The portable gauge or transportation case containing the portable gauge is stored inside a locked storage shed within a secured outdoor area, such as a fenced parking area with a locked gate.
- The portable gauge or transportation case containing the portable gauge is stored in room with a locked door within a secured building for which the licensee controls access by lock and key or by a security guard.

When securing a portable gauge in a vehicle licensees must comply with the applicable requirements of the DOP that are found in 49 CFR Parts 170 through 189. A vehicle may be used for storage, however, it is recommended by VDH and DOT that this practice only be used for short periods of time or when a portable gauge is in transit. Storage in a hotel room is not authorized. When a portable gauge is being stored in a vehicle, the licensee is specifically required to use a minimum of two independent physical controls to secure the portable gauge. Examples include:

- The locked transportation case containing the portable gauge is physically secured to a vehicle with brackets, and a chain or steel cable (attached to the vehicle) is wrapped around the transportation case such that the case can not be opened unless the chain or cable is removed.
- The portable gauge or transportation case containing the portable gauge is stored in a locked trunk, camper shell, van or other similar enclosure and is physically secured to the vehicle by a chain or steel cable in such a manner that one would not be able to open the case or remove the portable gauge without removal of the chain or cable.

*For additional security guidance please refer to the *Commonwealth of Virginia Radiation Protection Regulatory Guild: Guidance for Portable Gauges or XRF Devices.* (Appendix O)

If using an XRF during an Investigation

Risk assessors should begin XRF analysis by following the manufacture's *Technical Performance Sheet* for the instrument used, as discussed in the new *HUD Guidelines*. Even though only a few surfaces may be analyzed, the full instrument warming up and calibration check procedures are required.

For each unit to be inspected, a diagram of the unit should be drawn noting windows, doors, and any other relevant information. Each room should be labeled and numbered. To best describe the location of the components tested, each wall should be labeled A, B, C, or D. Standing inside of the unit, wall A should be the wall that faces the street or front entrance of the unit; wall B is the wall to the right; facing the street or the main entrance of the unit, wall C is the wall behind you; and wall D is the wall to the left as illustrated in Diagram 1:

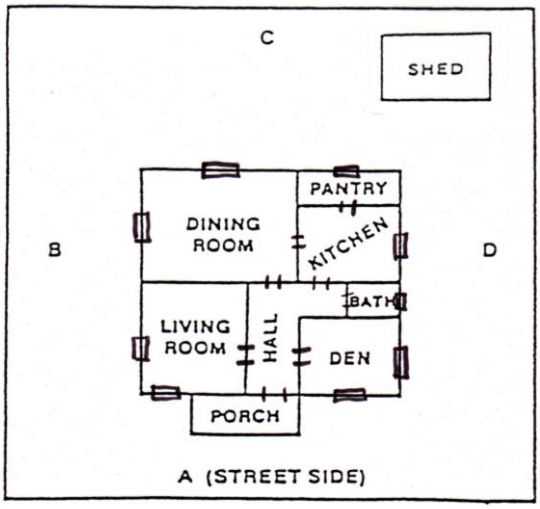


Diagram 1

Each XRF reading should have a room name and number; component name, substrate, and color; a wall location (e.g., center wall B); and paint condition. Noting this information will be beneficial when trying to re-identify what was tested. Some XRF software prints out a detailed report, which allows for this information to be entered. Documenting this information will assist the risk assessor in providing a hazard control plan.

The risk assessor should take three readings across any given surface, making sure that each spot selected has all layers present. The lead paint content is the average of those three readings, minus any bias (substrate) correction or other procedures specified in the *Technical Performance Sheet*. All calibration checks and raw data should be included in the report.

Dust Wipe Sampling

Studies have shown that dust lead levels are the strongest predictor of children's blood lead levels compared with a number of other variables. Proper measurement of dust lead levels is therefore essential to the risk assessment process.

There are two ways to describe the amount of lead in dust:

1) Loading (area concentration) (µg/ft² or µg/cm²)
2) Mass concentration (µg/g, ppm, or mg/kg)

Loading is a measure of the total amount of lead present in micrograms of lead per square foot of surface area. Weight concentration is a measure of the amount of lead contained in dust, expressed in micrograms of lead per gram of dust (µg/g). These two units are not interchangeable and cannot be converted into the other on a routine basis; however, the two units of measure are often correlated. It is important to note that loading can be reduced by cleaning while concentration usually is not.

Wipe sampling is the recommended method for most routine risk assessment work for the following reasons:

- Dust wipe sampling is relatively simple and inexpensive.
- Dust wipe sampling has been correlated with children's blood lead levels in a number of studies.
- Vacuum sampling methods are not standardized, which makes it not possible to identify hazards using vacuum sampling. Please do not use this method.

HUD, EPA, and ASTM have developed dust wipe sampling protocols. These specific protocols must be followed by risk assessors because the current standards were developed using only these methods. Wipe samples for settled lead dust can be collected from floors (both carpeted and uncarpeted); interior window sills, and other reasonably smooth surfaces (e.g., stair treads, bookshelves). Wipe media should be sufficiently durable so that they are not easily torn but nevertheless can be easily digested in the laboratory. Recovery rates of between 80 to 120 percent of the true value should be obtained for all media used for wipe sampling. Blank media should contain no more than 5 µg/wipe.

Type of Disposable Wipe

Any wipe material that meets the following criteria may be used:

- Contains low background lead levels (less than 5 µg/wipe)
- Is single thickness
- Is durable and does not tear easily
- Does not contain aloe
- Can be digested in the laboratory
- Has been shown to yield 80 to 120 percent recovery rates from samples spike with lead dust (not lead in solution)
- Remains moist during the wipe sampling process (wipes containing alcohol may be used as long as they do not dry out).

Non-sterilized, Non-powdered Disposable Gloves

Disposable gloves are required to prevent cross-sample contamination from hands. Such gloves can be purchased from medical supply and drug stores. **Some forms of talc used to powdered gloves may have lead contamination.**

Centrifuge Tubes

Use non-sterilized polyethylene centrifuge tubes (50 ml size) with sealable caps or equivalent hard-shell container that can be rinsed quantitatively companies or medical or chemical supply companies.

Template Options

1. Masking tape. Masking tape is used on-site to define the area to be wiped. Masking tape is required when risk assessors are wiping window sills in order to avoid contact with window jambs and channel edges. Masking tape on floors is used for outlining the exact are to be wiped.
2. Hard, smooth, reusable templates made of marinated paper, metal, or plastic. Disposable templates are also permitted so long as they are not used for more than a single surface. Templates must be larger than 0.1ft², but smaller than 2 ft². Templates for floors are typically 1 ft². Templates are usually not used for windows because of the variability in size and shape (risk assessors should use masking tape instead). Reusable templates must be cleaned after each sample. Note: Risk assessors should take periodic wipe samples from the

templates to determine if the template is contaminated.

Additional Sampling Supplies

- Container labels or permanent marker
- Trash bag or other receptacle (do not use pockets or trash containers at residence)
- Rack, bag, or box to carry tubes (optional)
- Measuring tape
- Disposable shoe coverings

Single-Surface Wipe Sampling Procedure

Outline Wipe Area

Floors: Identify the area to be wiped. Do not walk on or touch the surface to be sampled (the wipe area). Apply adhesive tape to the perimeter of the wipe area to form a square or rectangle of about one square foot. No measurement is required at this time. The tape should be positioned in a straight line, and corners should be nominally perpendicular. When putting down any template, do not touch the wipe area.

Window sills and Other Rectangular Surfaces: Identify the area to be wiped. Do not touch the wipe area. Apply two strips of adhesive tape across the ends of the sill to define a wipe area at lead 0.1 square foot in size (at least 4 inches x 4 inches). It is not necessary to tape the length of the window sill.
When using tape, do not cross the boundary tape or floor markings, but be sure to wipe the entire sampling areas. It is permissible to touch the tape with the wipe but not the surface beyond the tape.

Preliminary Inspection of the Disposable Wipes

Inspect the wipes to determine is they are moist. If they have dried out, do not use them. When using a container that dispenses wipes though a “pop-up” lid, the first wipe in the dispenser at the beginning of the day should be thrown away. The first wipe may be contaminated by the lid and is likely to have dried to some extent. Rotate the container before starting to ensure liquid inside the container contacts the wipes.

Preparation of Centrifuge Tubes

Examine the centrifuge tubes and make sure that the tubes match the tubes containing the blind spiked wipe samples. Partially unscrew the cap on the centrifuge tube to be sure that it can be opened. Do not use plastic bags to transport or temporarily hold wipe samples. The laboratory cannot measure lead left on the interior surface of the plastic bag.

Gloves

Put a disposable glove on one hand; use a new glove for each sample collected. If you

need to use two handles to handle the sample, use two new gloves, one for each hand. It is not necessary for you to wipe the gloved hand before sampling. Use a new glove to each sample collected. Do not touch any surface other than the wipe after putting on the glove.

Initial Placement of Wipe

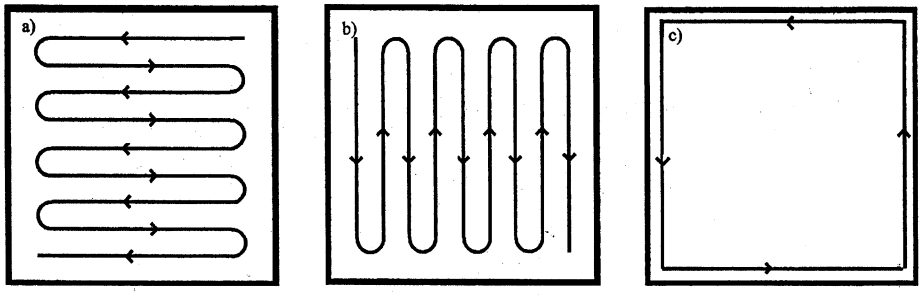
Place the wipe at one corner of the surface to be wiped with wipe fully opened and flat on the surface.

First Wipe Pass (side-to-side)

With the fingers together, grasp the wipe between the thumb and the palm. Press down firmly, but not excessively with both the palm and fingers (avoid using the heel of the hand). Do not touch the surface with the thumb. If the wipe area is a square, proceed to wipe side-to-side with as many "S" like motions as are necessary to completely cover the entire wipe area. Exerting excessive pressure on the wipe will cause it to curl. Exerting to little pressure will result in poor collection of dust. Do not use only the fingertips to hold down the wipe, because there will not be complete contact with the surface and some dust may be missed. Attempt to remove all visible dust from the wipe area.

Second Wipe Pass (top-to-bottom)

Fold the wipe in half with the contaminated side facing inward. (You can straighten out the wipe by laying it on the wipe area, contaminated side up, and folding it over). Once the wipe is folded, place it in the top corner of the wipe area and press down firmly with the palm and fingers. Repeat wiping the area with "S" like motions; but, on second pass, move in a top-to-bottom direction. Attempt to remove all visible dust. Do not touch the contaminated side of the wipe with the hand or fingers. Do not shake the wipe in an attempt to straighten it out, since dust may be lost during shaking.



Rectangular Areas (e.g., window sills)

If the surface is a rectangle (such as a window sill), tow side-to-side passes must be made, the second pass with the wipe folded so that the contaminated side faces inward. For a window sill, do not attempt to wipe the irregular edges presented by the contour of the window channel. Avoid touching other portions of the window with the wipe. If paint chips or gross debris are in the window sill, attempt to include as much of it was possible on the wipe. If all the material cannot be picked up with one wipe, field personnel may use a second wipe at their discretion and insert in the same container.

Many window troughs contain paint chips or other gross debris. Remove large sticks or

stones or other debris, but do not remove paint chips. Attempt to include any paint chips that adhere to the moist wipe material. Larger paint chips that do not adhere on the wipe do not need to be included in the sample.

Packaging the Wipe

After wiping, fold the wipe with the contaminated side facing inward again, and insert the wipe without touching anything else into the centrifuge tube or other hard-shelled container. Roll or fold the wipe into the container to avoid losing sample when inserting the wipe into the tube. If gross debris is present, such as paint chips in a window trough, make every attempt to include as much of the debris as possible in the wipe.

Labeling the Centrifuge Tube

Seal the tube, and label it with the appropriate identifier. Record the laboratory submittal sample number on the field sampling form. (See Appendix D-Dust)

Area Measurement

After sampling, measure the surface area wiped to the nearest eight of an inch using a tape measure or a ruler. No more than 2 square feet should be wiped with the same wipe, or else the wipe may fall apart or dry out. Record specific measurements for each area wiped on the field sampling form.

Form Completion

Fill out the appropriate field sampling forms completely. Collect and maintain any field notes regarding type of wipe used, lot number, collection protocol, etc.

Trash Disposal

After sampling, remove the masking tape and throw it away in a trash bag. Remove the glove(s); put all contaminated gloves and sampling debris used for the sampling period into a trash bag. Remove the trash when leaving the dwelling. Do no throw away gloves or wipes inside the dwelling unit where they could be accessible to young children, resulting in a suffocation hazard.

Composite Wipe Sampling

Before you decide to composite sample, consult with the analytical laboratory to determine if the laboratory is capable of analyzing composite samples. No more then four individual wipes should be included, and only one type of component (uncarpeted floor, window sill, or window trough) shall be included in a composite sample. When conducting composite wipe sampling you should use the procedure stated above with the following modifications:

- When outlining the wipe areas, set up all of the areas to be wiped before sampling. The size of these areas should be roughly equivalent, so that one room is not over sampled.
- After preparing the centrifuge tube, put on the gloves(s) and complete the wiping

procedures for all subsamples. A separate wipe must be used for each area sampled. After wiping each area, carefully insert the wipe sample into the same centrifuge tube (no more than four wipes per tube).

- Risk assessors do not have to remove their gloves between sub sample wipes for the same composite sample as long as their gloved hands do not touch an area outside of the wipe areas. If a glove is contaminated, the glove should be immediately replaced with a clean glove.
- Once all subsamples are in the tube, label the tube. Record a separate measurement for each area that is sub sampled on the field collection form and make sure to report the total surface area wiped to the laboratory. (See Appendix D)

Rules for Composite Sampling

Risk assessors should observe the following rules for compositing:

- Separate composite samples are required from carpeted and hard surfaces. Whenever possible, hard floors should be sampled instead of carpets. Collection efficiencies may vary considerably on carpets.
- Separate composite samples are required for each dwelling.
- Separate composite samples are required from each different component sampled.
- Floor surface areas sampled in each room should be approximately the same size 1ft². Window trough and interior window sill sampling sizes are dependent on window characteristics but should be as similar as possible from room to room.
- Do not use the same wipe to sample two different spots. Always use a new wipe for each spot sampled.
- If composite samples are collected, blank samples should also be submitted for analysis.

Blank Preparation

The EPA has specific guidance for selecting media for collection of dust wipe samples. The wipe media must meet the performance requirements of ASTM-1792. The following list is published by the American Industrial Hygiene Association, which is one of the accreditation organizations used by NLLAP. The following list includes wipe media which allegedly meet the requirements of ASTM-1792 and is not meant to be all-inclusive.

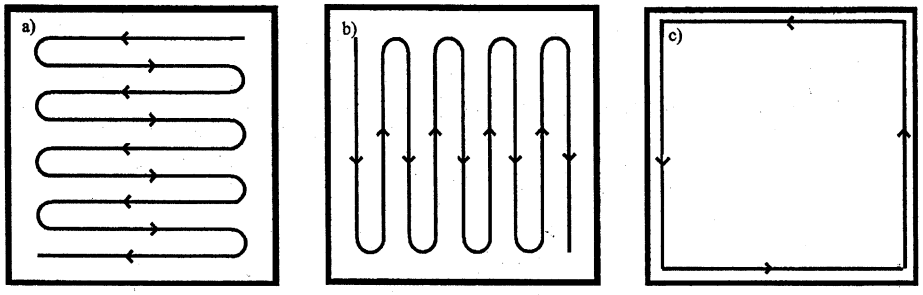
Palintest Dust Wipe available from Palintest located at 21 Kenton Lands Road, Erianger, KY, 41018, 800-835-9629.
Lead Wipe (Aramsco) from Lynx Products, Thorofare, NJ, 800-767-6933.
Wash ‘n Dri Moist Disposable Towelettes from Softsoap Enterprises, Chaska, MN, 55318, 800-255-7552.
Ghost Wipes from Environmental Express, 490 Wando Park Blvd, Mt. Pleasant, SC, 29464, 800-343-5319

Dust Wipe Sampling Supplies

- ✓ 12” x 12” template
- ✓ 3/4“ or 1” masking tape
- ✓ 2” masking tape

- ✓ 3’ x 3’ piece of 6 mil poly sheeting
- ✓ Steel tape measure
- ✓ Hard shell containers such as plastic or glass vials for sample collection
- ✓ Indelible marker for labeling vial
- ✓ Box of wipes for cleaning scrapers, templates, hands as necessary
- ✓ EPA approved wipe media for sample collection (store in zip loc bag to prevent contamination of outside of packaged wipe)
- ✓ Thin powder-free gloves
- ✓ Trash bags
- ✓ Field log notebook
- ✓ Sample collection forms
- ✓ Laboratory Chain of Custody sheets
- ✓ Gallon size plastic baggies
- ✓ Pen
- ✓ Field log notebook {all field sampling notes (including collection forms), diagrams, questionnaires, site information should be inserted into the logbook so that the logbook contains all notes, results, etc as one comprehensive file for all information concerning the site}
- ✓ Canvas bag, box or other container for sampling supplies: “Sampling Kit”
- ✓ Keep list of supplies which are included in the sampling bag.

Sampling technique:



Dust Wipe Sampling Protocol: floors

Select floor area for dust wipe collection, taking care not to track across sampling area prior to collecting sample.

Place sheet of poly next to sample area: this will serve at set up location.

Place template on floor and secure at corners with making tape. If template is not available, using making tape and steel measuring tape, tape off a square which is 12” on the inside of the tape.

Label sample vial with date, unique sample number and sampler’s initials, (time will be added later), and record in field logbook.

Put on gloves and open sample vial.

Open the EPA approved wipe media (checking to make sure the wipe is still wet and not damaged in any way), place wipe on open flat hand with the fingers together and place wipe on floor inside template.

Wipe the area from side to side with an S shaped pattern until the entire area is wiped one time.

Fold the wipe in half with the wiped side to the inside of the fold.

Place the wipe back onto the floor inside the template and wipe at a ninety degree angle in a second S shaped pattern.

Fold the wipe in half again, folding the wiped side to the inside.

Place wipe in one inside corner of the template and wipe inside edge of the template on all four sides.

Fold the wipe in half with the wiped side to the inside and place in a sample vial, seal vial.

Label the vial with the time.

Record the time on both sample vial and field logbook.

Place the vial in a labeled gallon baggie, seal baggie (all vials will go into this baggie).

Use the non-laboratory wipes to clean the template and wipe off the poly.

Discard gloves, place in trash bag.

Place all trash in trash bag, and place all tools into sampling kit.

Record sample location and number on diagram, move to next sample location.

AFTER ALL DUST WIPES ARE COLLECTED, fill out Chain of Custody sheet, taking care to specify area included in wipe sample and remove all sampling trash from property.

Dust Wipe Sampling Protocol: window sills

Select window sill for dust wipe collection.

Place sheet of poly under the sample area: this will serve at set up location.

Tape off all edges of the sill area to be wiped, taking care not to touch the inside sill area. (This aids the risk assessor in collection of the wipe by protecting from the possibility of over wiping the sill edges).

Label sample vial with date, unique sample number, and sampler's initials, (time will be added later), and record in field logbook.

Put on gloves and open sample vial.

Open the EPA approved wipe media (checking to make sure the wipe is still wet and not damaged), place wipe on open flat hand with the fingers together and place wipe on sill inside template.

Wipe the area going side to side with an S shaped pattern until the entire area is wiped one time.

Fold the wipe in half with the wiped side to the inside of the fold.

Place the wipe back onto the sill inside the template and wipe at a ninety degree angle in a second S shaped pattern.

Fold the wipe in half again, folding the wiped side to the inside.

Place wipe in one inside corner of the template and wipe inside edge of the taped window sill area on all four sides.

Fold the wipe in half with the wiped side to the inside and place in a sample vial, seal vial.

Label the vial with the time.

Measure to the nearest 1/4" the area wiped inside the tape; record in field logbook.

Record the time on both sample vial and field logbook.

Place the vial in a labeled gallon baggie, seal baggie (all vials will go into this baggie).

Use the non-laboratory wipes to clean the poly.

Discard gloves, place in trash bag.

Place all trash in trash bag, and place all tools into sampling kit.

Record sample location and number on diagram, move to next sample location.

AFTER ALL DUST WIPES ARE COLLECTED, fill out Chain of Custody sheet (Appendix H), taking care to specify area included in wipe sample and remove all sampling trash from property.

Field Blanks and Laboratory (Media) Blanks for Dust Wipes

Field Blank Protocol:

Field blanks are sample wipes that are exposed to the same handling except that they are not used to wipe an area. Field blanks should be collected for each dwelling unit sampled.

To collect a blank wipe, first remove a wipe from the container with a new glove.

Shake the wipe open.

Refold wipe as it occur during the actual sampling procedure.

Insert it into the centrifuge tube without touching any surface or other object.

Perform sampling at a minimum frequency of 5% or 1 for every 20 wipe samples collected, whichever is greater.

Laboratory (Media) Blank Protocol:

Laboratory blanks are to ensure that the media is not contaminated with lead during manufacturing and packaging. No lab blank should contain lead $\geq$ 5 ug. For each lot of wipe media: take one laboratory blank in the following manner:

When a new lot of wipe media is received and while in the office: Label sample vial with date, unique sample number and sampler's initials, (time will be added later), and record in field logbook.

Put on gloves and open sample vial.

Open the EPA approved wipe media (checking to make sure the wipe is still wet and not damaged in any way), place wipe on open flat hand with the fingers together and place wipe on sill inside template.

Fold sample in half three times, the same as if a sample was collected.

Place the wipe in the vial.

Enter time on vial and in logbook.

Note: When filling out Chain of Custody, do not reveal which samples are laboratory or media blanks.

Soil Sampling

The elements of soil sampling are included below and are followed by a step-by-step procedure for collecting soil samples.

Soil Sampling Protocol:

Compositing

In order to reduce variability, all soil samples collected for routine residential lead-based paint risk assessment and EIBL purposes are composite samples. This means that soil collected from more than one spot is mixed with soil collected from another nearby spot. Usually, one composite sample is collected from each of bare areas designated by the risk assessor as a child's play area(s) (if it can be identified) and a composite sample derived from the rest of the bare areas in the yard which are not designated as child play areas. Each composite sample usually consists of 5-10 subsamples mixed together.

Coring and Scooping Techniques

Soil samples are typically collected with a coring device, which works well for most soils. Some sandy or "friable" soils may require the use of a scooping device, such as a stainless steel spoon or disposable plastic scoop. The risk assessor should collect soil no deeper than 1/2 inch.

Professional soil core sampling devices are available. These devices may be operated in either of two ways:

1. By using a "T-handle" or other holding device; or
2. By using a hammer attachment on top of the coring tool or probe (for hard or frozen soil).

The T-handle allows the operator to push the tool into the ground. The operator can use the T-handle to twist the coring tool as it is pushed into the ground, thereby allowing the cutting edge of the soil probe to cut through roots and packed earth. Although the T-handle is easiest to use, if the soil to be sampled is particularly hard and compacted, the operator may need to use a hammer attachment to collect the sample. To use the coring tool in this manner, the operator attaches the hammer device to the top of the coring tool and places the tip of the probe on the ground where the sample is to be collected. The operator then raises the hammer and allows it to fall while guiding it with the hands.

Another method that has been used successfully in soil sampling is to use a 5 cc disposable syringe with the needle end cut off. The plunger is used to remove the soil plug to avoid contact with the fingers. No cleaning is required, since the device is disposable. The syringe should be at least 1/2 inch in diameter. Syringes will not work well in hard or compacted soil.

Obtaining a Core Sample:

Insert the selected tool at least 1/2 inch into the soil, then moves the tool gently from side to side to loosen a plug of soil. With many soil types, a coring depth of up to 2 inches may be required to retain the core in the sampling tool.

Pull the tool from the ground and use a clean spatula or gloved finger to push the soil sample so that the upper part of the soil plug lies between 1/2 inch marks made on the coring device. This 1/2 inch section of the soil core is transferred to a sample container. Only the top 1/2 inch of soil should be sent to the laboratory for lead-based paint risk assessment purposes.

Collect all subsamples are collected in this manner. The group of subsamples from the sampling grid or line is referred to as a "composite" sample, meaning that it is composed of the individual subsamples.

After collecting a composite sample, the risk assessor should decontaminate the soil probe. It does not need to be cleaned after each sub sample is collected, however. This process consists of wiping the end of the probe with wet wipes until all traces of visible dirt have been removed.

Soil Sampling Supplies:

- ✓ Soil coring device, handle, and hammer attachment or equivalent (hammer is optional);
- ✓ Stainless steel spatula or spoon (or disposable plastic);
- ✓ 5 cc disposable syringe with the needle end cut off
- ✓ Ruler or tape measure;
- ✓ Graph paper for soil plot sketches;
- ✓ Non-powdered, disposable gloves;
- ✓ Sealable plastic containers or plastic bags;
- ✓ Commercial disposable wipes;
- ✓ Self-adhesive labels, pencil, and marking pen;
- ✓ Sample collection forms
- ✓ Chain of Custody forms
- ✓ Field log notebook {all field sampling notes (including collection forms), diagrams, questionnaires, site information should be inserted into the logbook so that the logbook contains all notes, results, etc as one comprehensive file for all information concerning the site}
- ✓ Keep a list of supplies which are included in the sampling bag

Depth

The depth of soil to be sampled is the top 1/2 inch, as this is the depth a child contacts most frequently. Studies have shown that soil samples collected with this protocol have been correlated with children's blood-lead levels.

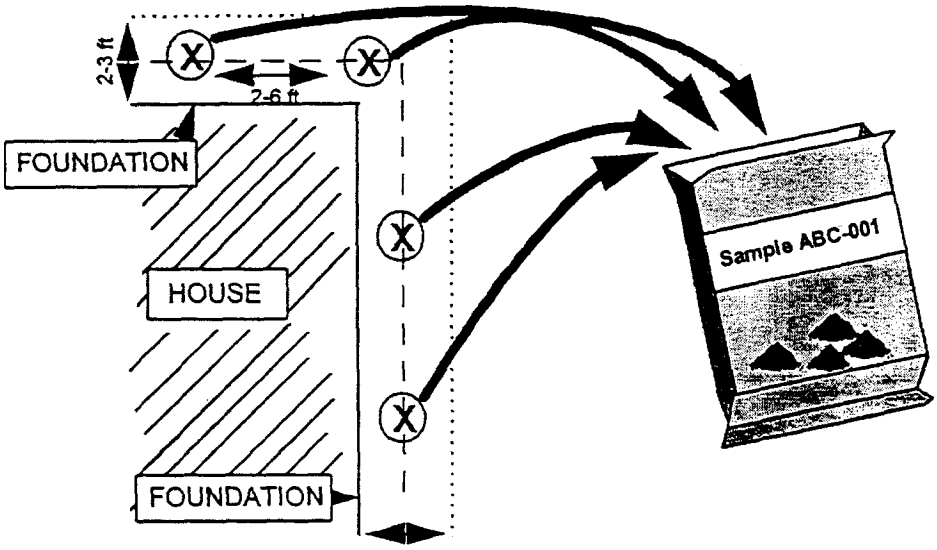
In some cases, sampling at deeper levels may be helpful if an owner is planning some form of excavation or tilling of a garden in the future. Deeper sampling may be required to determine the depth of contamination if soil abatement by removal and replacement is a recommended hazard control option. Requirements of any specific owner should be evaluated to determine the type of information/testing needed.

Number and Location of Soil Samples

Many different configurations of dwelling exteriors are likely to be encountered in the

field. In most situations, several composite samples per dwelling will be adequate (one from each child play area, the other from the other bare soil areas). If the drip line is bare, this most likely will be identified as a play area due to the proximity to the dwelling. Each composite sample should consist of 5-10 subsamples (5 for smaller bare areas, 10 for larger), collected roughly along an X-axis.

Diagram for drip line sampling:



2-3 ft

For samples collected along the foundation drip line, subsamples should be collected at least two to six feet apart. Each sub sample is then placed into a single container to make up a composite soil sample.

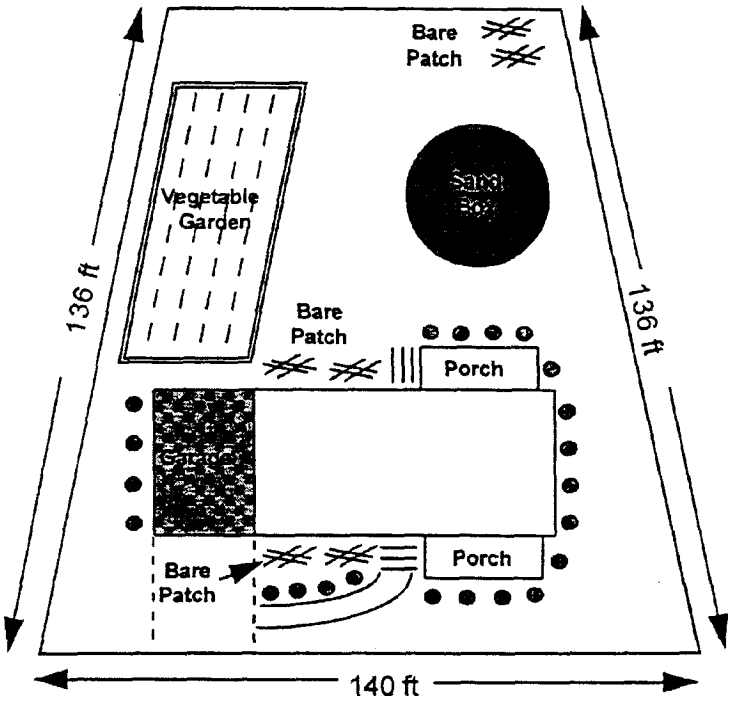
Sketches

Begin by preparing a site description. Make a detailed drawing showing:

- ✓ The boundary of the lot;
- ✓ The position of the main building and any other structures such as garages and storage sheds;
- ✓ The position of the play areas;
- ✓ The position of areas with exposed soil;
- ✓ Areas of heavier traffic.

Since only areas of **bare soil** are considered potential lead hazards under Title X*, the risk assessor should only sample areas of bare soil unless otherwise requested. Additional sites may be sampled if the ground cover on the sites may be disturbed in the future (e.g., gardening or excavation).
*Title X defines "lead-contaminated soil" as **bare soil** on residential property that contains lead at or in excess of the levels determined by the EPA to be hazardous to human health.

•80ft



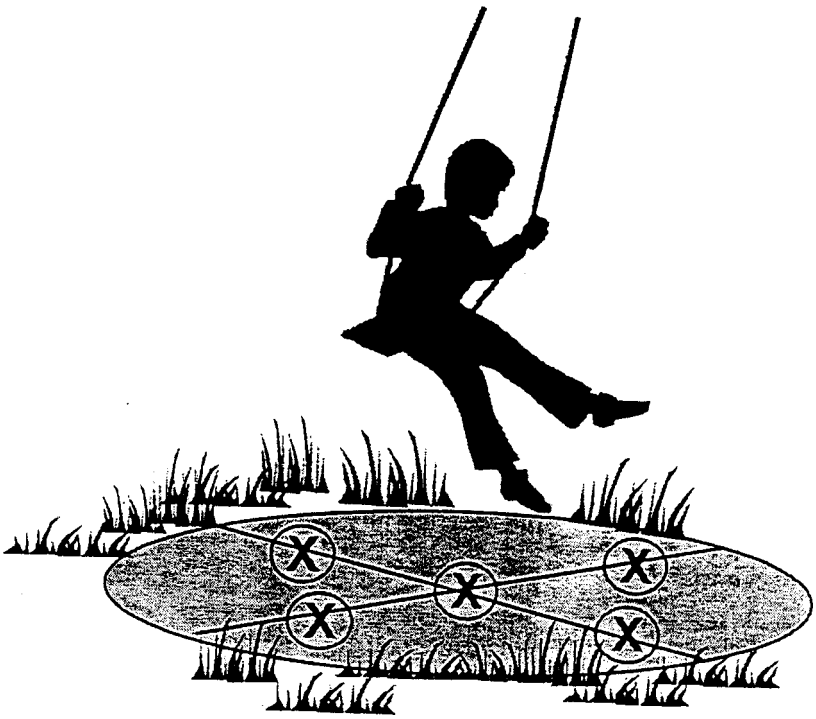
Note: Not drawn to scale.
Example of site description showing lot boundary, building location, garage location, play area (sand box), and areas of bare soil, including vegetable garden

When Soil Sampling is <u>Not</u> Required:

If there is no bare soil, sampling is not necessary. This includes areas where all soil is covered by pavement or a good dense cover of grass, ivy, or similar material. However, in most cases, there will be at least small bare areas that should be sampled**.**

Location of Subsamples

Each composite sample should consist of approximately equal soil subsamples collected from 5-10 distinct locations roughly equidistant from each other along an axis. For samples collected along the foundation drip line, subsamples should be collected roughly 2-6 feet away from each other. At other sampling locations, samples should be collected at roughly equidistant points along each axis of an X-shaped grid. Samples should be collected from bare spots.



Areas of bare soil should be divided by an x-shaped grid. Samples should then be collected at equidistant points along each axis.

Paint Chips in Soil

If paint chips are present in the soil, they should be included as part of the soil sample. However, there should be no special attempt to over-sample paint chips. The laboratory should be instructed to disaggregate (break up) paint chips by forcing them through a sieve in the laboratory. Although paint chips should not be over-sampled, they also should not be excluded from the soil sample, since they are part of the soil matrix.

Analysis of Soil Samples Results

As with dust samples, only laboratories recognized under the EPA National Lead Laboratory Accreditation Program should be used by risk assessors.

Soil Sampling Protocol:

Walk the entire property, draw a diagram the property and locate all bare areas on the diagram.

Based on information supplied by resident and on risk assessor's observations, determine which areas are child play areas and which are non-play areas.

Each play area will be sampled with a composite sample.

All other bare areas will be composited together into one composite area (subject to risk assessor's judgment).

Superimpose an "X" over each child play area.

Put on powder free gloves.

Dependent upon size, collect 5-10 samples along the "X" of the top 1/2 inch of soil for the first child play area, using one of the collection devices described above.

Place all samples in one sample container such as a heavy duty zip type baggie or hard shelled sealable container.

Mix to ensure homogeneity.

Label sample container with date, initials of sampler, time and unique sample number.

Record information in field logbook (including description of area and sample location), and locate sample number on diagram.

Clean sampling equipment with lead free commercial wipe.

Discard gloves.

Repeat steps 6-13 for each child play area.

Superimpose an "X" over each bare area designated as a non-play area.

Collect between 5-10 total s from all non-play bare areas.

Mix sample to ensure homogeneity.

Label sample container with date, initials of sampler, time and unique sample number.

Record information in field logbook (including description of area and sample location), and locate sample number on diagram.

Clean sampling equipment with lead free commercial wipe.

Discard gloves.

After all soil samples are collected, fill out Chain of Custody sheet, and remove all sampling trash from property.

Place trash in trash bag and remove all sampling trash from property.

Blank and Control Samples

No additional soil blank or field "spike" (control) are required for routine lead-based paint risk assessments.

Water Sampling

Sampling Technique for Lead in Drinking Water

Because the most likely sources of lead in drinking water are internal to the dwelling, lead tends to build up in water stagnant in the pipes overnight. Therefore, the highest levels of lead in tap water are usually encountered in the first water from the tap in the morning, the so-called "morning first draw." The sampling strategy outlined below is designed to differentiate between different sources of lead in tap water and suggest effective ways to deal with any identified problem.

Water Sampling Supplies:

- ✓ 2 – 250 cc acidified containers from lab (nitric acid)
- ✓ 750 cc acidified containers from lab
- ✓ One liter acidified container from lab
- ✓ Sample labels
- ✓ Gloves
- ✓ Indelible marker
- ✓ Pen
- ✓ Field log notebook
- ✓ Chain of custody forms
- ✓ Sign for kitchen tap
- ✓ Field log notebook {all field sampling notes (including collection forms), diagrams, questionnaires, site information should be inserted into the logbook so that the logbook contains all notes, results, etc as one comprehensive file for all information concerning the site}
- ✓ Keep list of supplies which are included in the sampling bag

Water Sampling Protocol: The "Guiding Principle" for sampling the first morning draw from the primary spigot(s) used for drinking and cooking, is to measure what the child is actually exposed to on a regular basis and identify as a potential "contributing" source of lead exposure. Note: you are not seeking to evaluate the community water supply.

Contact laboratory to obtain sample containers. (The best sampling collection and preservation method is to sample into acidified containers).

Arrange sampling date with residents. Explain the "8 hour undisturbed water period" and process to them and work out the best time frame for collecting the first draw.

Deliver a sign to the residents to place on the kitchen tap at night to remind them not to use the tap until sampling is completed. Ask them to place a bag over spigots used for drinking water the night before sampling is to occur.

Arrive at residence at agreed upon time and date. If advance notice is given, the samples can be obtained when performing the lead risk assessment of the building.

Label each sample container (date, sampler's initials, and unique number) and fill field logbook with all field information. NEVER OVERFLOW BOTTLES BECAUSE THE ACID PRESERVATION WILL BE DILUTED.

*** Note: A complete water analysis will be performed later if the first draw shows any lead. However, complete sampling should <u>always</u> be performed if residence uses water from a well, as there are more components where an initial sample will not pick up a lead source.**

<u>FIRST SAMPLE:</u> Take 250 cc of water from the cold water kitchen tap after there has been no water usage for at least 6, preferably 8 hours (morning first draw). Put time on sample label and in logbook.

<u>SECOND SAMPLE:</u> Take 750 cc immediately after the first sample, and without wasting any water in between. Put time on sample label and in logbook..

<u>THIRD SAMPLE:</u> Take 250 cc after the water turns cold or any other indication that the water is representative of service line (let water run approximately 3-5 minutes). Put time on sample label and in logbook.

<u>FOURTH SAMPLE:</u> Take 1000 cc after the water has run for about 3-5 additional minutes after the third sample, or has otherwise been determined to be representative of water from the supply source (e.g.. has reached a constant temperature). Put time on sample label and in logbook.

Samples are typically collected in clean, plastic (ex. Nalgene) bottles. If the samples are not analyzed within 28 hours, some of the lead in the water may be transferred to the container walls. This may be avoided by the use of laboratory acidified containers. Laboratory analysis often consists of atomic absorption spectroscopy (AAS) or inductively coupled plasma (ICP) analysis. In some cases, sample digestion may be required. A risk assessor should always contact the laboratory **before** water samples are collected to ensure that the sample is collected per analysis method requirements. Laboratory lead in water results are usually reported in units of parts per billion (ppb).

The simple testing program outlined above is adequate to determine the status of lead in the tap water in a single family home. In a multi-unit project, the situation is more complicated, because the plumbing system is larger and more complicated, and because there may be additional sources of drinking water such as water coolers. Nevertheless, the simple test procedure for a single-family home can still give the residents of a particular unit important information. Also, the same principle of successive testing to isolate sources of lead in the water can be applied to design effective customized sampling procedures even for very large buildings.

Questions about the proper procedures to follow for testing for lead in drinking water can be directed to the Safe Drinking Water Hotline at 1-800-426-4791. The information specialists at this number can provide callers with telephone numbers of individuals to contact in their own states. Some state offices also can provide callers with information on laboratories certified to test for lead in drinking water in that state. **The VDH Office of Drinking water can answer most questions related to public drinking water regulations and testing. (804) 864-7500 or (804) 864-7489**

Interpretation of Results

- Lead dust results that equal or exceed the following levels can be considered possible sources of lead exposure:
    - Floors; 40 $\mu g/ft^2$
    - Window sills: 250 $\mu g/ft^2$
- Paint is considered to be lead-based if the level is equal to or greater than 0.5% by weight or 1.0 mg/cm^2. If the paint is lead based paint and is also deteriorated, the surface is a paint lead hazard.
- A soil lead hazard is defined as bare soil on residential properties that contain lead greater than or equal to 400 ppm in child play areas and an average greater than or equal to 1200 ppm in other bare soil areas.
- 15 ppb is considered elevated for water in dwellings. EPA research revealed a direct correlation between elevations in children's' blood lead levels and concentrations of 15 ppb or higher in their primary water source.

In most circumstances, the four consecutive samples will show decreasing levels of lead: the first sample will have the highest level: the fourth will have the lowest. Perhaps the most common situation of concern will be when the first and second samples exceed the action level, but the third sample is much lower. This indicates that the water is contaminated with lead from the plumbing internal to the dwelling, from lead present in the pipes or connections, combined with acidity of the water itself. The residents can take several simple steps to protect themselves in this case. 1) When using water after a period of inactivity, such as first thing in the morning, let the water run for 2-3 minutes to reduce the lead levels. After letting the water run for this extended time-it should become cold, fill a jug of water and refrigerate for use during the day. 2) Because warm water is more corrosive, always use water from the cold tap for cooking. 3) Never use the first draw or warm water when making baby formula.

If there is concern about letting water run from the tap before using it to drink or cook with, it is suggested that this water be used to water plants that are not eaten or for other activities that do not involve ingesting the water. When the third sample shows elevated lead levels, the problem is traceable to the service line from the water supply. In such cases, even though the residents may own all or part of their service line, the water company should be contacted to discuss service line replacement. EPA's National Primary Drinking Water regulations for lead mandate a program of replacement of lead service lines over time under certain conditions. Unfortunately, such replacement may take many years. The use of bottled water for drinking and cooking or filtering techniques if feasible, are possible practical solutions to such a problem. In the unlikely event that the fourth sample shows lead above the action level, the source is the water supply itself. Again, the residents should contact the water company.

Additional Sample Collection:

There may be unusual sources of lead in a lead poisoned child's environment and all potential sources must be considered. Based on results from the *Nursing Assessment Form* other sources of lead exposure shall be evaluated. The Resident Questionnaire (Appendix B) should also be obtained by the risk assessor before sampling. **These forms must be received/completed before a risk assessment is performed.**

Reporting: The Environmental Elevated Blood Lead Level (EBLL) Investigation Report

After the completion of the investigation, the report should be prepared to include a summary, applicable XRF data, environmental and other type of sample results and information, recommendations for the residence, abatement and interim control hazard options, and a reevaluation schedule. (See Appendix I for an example of an investigation report) It is also imperative that a disclosure statement be included on the report**. Copies of the report are to be distributed to the owner, tenant, nursing staff/physician, and per § 36-106 Code of Virginia, the locality's code enforcement authority.**

Environmental EBLL Investigation Report (See also Appendices J and K)

The report should include the following information**:**

- Date of assessment
- Address of each building
- Date of construction of buildings
- Apartment number if applicable
- Name, address and telephone number of each owner of each building
- Name, signature and license number of the risk assessor conducting the assessment
- Name, address and telephone number of the licensed firm employing each licensed risk assessor if applicable
- Name, address and telephone number of each recognized laboratory conducting analysis of collected samples
- Results of the visual inspection
- Testing method and sampling procedure for paint analysis
- Specific locations of each painted component tested for the presence of lead
- All data collected from on-site testing, including quality control data and, if used, the serial number of any XRF device
- All results of laboratory analysis on collected paint, soil and dust samples
- Any other sampling results
- All field sampling paperwork (as an appendix)
- All completed data forms as included herein
- Background information collected regarding the physical characteristics of the residential dwelling or child-occupied facility, and occupant use patterns that may cause lead-based paint exposure to one or more children age 6 years and under.

- To the extent that they are used as part of the lead-based paint hazard determination, the results of any previous inspections or analyses for the presence of lead-based paint, or other assessments of lead-based paint-related hazards.
- Description of the location, type and severity of identified LBP hazards and any other potential lead hazards
- Description of interim controls and/or abatement options for each identified lead-based paint hazard and a suggested prioritization for addressing each hazard. If the use of an encapsulant or enclosure is recommended, the report shall recommend a maintenance schedule for the encapsulant or enclosure
- Any applicable comments on known local funding for abatement.

Enforcement

The enforcement of lead based paint hazard controls is turned over to the Department of Inspections or the locality's building code enforcement agency. This is the reason why a copy of every risk assessment report must be given to the local building code official. Experience has shown that enforcement of lead-based paint hazard remediation can best be accomplished by a team approach, between the environmental health staff in the local health department and the code enforcement in the local jurisdiction.

The **Virginia Uniform Statewide Building Code (USBC)** is a state regulation promulgated by the Virginia Board of Housing and Community Development, which sets standards for the construction of buildings. The **Code of Virginia § 36-106** was amended to address identified lead hazards that pose a hazard to pregnant women and children under the age of 6 years. This amendment states that violators of the USBC shall be criminally prosecuted if the lead hazard is not remediated through lead hazard control.

Licensed Lead Workers and Contractors

The Virginia **Department of Professional and Occupational Regulation's (DPOR)** lead regulations have specific requirements which apply to lead activities in residences. The requirements for licensing and lead-based paint activities may be found on the DPOR Web page.

These requirements are based on evidence-based research that revealed that renovations that disturbed lead-based paint and dispersed lead dust throughout a home make the home unsafe for occupancy. Failure to contain lead dust and paint chips and to clean properly makes small children especially vulnerable to lead poisoning. DPOR issues licenses to contractors, inspectors, and workers who meet the requirements and maintains a list of licensed lead professionals in the Commonwealth of Virginia. Effective April 22, 2010, any renovation in pre-1978 housing and child-occupied facilities must be completed by certified renovation firms using renovators with accredited training, and following the work practice requirements of the EPA Renovation, Repair, and Painting Rule (RRP). Workers conducting lead based paint activities are also at risk for lead poisoning if lead safe work practices are not followed. **The Department of Labor and Industry (DOLI)** is the state agency responsible for enforcement of worker safety requirements under the *Lead in Construction Standard* developed by the Occupational Safety and Health Administration (OSHA). **http://www.doli.virginia.gov/**

Hazard Control Options:

Question: *What criteria should guide an owner or property manager in the selection of the use of abatement or interim controls in the design of a lead hazard reduction strategy?*

Answer: *Determine if the hazards identified are potential or immediate hazards. Lead-based paint hazards are classified as potential or immediate hazards. Any friction, impact, or accessible, chewable surface component with LBP is considered a potential hazard. If the paint is in intact, potential hazards can be managed in-place and monitored for integrity. If at any time the paint integrity becomes disturbed, it is then considered an immediate hazard.*

Immediate hazards are those six high hazard situations believed to produce lead exposures that poison children. They include:

1. **Deteriorated lead-based paint (LBP),** whether it is interior or exterior that is peeling, chipping, chalking or cracking, or located on any surface that is damaged or deteriorated.
2. Deteriorate LBP on any interior or exterior **"friction surface"** subject to abrasion or friction, such as painted floors and friction surfaces on windows.
3. Deteriorated LBP on any interior or exterior **"impact surface"** subject to damage by repeated impacts, such as parts of door frames.
4. Deteriorated LBP on any interior or exterior **"accessible chewable surface"** accessible for a young child to mouth or chew, such as a window sill.
5. **"Dust Lead Hazard"** is defined as surface dust in residential dwellings that contain an area or mass concentration of lead in excess of 40 $\mu g/ft^2$ for floors, 250 $\mu g/ft^2$ for window sills, and 400 $\mu g/ft^2$ for window wells.
6. **"Soil Lead Hazard"** According to the EPA 403 rule**:** A soil-lead hazard is present:

   In a play area when the soil-lead concentration from a composite play area sample of bare soil is equal to or greater than 400 parts per million; or
   In the rest of the yard when the arithmetic mean lead concentration from a composite sample (or arithmetic mean of composite samples) of bare soil from the rest of the yard (i.e., non-play areas) for each residential building on a property is equal to or greater than 1,200 parts per million.

Hazard Control Options: Abatement

Abatement is a measure or measures designed to **permanently** eliminate lead-based paint hazards. From a public health perspective, properly conducted abatement is the desired response to lead hazards. Abatement has two principal advantages: (1) it provides a long-term solution, and (2) little (if any) monitoring or reevaluation of the treated surfaces is necessary since failure is less likely to occur. LBP abatement refers to a group of measures that can be expected to eliminate or reduce exposures to lead hazards for at least 20 years under normal conditions since 20 years is the expected life span of many commonly used building components. Abatement is the closest one can get to a "permanent solution" to lead hazards in housing.
Abatement measures include: ***(DOLI must be notified)***

- Building component replacement;
- Enclosure systems;
- Paint removal (on-site or off-site);
- Encapsulation (with patch test and a 20 year warranty);

- Permanent soil covering (paving); and
- Soil removal and replacement. ***(DEQ should be consulted)***

Building Component Replacement

Building component replacement consists of removal of doors, windows, trim and other building items that are coated with lead-based paint and their replacement with new lead-free components. This measure is appropriate when the component is mostly deteriorated, since interim control measures are unlikely to be effective on unsound components (rotted windows sashes, door, etc.). The advantages of building component replacement are that it creates a permanent solution by removing all lead-based paint; it minimizes dust contamination to the property; and it minimizes worker and resident exposure. The disadvantage is it can be relatively expensive; in some historic preservation projects, component replacement may not be permitted; and when trim removal reveals an opening, large amounts of dust can be released.

Enclosure Systems

Enclosure systems consist of mechanically attaching a rigid, durable barrier to building components, with all edges and seams sealed with caulk or other sealant. Enclosures are intended to prevent access and exposure to lead-based painted surfaces and provide a "dust-tight" system to trap any lead-contaminated dust. Some materials for enclosure include:

Interior finish	-	drywall, paneling, wainscot
Exterior finish	-	aluminum, vinyl siding
Exterior trim	-	aluminum or vinyl coil stick
Steps	-	vinyl or rubber tread and riser coverings
Floors	-	underlayment and vinyl or other sheet finish goods

The advantages of enclosure are it allows the use of standard, locally available construction materials; it is highly reliable and may be more durable than encapsulation; it produces minimal waste, and it generates minimal levels of lead dust. There are several disadvantages of enclosure**. It does not permanently remove lead-based paint** (it only makes the dwelling free of hazards). The systems are vulnerable to water and physical damage. Future renovations can result in exposure to surfaces and create hazards (note: it is important to **label surfaces** that have lead-based paint before they are enclosed.). It cannot be used on unsound structures. Enclosures should be monitored annually by the owner. Note that aluminum or vinyl exterior siding can conceal rotting wood.

On-Site Paint Removal

On-site paint removal consists of an on-site separation of paint from the substrate using a variety of methods. Appropriate methods include heat guns operated at temperatures not greater than 1,100 digress Fahrenheit, chemical removal, and mechanical (HEPA sanding, wet scraping, HEPA vacuum blasting, HEPA vacuum needle blasting). The advantage of on-site paint removal is it can be less costly than replacing or enclosing building components. The disadvantage of on-site paint removal is a significant amount of dust may be released; caustic chemicals are used; chemical stripping can leave lead residues; certain mechanical methods are not effective on certain substrates; and specialized equipment is needed.

Off-Site Paint Removal

Off-site paint removal consists or removing paint through chemical or other means at a facility not on the abatement site (chemical stripping/dipping operations). The advantage of using off-site paint removal is that it has a low reevaluation failure rate; it is appropriate for historic preservation; minimal waste is generated on-site; and minimal ongoing monitoring is needed. The disadvantages of using off-site paint removal is that it can be expensive; it may deteriorate glues or other elements of components which may cause components to disintegrate; and it does not remove lead from the wood, which may release lead dust if it is disturbed again.

Encapsulation

Encapsulation is the process of rendering lead-based paint inaccessible by providing a barrier between the paint and the environment. The barrier is formed using a liquid-applied coating (with or without reinforcement materials) and/or an adhesively bonded covering material. Generally, encapsulants are attached to the surface by bonding the product directly to the surface or by using an adhesive. The advantages of encapsulation are that lead dust is not generated (if surface preparation is minimal); it may be less costly compared to other abatement methods; and a wide range of encapsulation products are available to meet different needs. The disadvantages of encapsulation is that it is inappropriate for use on friction, impact, chewable, or severely deteriorated surfaces; information on long term durability is limited; durability depends on the condition of previous paint layers; it is susceptible to water damage; and it may not be applied in extremely hot or cold weather conditions.

Permanent Soil Covering

Permanent soil covering consists of permanently covering bare, lead contaminated soil with concrete, asphalt, or other permanent materials. The advantage of permanent covering is that it is a permanent solution, provided that the source of lead in the soil has also been controlled; and it is less costly than removal and replacement of soil. The disadvantage of permanent covering is that it is not appropriate for certain land uses (backyards, sandboxes).

Removal and Replacement of Bare Soil

Removal and replacement of bare soil involves removing the top 2 – 6 inches of lead contaminated soil; disposing of it in accordance with federal and state standards; and putting new soil in its place. The advantage of removal and replacement is that it permanently removes the source of lead by taking it off-site. The disadvantage of removal and replacement is that the soil must be tested to determine if it is a hazardous waste or not and that it can generate lead dust if not contained. The EPA 403 Rule states that the soil that is removed shall not be used as topsoil at another residential property or child-occupied facility.

Hazard Control Options: Interim Controls

Because the cost of abatement can be prohibitively expensive, interim controls are another option to consider. Interim controls are intended to make dwellings "lead safe" by temporarily controlling lead based paint hazards, as opposed to abatement, which is intended to permanently remove lead or lead hazards. Interim control measures are fully effective **only** if they are carefully monitored, maintained, and periodically reevaluated by a licensed risk assessor**. Do not recommend this option if confident that continued monitoring will not take place.** If interim controls are properly maintained, they can be effective indefinitely. As long as surfaces are covered with lead based paint, however, they constitute potential hazards. Interim Control measures include:

- Paint film stabilization
- Friction–impact reduction treatments
- Specialized cleaning (also called dust removal)
- Education of tenants and landlords

Paint film stabilization

Paint film stabilization can repair deteriorated paint and create a new, intact painted surface. In the HUD "Lead Safe Work Practice Regulation" (24 CFR Part 35 et.al.), this technique is referred to as paint stabilization.

The advantages of paint film stabilization are that the cost is typically lower than abatement. The disadvantages are that it is not an appropriate control for severely damaged substrates, high wear areas, or friction-impact surfaces. Surface preparation and repair of substrates may generate large amounts of leaded dust and on-going monitoring is essential to maintain a lead-safe environment.

It is important to note that certain paint removal practices are prohibited because they create excessive risks to workers and occupants, they are difficult to clean up, and effective substitutes are available.

Friction/Impact Surface Treatment

Examples of building components that may contain friction or impact surfaces include the following:

- Window systems;
- Doors;
- Stair treads and risers;
- Baseboards;
- Drawers and cabinets; and
- Porches, decks, interior floors, and any other painted surfaces that are abraded, rubbed, or impacted.

A friction surface is defined as an interior or exterior surface that is subject to abrasion or friction, including, but not limited to, certain window, floor, and stair surfaces. Friction surfaces can be treated either by covering the surfaces with an abrasion resistant material to eliminate the friction surface or by repairing the component to good working condition so that less dust is created.

Impact surfaces can be protected by placing barriers in front of the impact surface. Some examples of impact surface treatment are new shoe molding in front of baseboards; new chair rail to protect lead-based painted walls from jolts by the backs of chairs; corner molding over outside comers of walls; and doorstops can be replaced.

Interim control treatments for friction surfaces shall eliminate friction points or treat the friction surface so that paint is not subject to abrasion. Examples of acceptable treatments include rehanging and/or plaining doors so that the door does not rub against the door frame, and installing window channel guides that reduce or eliminate abrasion of painted surfaces. Paint on stair treads and floors shall be protected with a durable cover or coating that will prevent abrasion of the painted surfaces. Examples of acceptable materials include carpeting, tile, and sheet flooring. Interim control treatments for impact surfaces shall protect the paint from impact. Examples of acceptable treatments include treatments that eliminate impact with the paint surface, such as a doorstop to prevent a door from striking a wall or baseboard.

It is important to note that interim controls for impact or friction surfaces do not include covering such a surface with a coating or other treatment, such as painting over the surface, that does not protect lead based paint from impact or abrasion.

Advantages of friction-impact treatments are that the cost may be less than component replacement, and although dust is generated, it is less than for many other controls.

Specialized cleaning

After hazard reduction activities have been completed, the worksite shall be cleaned using cleaning methods, products, and devices that are successful in cleaning up dust-lead hazards, such as a HEPA vacuum or other method of equivalent efficacy, and lead-specific detergents or equivalent.

Dust-lead hazard control:

Dust control shall involve a thorough cleaning of all horizontal surfaces, such as interior window sills, window troughs, floors, and stairs, but excluding ceilings. All horizontal surfaces, such as floors, stairs, window sills and window troughs, that are rough, pitted, or porous shall be covered with a smooth, cleanable covering or coating, such as metal coil stock, plastic, polyurethane, or linoleum.

The advantages of dust removal are that normal supplies can be used, with the addition of a HEPA vacuum, and the cleaning can be completed relatively quickly and easily. Dust removal directly removes the hazard implicated as the highest cause of childhood lead poisoning. The disadvantages are that cleaning is only effective on fairly smooth, "cleanable" surfaces, and this technique is not effective at reducing exposures if the source of the dust is not controlled.

Education

Education of both the landlord and the tenant can be, in some cases, a very effective measure for reducing childhood exposures. If the landlord understands the implementation of lead safe work practices and necessary controls into his normal maintenance procedures, control of exposures can become routine. Additionally, if the tenant understands how hand-washing and attention to cleaning and condition of child play areas is important in reducing exposures, the two groups working towards the same goal can provide a safer environment.

When Are Interim Controls Appropriate?

Interim controls are most easily implemented when most LBP surfaces are intact and structurally sound, and if the lead exposure comes primarily from small particles of deteriorating paint and from levels of lead in household dust and/or soil. Interim controls are also appropriate if the housing unit is slated for demolition or renovation within a few years. **Interim controls are effective only if they are carefully monitored and maintained and periodically reevaluated by a licensed risk assessor.**

If the housing unit has substantial structural defects or if interior or exterior walls or major components, such as windows and porches, are seriously deteriorated or subject to excessive moisture, interim controls are unlikely to be very effective. Paint cannot be effectively stabilized unless substrates are dry, structurally sound, and waterproof. .

Relocation and Work Preparation

Integral to the abatement planning process is the determination of the need to relocate the occupants and their belongings. This decision is based on health and safety issues rather than convenience or economics, especially when there is a lead-poisoned child, pregnant women, or people with immune deficiencies involved. A rule of thumb is that if the surface of lead paint is to be broken during abatement, occupants and their belongings must be temporarily relocated. Additionally, if construction will result in other hazards (such as exposed electrical wires), residents should be relocated**.** It is not safe for occupants to enter the worksite during hazard reduction activities. **Relocation is obviously the best way to ensure that occupants are not further exposed during control option activities. This is especially crucial with a lead poisoned child.** Relocation dwellings should be acceptable to residents so that they will not attempt to return to their own dwellings during lead hazard control work. Dwellings serving as temporary relocation units must be lead-safe. Relocation is usually a substantial undertaking, involving not only the movement of people and their possessions, but also the coordination of mail, phone, school, and community changes. Whenever possible, children should continue to attend the same school during the relocation period, even though this may involve finding special transportation. Due to their complex nature, relocation considerations may dictate the scheduling of the project. If furniture is not removed during abatement work, it should be protected at all times. As many things as possible should be packed to prevent damage while the work is going on. This includes any breakables, kitchen utensils, and items on top of shelves, tables, or dressers. All large furniture should then be moved into the center of the room, covered with plastic sheeting, and sealed to the floor with duct tape. (Furniture and floor areas should be cleaned prior to covering to prevent recontamination when uncovering takes place.) Area rugs and/or carpeting should be removed or completely covered and sealed with plastic sheeting. Heating and air-conditioning systems should be turned off and vents should be covered and sealed with plastic sheeting.

Clean up

Cleaning up is the most important step in controlling spread of dust and debris presently in the residence and which is generated during control activities. If lead dust is not properly controlled and cleaning performed, especially both during and after hazard control work, the area could be **more hazardous** than before work began. To minimize the level of hazards present while hazard controls are taking place, daily clean up, personal clean up, and final clean up is recommended. This always includes specialized cleaning at the end of work and clearance testing. Risk assessors that may be involved with abatement projects are trained to perform preliminary and final visual clearance of the work areas prior to collecting clearance samples. This process ensures that all lead control activities, including specialized cleaning, is completed prior to sampling and clearing the area for re-occupancy.

Clearance and Reevaluation

After the completion of any lead hazard control measure which was identified as a source of exposure, a clearance evaluation **must** take place to ensure the area no longer has lead hazards, and performed before the family moves back into the residence. Once clearance is established, regular monitoring and reevaluations should take place to ensure that the hazard control is still intact and that LPB hazards have not reappeared. Interim controls require more frequent monitoring than abatement since they are designed as short-term measures. Ongoing monitoring is a systematic approach for ensuring that dwelling units remain free of lead hazards through the evaluation of potential hazards and the management and maintenance of the LBP

that remains in the unit. This means checking paint conditions, levels of lead in the dust and soil, and the integrity of the control methods on a regular basis. Clearances and reevaluations must be performed by a licensed risk assessor and the testing shall be coordinated through the Lead Safe Virginia Program.

A clearance evaluation occurs in two phases: 1) preliminary and final visual examination and 2) environmental sampling. Clearance is established once sampling results are below EPA/HUD established limits.

Preliminary Visual Examination

The preliminary visual inspection takes place after preliminary cleanup is completed. Preliminary cleanup involves removal of plastic sheeting used for containment during the abatement, followed by HEPA vacuuming of the area, and washing with a detergent solution. The inspector should then visually inspect the affected area to ensure that abatement has been performed on all surfaces requiring it, and that all visible dust and debris have been removed. If the results of the visual inspection are unsatisfactory, further abatement must be performed as necessary and/or surface must be re-cleaned until satisfactory results are achieved.

Following satisfactory completion of the preliminary inspection, final clean up is carried out. This involves painting and sealing of all abated surfaces, including all floors whether abated or not followed by HEPA vacuuming, washing, and a second HEPA vacuuming. This is followed by a final inspection, with two purposes to ensure that the abatement work is complete (no paint requiring abatement remains in the dwelling), and, even more important, to be sure that lead levels in surface dust in the dwelling are reduced to acceptably low levels. Thus, there are two stages to the final inspection:

- Final visual inspection; and
- Surface dust sampling (clearance)

The final visual inspection determines that the abatement exactly followed the abatement plan. Special attention should be paid to the following potential problem areas:

- <u>Areas where lead paint has been removed adjacent to intact paint:</u>
  - An example is where paint is removed from a door frame but not from the adjacent wall. The boundary between the abated and unabated areas must be sound.
- <u>Windows:</u>
  - These should be checked for paint in hard-to-reach areas, especially sills, thresholds, the tops of parting bead areas, and under the lips of window sills.
- <u>Sealing and repainting.</u>
  - All abated areas should be repainted or otherwise sealed.

Clearance Wipe Sampling for Lead in Dust

There are EPA standards for lead in surface dust. There are separate clearance standards for floors, window sills, and window wells because of differences in lead levels, abatement techniques, and ease of cleanup on the three types of surfaces. The clearance standards for single wipe samples are:

<u>FLOORS:</u> 40 micrograms per square fool (µg/ft²)
<u>WINDOW SILLS:</u> 250 micrograms per square foot (µg/ft²)
<u>WINDOW WELLS:</u> 400 micrograms per square fool (µg/ft²)

The required method for testing surfaces is dust wipe sampling. However, before dust wipe samples are taken, the surfaces should be visually inspected to check for dust. If dust is visible, the area should be re-cleaned before wipe sampling. Because virtually all airborne dust settles within 1 hour, dust wipe sampling should not be conducted until at least 1 hour after the completion of final cleaning.
*Note –Dust wipe sampling for clearance must be carried out in a carefully controlled manner in accordance with the dust wipe protocol included within this document.

Number and Location of Wipe Samples

The EPA (Lead; Identification of Dangerous Levels of Lead; Final Rule) details the required number of clearance dust wipe samples that must be taken. For an abatement using a containment area, a floor, window sill, and window well wipe samples must be taken in no less than four rooms, hallways or stairwells. In addition, one dust wipe sample must be taken from the floor outside the containment area. For abatement without a containment area, two dust wipe samples (one from a window sill or well and one floor) shall be taken from each of no less than four rooms, hallways or stairwells in the residential dwelling or child-occupied facility.

The exact location to be sampled should be randomly selected. For example, randomly select a location within a room for the floor sample. Likewise, if a room has several windows, randomly select a window sill and a window well (independently) for sampling. A random number generator on a band-held calculator or a table of random numbers is useful tools for accomplishing random selection.

Soil Sampling and Reevaluation

Soil sampling is typically not conducted for ongoing reevaluation since a visual examination will enable risk assessors to ascertain if previously covered areas bare now or if interim control measures used to cover contaminated soil are still intact.

Reevaluation

Reevaluations are simply risk assessments with more limited sampling. They include a detailed visual examination of paint films and existing hazard controls, and limited interior dust sampling. All reevaluations should be documented and provided to the owner/tenant in a written summary. If any LBP hazards (either new or failed control measures) are found, recommend acceptable options for controlling the hazard.

Reevaluation Frequency

Reevaluation frequency is determined by the ongoing monitoring schedule and is based on lead-based paint hazards identified during the EIBL investigation and control option chosen. A complete chart is included under the EIBL investigation example found in the Appendix N.

Reporting

Refer to Appendix N for an example of a clearance report.

Glossary

Abatement:
Any measure or set of measures designed to permanently eliminate lead-based paint hazards.

Bare Soil:
Soil not covered with grass, sod, some other similar vegetation, or paving, including the sand in sandboxes.

Blood-Lead Level:
A measurement of how much lead is in your blood. This is usually given in units of micrograms per deciliter (μg/dL).

Building Component:
Any element of a building that may be painted or have dust on its surface, e.g., walls, stair treads, floors, railings, doors, window sills, etc.

Chemical Stripping:
A paint removal method that uses chemicals to strip off paint.

Chewable Surface:
Any painted surface that can be chewed or mouthed by a young child. A chewable surface is usually a protruding, horizontal part of a building, such as an interior window sill.

Child-Occupied Facility (COF):
A building, or portion of a building, constructed prior to 1978, visited by the same child, 6 years of age or under, on at least 2 different days within any week, provided that each days visit lasts at least 3 hours, the combined weekly visit lasts at least 6 hours, and the combined annual visits last at least 60 hours.

Common Area:
A room or area that is accessible to all residents in a community (e.g., hallways or lobbies); in general, any area not kept locked.

Containment:
A process to protect workers and the environment by controlling exposures to the lead-contaminated dust and debris created during abatement.

Deteriorated Lead-Based Paint:
Any lead-based paint coating on a damaged or deteriorated surface or fixture, or any interior or exterior lead-based paint that is peeling, chipping, blistering, flaking, worn, chalking, alligatoring, cracking or otherwise becoming separated from the substrate.

Disposal (of hazardous waste):
The discharge, deposits, injection, dumping, spilling, leaking or placement of solid or hazardous waste on land or in water so that none of its constituents can pollute the environment by being emitted into the air or discharged into a body of water, including groundwater.

dL:
Short for "deciliter." A deciliter is a little less than half of a cup. The level of lead in your blood is usually measured in micrograms (μg) of lead per deciliter (dL) of blood.

Drip line:
Area along ground perimeter of house where run off from the roof is deposited.

Dust Removal:
A form of interim control that involves initial cleaning followed by periodic monitoring and re-cleaning as needed. Depending on the severity of lead-based paint hazards, dust removal may be the primary activity or just one element of a broader control effort.

EBLL:
Abbreviation for “elevated blood lead level”.

Encapsulation:
Any covering or coating that acts as a barrier between lead-based paint and the environment, the durability of which relies on adhesion and the integrity of the existing bonds between multiple layers of paint and between the paint and the substrate.

Enclosure:
The use of rigid, durable construction materials that are mechanically fastened to the substrate to act as a barrier between the lead-based paint and the environment.

Friction Surface:
Any interior or exterior surface that is subjected to abrasion.

Gram:
A metric unit of weight. A penny weighs about 2 grams. The abbreviation of gram is "g."

Heat Gun:
A device capable of heating lead-based paint causing it to separate from the substrate. For lead hazard control work, the heat stream leaving the gun should not exceed 1,100° F (some authorities may use a different temperature).

High-Efficiency Particulate Air (HEPA) Filter:
A filter capable of removing particles of 0.3 microns or larger form air at 99.7 percent or greater efficiency.

Impact Surface:
A surface (e.g., stair risers) subject to damage by repeated impact or contact.

Inspection (Lead-based paint inspection):
A surface by surface investigation for the presence of lead-based paint conducted by a licensed inspector/risk assessor according to the VA Lead-Based Paint Activities Regulations.

Inspector:
An individual who has completed training from an accredited program and been licensed or certified by the appropriate state or local agency to: 1) perform inspections to determine and report the presence of lead-based paint on a surface-by-surface basis through on-site testing; 2) report the findings of such an inspection; 3) collect environmental samples for laboratory analysis; 4) perform clearance testing; and 5) document successful compliance with lead-based paint hazard control requirements or standards.

Interim Controls:
A set of measures designed to reduce temporarily human exposure or likely exposure to lead-based paint hazards, including specialized cleaning, repairs, maintenance, painting, temporary containment, ongoing monitoring of lead-based paint hazards or potential hazards, and the establishment and operation of management and resident education programs.

Investigation (Lead Investigation):
The use of various techniques to identify the source or possible source of a lead hazard where a lead poisoned child is involved.

Lead:
A bluish white metallic element found mostly in combination with another metal. Used in pipes, batteries, solder, and shields against radioactivity.

Lead Paint Hazard:
A condition in which exposure to lead from lead-contaminated dust, lead-contaminated soil or deteriorated lead-based paint would have an adverse effect on human health.

Lead-Based Paint Hazardous Control:
Activities to control and eliminate lead-based paint hazards, including interim controls, abatement and complete abatement.

Lead-Based Paint:
Paint, varnish, shellac or other surface coatings that contain 1.0 mg\cm^2 or more of lead or are 0.5% lead by weight. Lead Contaminated Dust: Surface dust in residences that contains an area or mass concentration of lead in excess of the standard established by the EPA.

Lead Dust:
Dust or debris that is contaminated with lead particles. Lead dust is created when lead paint is disturbed, damaged or deteriorated.

Lead-Free Dwelling:
A lead-free dwelling contains no lead-based paint and has interior dust and exterior soil lead levels below the applicable HUD and EPA standards.

Lead Hazard Screen:
A means of determining whether residences in good condition should have a full risk assessment. Also called a risk assessment screen.

Lead Paint Hazard:
Any condition that causes exposure to lead from lead dust, soil paint that would cause ill health.

Lead Poisoned:
Having a blood lead level defined as elevated enough to cause adverse health effects.

Licensed:
Risk assessors, inspectors, and abatement contractors in the state of Virginia should be licensed by the VDPOR to safely undertake risk assessments, inspections, and abatement work.

Micrograms:
The prefix micro means one-millionth; a micro-gram is 1/1,000,000 of a gram. μg\dl: Micrograms (μg) per cubic meter (m3). Lead in the air is measured in this way.

Occupied Area:
A building, or portion of a building, constructed prior to 1978, visited by the same person, on at least 2 different days within any week, provided that each days visit lasts at least 3 hours, the combined weekly visit lasts at least 6 hours, and the combined annual visits last at least 60 hours.

Paint Removal:
An abatement strategy that entails the removal of lead-based paint from surfaces. For lead hazard control work, this can mean using chemicals, heat guns below 1,100° F, and certain contained abrasive methods.

PEL:
Short for "Permissible Exposure Limit." This is the maximum amount of lead that the OSHA Lead Standard says you can breathe over an 8-hour shift. The PEL for lead is 50 micrograms of lead for every cubic meter of air ($\mu g\backslash m^3$).

Polyethylene Plastic:
All references to polyethylene plastic refer to 6-mil plastic sheeting or polyethylene bags (or doubled bags using 4-mil polyethylene bags).

ppm:
Stands for "parts per million." For example, paint that is 600 ppm lead has 600 parts of lead for every million parts of paint.

Priming:
To prepare a surface for painting.

Renovation:
Work that involves construction and/or home or building improvement measures such as window replacement, weatherization, remodeling and repainting.

Replacement:
A strategy of abatement that entails the removal of building components coated with lead-based paint (such as windows and doors) and the installation of new components free of lead-based

paint.

Resource Conservation Recovery Act (RCRA):
The primary Federal statute governing waste management from generation to disposal. RCRA defines the criteria for hazardous and nonhazardous waste.

Risk Assessment (Lead Hazard Risk Assessment):
An on-site investigation conducted by a licensed inspector/risk assessor in accordance with Virginia Lead-Based Paint Activities Regulations to determine the existence, nature, severity, and location of lead and lead-based paint hazards, and the provisions to the property owner/occupant of a report explaining the results of the investigation and providing options for reducing those hazards with a rationale for those options.

Risk Assessor:
A licensed individual who has completed training with an accredited training program and who has been certified to 1) perform risk assessments; 2) identify acceptable abatement and interim control strategies for reducing identified lead-based paint hazards; 3) perform clearance testing and reevaluations; and 4) document the successful completion of lead-based paint hazard control activities.

Sample Collection Container:
Container for holding and transporting the samples from the field to the laboratory. The internal volume of the container must be sufficient to hold the entire collected sample.

Sampling Location:
Specified area within a sampling site that is subjected to sample collection. Multiple sampling locations are commonly designated for a single sampling site. An example would be at the bottom of a specific slide in a specific playground area.

Sampling Site:
Local geographical area that contains the sampling locations. A sampling site is generally limited to an area that can be easily covered on foot. An example would be John Smith's house 3102 Nowhere Avenue, Detroit, MI

Substrate:
A surface on which paint, varnish, or other coating has been applied or may be applied. Examples of substrates include wood, plaster, metal, drywall, etc.

Target Housing:
Any residential unit constructed before 1978, except dwellings that were developed specifically for the elderly or persons with disabilities unless a child younger than six years resides or is expected to reside in the dwelling.

Title X:
The Lead Hazard Reduction Act of 1992. It requires the government to regulate people's exposure to lead much more closely.

$\mu g/ft^2$:
Micrograms (μg) per square foot (ft^2) of area. Dust samples measure lead in a certain area in micrograms per square feet.

Window Trough:
For a typical double-hung window, the portion of the exterior window sill (or stool) and the frame of the storm window.

Window Well:
The space that provides exterior access and/or light to a window that is below grade, i.e., below the level of the surrounding earth or pavement.

XRF Analyzer:
An instrument that determines lead concentration in milligrams per square centimeter (mg/cm^2) using the principle of x-ray fluorescence (XRF).

ACRONYMS

BLL	Blood Lead Level
BOCA	Building Officials and Code Administrators
CDC	Centers for Disease Control
CFR	Code of Federal Regulations
CLPPP	Childhood Lead Poisoning Prevention Program
COF	Child-Occupied Facility
CPSC	Consumer Product Safety Commission
DEQ	Department of Environmental Quality
DOLI	Department of Labor and Industry
DPOR	Department of Professional & Occupational Regulation
EHS	Environmental Health Specialist
EPA	Environmental Protection Agency
HEPA	High Efficiency Particulate Air
HIPPA	Health Insurance Portability and Accountability Act
HUD	U.S. Department of Housing and Urban Development
LBP	Lead-Based Paint
NLLAP	National Lead Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PCS	Performance Characteristics Sheet
PHN	Public Health Nurse
ppb	Parts Per Billion
PPE	Personal Protection Equipment

ppm	Parts Per Million
RadMat	Radiation Material
RHP	Radiological Health Program
RSO	Radiation Safety Officer
TLD	Thermoluminescent Dosimeter
TSP	Tri-Sodium Phosphate
USBC	Uniform Statewide Building Code
VDH	Virginia Department of Health
VRPR	Commonwealth of Virginia Radiation Protection Regulations
XRF	X-ray Fluorescence

REFERENCES

Anderson, Jackson L., Jr., C.P.C.U. "Legal Liability, Loss, Risk Management, and Insurance Considerations for Lead Hazard Control Professionals." *Lead-Based Paint Hazards Assessment and Management,* Ed. Vincent M. Coluccio, Dr, P. H. New York: Van Nostrand Reinhold, 1994, p. 211.

Environmental Protection Agency. Federal Register. Part XI, 40 CFR, Part 745. August 29, 1996.

Environmental Protection Agency. *Residential Sampling for Lead: Protocols for Dust and Soil Sampling*. March 29, 1995.

Environmental Protection Agency. *A Field Test of Lead-Based Paint Testing Technologies: Summary Report.* Washington, D.C., May 1995.

Environmental Protection Agency 403 Rule: *Lead: Identification of Dangerous levels of Lead, 2001*

Environmental Protection Agency Section 406, the Renovators' and Remodelers' Disclosure Rule

Environmental Protection Agency Model Curriculum for Lead Inspectors and Risk Assessors

Environmental Protection Agency Section 1018, the Real Estate Notification and Disclosure Rule

Health Laws of Virginia. Part II, Title 2.1, Chapters 21 and 26. Charlottesville, Virginia: Michie, 1997

U.S. Department of Housing and Urban Development: *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*; Office of Healthy Homes and Lead Hazard Control; Second Edition, July 2012

Jacobs, David, et.al. and U.S. Department of Housing and Urban Development. *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing.* 1995: Chapter 7. Revised 1997.

National Center for Lead-Safe Housing/Alliance to End Childhood Lead Poisoning. *A Framework For Action To Make Private Housing Lead-Safe: A Proposal to Focus National Attention.* Washington, D.C., June 1993.

National Center for Lead-Safe Housing. Technical Assistance Bulleting 2. *Creating A Lead-Based Paint Hazard Control Policy: A Practical, Step-by-Step Approach for Nonprofit Housing Organizations.* Maryland, 1994.

National Center for Lead-Safe Housing. Student Manual: *Lead-Based Paint Risk Assessment Model Curriculum*. June 1995.

RMD Inc. *LPA-1 Lead Paint Analysis System User's Guide*.

Virginia Department of Health – Radiological Health Program. *X-Ray Fluorescence (XRF) Device Regulatory Guide*. Richmond, VA

Virginia Department of Professional and Occupational Regulation. *Virginia Lead-Based Paint Activities Regulations, Statues, Title 54.1., Chapter 5*. Richmond, VA.

Virginia Uniformed Statewide Building Code, Chapter 34, Section 3402.8.

APPENDICES

Appendix A

Building Condition Form

Condition	Yes	No
Roof missing parts of surfaces (tiles, boards, shakes, etc.)		
Roof has holes or large cracks		
Gutters or downspouts broken		
Chimney masonry cracked, bricks loose or missing, obviously out of plumb		
Exterior or interior walls have obvious large cracks or holes, requiring more than routine pointing (if masonry) or painting		
Exterior siding has missing boards or shingles		
Water stains on interior walls or ceilings		
Plaster walls or ceilings deteriorated		
Two or more windows or doors broken, missing, or boarded up		
Porch or steps have major elements broken, missing, or boarded up		
Foundation has major cracks, missing material, structure leans, or visibly unsound		
* Total number		

* If the "Yes" column has two or more checks, the dwelling is usually considered to be in poor condition for the purposes of a risk assessment. However, specific conditions and extenuating circumstances should be considered before determining the final condition of the dwelling and the appropriateness of a lead hazard screen.

Notes:

Paint Conditions on Selected Surfaces
(Single-Family, Owner-Occupied)

Building component	**Location Notes**	**Paint condition (deteriorated or intact)**	**Deterioration due to friction or impact?**	**Deterioration due to moisture?**	**Location of painted component with visible bite marks**
Building siding					
Exterior trim					
Exterior windows					
Exterior doors					
Railings					
Porch floors					
Other porch surfaces					
Interior doors					
Ceilings					
Walls					
Interior windows					
Interior floors					
Interior trim					
Stairways					
Radiator (or radiator cover)					
Kitchen cabinets					
Bathroom cabinets					
Other surfaces:					

Note: If the overall condition of a component is similar throughout a dwelling, that condition should be recorded. If a component in a couple of locations is in poor condition, but the overall condition is good or fair, the specific sites of the badly deteriorated paint should be noted. The specific locations of any component with bite marks should be recorded.

Appendix B

Resident Questionnaire for Investigation of Children With Elevated Blood Lead Levels

The results of this questionnaire will be used for two purposes:

- To determine where environmental samples should be collected.
- To develop corrective measures related to use patterns and living characteristics (e.g., flushing the water line if water lead levels are high, moving the pet's sleeping area if it appears the pet is tracking in leaded dust, and so forth).

The investigator should always recommend temporary measures to immediately reduce the child's exposure to lead hazards.

General Information

1. Where do you think the child is exposed to the lead hazard? _____

2. Do you rent or own your home? rent own (circle)

   If rented, are there any rent subsidies? yes no (circle)

   If yes, what type: (check)

   ___ Public housing authority

   ___ Section 8

   ___ Federal rent subsidy

   ___ Other (specify): _____

   Landlord Information (or rent collector agent)

   Name:_____

   Address:_____

   Phone: _____

3. When did you/your family move into this home?

   Complete the following for all addresses where the child has lived during the past 12 months:

Dates of residency	**Address (include city and State)**	**Approximate age of dwelling**	**General condition of dwelling: Any remodeling or renovation ? Any deteriorated paint**

4. Is the child cared for away from the home? (This would include preschool, day-care center, day-care home, or care provided by a relative or friend.)

   If YES, complete the following:

Type of care	**Location of care (name of contact, address, and phone number)**	**Approximate number of hours per week at this location**	**General condition of structure. Any deteriorated paint? Any recent remodeling or renovation?**

Lead-Based Paint and Lead-Contaminated Dust Hazards

1. Has this dwelling been tested for lead-based paint or lead-contaminated dust? yes no (circle)

   If yes, when? Where can this information be obtained? _____

2. Approximately what year was this dwelling built? _____ If unknown, was the dwelling built before 1950? yes no (circle)

3. Has there been any recent repainting, remodeling, renovation, window replacement, sanding, or scraping of painted surfaces inside or outside this dwelling unit? yes no (circle)

4. If yes, describe activities and duration of work in more detail.

   _____

5. Has any lead abatement work been conducted at this dwelling recently? yes no (circle)

6. Where does the child like to play or frequent? (Include rooms, closets, porches, outbuildings.)

   _____

7. Where does the child like to hide? (Include rooms, closets, porches, outbuildings.)
   Complete the following table:

Areas where child likes to play or hide	*** Paint condition (intact, fair, poor, or not present)***	**Location of painted component with visible bite marks**

**** Paint condition: Note location and extent of any visible chips and/or dust in window wells, on window sills, or on the floor directly beneath windows. If you see peeling, chipping, chalking, flaking, or deteriorated paint, note locations and extent of deterioration.***

Assessment: (check)

_____ Probable lead-based paint hazard.

_____ Probable leaded dust hazard.

Action: (check)

_____ Obtain records of previous environmental testing noted above.

_____ XRF Inspection of dwelling (circle one): limited complete.

_____ Paint Testing—deteriorated paint: add any additional areas to Form 5.3.

_____ Leaded dust sampling of home: add any additional areas to the list of rooms to be sampled, using Form 5.4.

_____ Other sampling (specify): _____

Water Lead Hazards

1. What is the source of drinking water for the family? (circle) municipal water private well

   Other (specify): _____

   (This information will be used to help determine responsibility and methods of controlling lead exposures from water.)

   If tap water is used for drinking, please answer the following:

2. From which faucets do you obtain drinking water? (Sample from the main drinking water faucet.)

   _____

3. Do you use the water immediately or do you let the water run for a while first? yes no (circle)
   (If water lead levels are elevated in the first flush, but low in the flushed sample, recommend flushing the water after each period the water has remained standing in the pipe for more than 6 hours.)

4. Is tap water used to prepare infant formula, powdered milk, or juices for the children? yes no (circle)

   If yes, do you use hot or cold tap water? yes no (circle)

   If no, from what source do you obtain water for the children? _____

5. Has new plumbing been installed within the last 5 years? yes no (circle)

   If yes, identify location(s)._____

   Did you do any of this work yourself? yes no (circle)

   If yes, specify. _____

6. Has the water ever been tested for lead? yes no (circle)

   If yes, where can test results be obtained? _____

Determine whether the dwelling is located in a jurisdiction known to have lead in drinking water either public municipal or well water. Consult with State/local public health authorities for details. (check)_____ at risk _____ not at risk

Assessment: (check)

_____ At risk for water lead hazards.

Actions: (check)

_____ Test water (first-draw and if needed flush samples).

_____ Other testing (specify): _____

_____ Counsel family (specify): _____

Lead in Soil Hazards

(Use the following information to determine where soil samples should be collected.)

1. Where outside does the child like to play?_____
2. Where outside does the child like to hide? _____
3. Is this dwelling located near a lead-producing industry (such as a battery plant, smelter, radiator repair shop, or electronics/soldering industry?) yes no (circle)
   If yes, describe: _____
4. Is the dwelling located within two blocks of a major roadway, freeway, elevated highway, or other transportation structures? yes no (circle)
5. Are nearby buildings or structures being renovated, repainted, or demolished? yes no (circle)
6. Is there deteriorated paint on outside fences, garages, play structures, railings, building siding, windows, trims, or mailboxes? yes no (circle)
   If yes, describe: _____
7. Were gasoline or other solvents ever used to clean parts or disposed of at the property? yes no (circle)
8. Are there visible paint chips near the perimeter of the house, fences, garages, play structures? yes no (circle)
   If yes, note location. _____
9. Has soil ever been tested for lead? yes no (circle)
   If yes, where can this information be obtained? _____
10. Have you burned painted wood in a woodstove or fireplace? yes no (circle)
    If yes, have you emptied ashes onto soil? If yes, where? _____

Assessment: (check)

_____ Probable soil lead hazard.

Actions: (check)

_____ Test soil. Complete Field Sampling Form for Soil (Form 5.5). Obtain single samples for each bare soil area where the child plays.

_____ Advise family to obtain washable doormats for entrances to the dwelling.

_____ Counsel family to keep child away from bare soil areas thought to be at risk.
(specify): _____

Occupational/Hobby Lead Hazards

Use the information in this section to determine if the child's source of lead exposure could be related to the parents', older siblings' or other adults' work environment. Occupations that may cause lead exposure include the following:

- Paint removal (including sandblasting, scraping, abrasive blasting, sanding, or using a heat gun or torch).
- Chemical strippers.

- Remodeling, repairing, or renovating dwellings or buildings, or tearing down buildings or metal structures (demolition
- Plumbing.
- Repairing radiators.
- Melting metal for reuse (smelting).
- Welding, burning, cutting, or torch work.
- Making or repairing stained glass
- Pouring molten metal (foundries).
- Auto body repair work.
- Working at a firing range.
- Making batteries.
- Making paint or pigments.
- Painting.
- Salvaging metal or batteries.
- Making or splicing cable or wire.
- Creating explosives or ammunition.
- Making or repairing jewelry.
- Making pottery.
- Building, repairing, or painting ships.
- Working in a chemical plant, a glass factory, an oil refinery, or any other work involving lead.
- Working in recycling industry

Where do adult family members work? (include mother, father, older siblings, other adult household members)

Name	Place of employment	Occupation or job title	Probable lead exposure (yes/no)

Potential "home" exposures

1. Are work clothes separated from other laundry?
2. Is the same automobile/truck used for potential hazardous work used by family members or children?
3. Has anyone in the household removed paint or varnish while in the dwelling? (includes paint removal from woodwork, furniture, cars, bicycles, boats)
4. Has anyone in the household soldered electric parts while at home?
5. Does anyone in the household apply glaze to ceramic or pottery objects?

6. Does anyone in the household work with stained glass?

7. Does anyone in the household use artist's paints to paint pictures or jewelry?

8. Does anyone in the household reload bullets, target shoot, or hunt?

9. Does anyone in the household melt lead to make bullets or fishing sinkers?

10. Does anyone in the household work in auto body repair at home or in the yard?

11. Is there other evidence of take-home work exposures or hobby exposures in the dwelling?

Assessment: (check)

_____ Probable occupational-related lead exposure.

_____ Probable hobby-related lead exposure.

Actions: (check)

_____ Counsel family (specify):

_____ Refer to (specify): _____

Child Behavior Risk Factors

1. Does child suck his/her fingers? yes no (circle)
2. Does child put painted objects into the mouth? yes no (circle)

   If yes, specify: _____
3. Does child chew on painted surfaces, such as old painted cribs, window sills, furniture edges, railings, door molding, or broom handles? yes no (circle)
   If yes, specify: _____
4. Does child chew on putty around windows? yes no (circle)
5. Does child put soft metal objects in the mouth? These might include lead and pewter toys and toy soldiers, jewelry, gunshot, bullets, beads, fishing sinkers, or any items containing solder (electronics). yes no (circle)
6. Does child chew or eat paint chips or pick at painted surfaces? Is the paint intact in the child's play areas? yes no (circle)
7. Does the child put foreign, printed material (newspapers, magazines) in the mouth? yes no (circle)
8. Does the child put matches in the mouth? (Some matches contain lead acetate.) yes no (circle)
9. Does the child play with cosmetics, hair preparations, or talcum powder or put them into the mouth? Are any of these foreign made? yes no (circle)
10. Does the child have a favorite cup? A favorite eating utensil? If yes, are they handmade or ceramic? yes no (circle) If yes, describe: _____
11. Does the child have a dog, cat, or other pet that could track in contaminated soil or dust from the outside? Where does the pet sleep? yes no (circle) If yes, describe:_____
12. Where does the child obtain drinking water? _____
13. If child is present, note extent of hand-to-mouth behavior observed. _____

Assessment: (check)

_____ Child is at risk due to hand-to-mouth behavior.

_____ Child is at risk for mouthing probable lead-containing substance (specify): _____

_____ Child is at risk for other (specify): _____

Actions:

_____ Counsel family to limit access or use of (specify):

_____ Other (specify): _____

Other Household Risk Factors

1. Are imported cosmetics such as Kohl, Surma, or Ceruse used in the home?
2. Does the family ever use any home remedies or herbal treatments? (What type?)
3. Are any liquids stored in metal, pewter, or crystal containers?
4. What containers are used to prepare, serve, and store the child's food? Are any of them metal, soldered, or glazed? Does the family cook with a ceramic bean pot?
5. Does the family use imported canned items regularly?
6. Does the child play in, live in, or have access to any areas where the following materials are kept: shellacs, lacquers, driers, coloring pigments, epoxy resins, pipe sealants, putty, dyes, industrial crayons or markers, gasoline, paints, pesticides, fungicides, gasoline, gear oil, detergents, old batteries, battery casings, fishing sinkers, lead pellets, solder, or drapery weights?
7. Does the child take baths in an old bathtub with deteriorated or nonexistent glazing?

Assessment: (check)

_____ Increased risk of lead exposure due to _____

Actions: (check)

_____ Counsel family to limit access or use (specify): _____

_____ Other (specify): _____

Assessment for Likely Success of Hazard Control Measures

1. What cleaning equipment does the family have in the dwelling? (circle)

   broom, mop and bucket, vacuum (does it work?), sponges and rags
2. How often does the family:

   Sweep the floors?

   Wet mop the floors?

   Vacuum the floors?

   Wash the window sills?

   Wash the window troughs?
3. Are floor coverings smooth and cleanable?
4. What type of floor coverings are found in the dwelling? (circle all that apply)

   vinyl/linoleum carpeting wood other (specify): _____
5. Cleanliness of dwelling (circle one): Code: 1 = appears clean, 2 = some evidence of housecleaning, 3 = no evidence of housecleaning,

4 = _____, 5 = _____, 6 = _____, 7 = _____

[Pick the best category based on overall observations of cleanliness in the dwelling.]

1. Appears clean.
2. Some evidence of housecleaning.
3. No evidence of housecleaning.

No visible dust on most surfaces.

Evidence of recent vacuuming of carpet.

No matted or soiled carpeting.

No debris or food particles scattered about.

Few visible cobwebs.

Clean kitchen floor.

Clean doorjambs.

Slight dust buildup in corners.

Slight dust buildup on furniture.

Slightly matted and/or soiled carpeting.

Some debris or food particles scattered about.

Some visible cobwebs.

Slightly soiled kitchen floor.

Slightly soiled doorjambs.

Heavy dust buildup in corners.

Heavy dust buildup on furniture.

Matted and/or soiled carpeting.

Debris or food particles scattered about.

Visible cobwebs.

Heavily soiled kitchen floor.

Heavily soiled doorjambs.

Assessment: (check)

_____ Cleaning equipment inadequate.

_____ Cleaning routine inadequate.

_____ Floor coverings inadequate to maintain clean environment.

Actions: (check)

_____ Counsel family to limit access or use (specify): _____

_____ Provide cleaning equipment.

_____ Instruct family on special cleaning methods.

_____ Flooring treatments needed.

_____ Other (specify): _____

Appendix C

Virginia Department of Health **Health District_____**

Field Sampling Form for Deteriorated Paint (One form for each housing unit, common area, or exterior)

Name of risk assessor _____

Name of property owner _____

Property address _____ Apt. no._____

Dwelling selection protocol _____All dwellings _____Targeted _____Worst case _____Random

Disclosure of information on Lead Based Paint and Lead Based Paint Hazards:

Housing built before 1978 may contain lead based paint. Lead from paint, paint chips, and dust can pose health hazards if not taken care of properly. Lead exposure is especially harmful to young children and pregnant women. Federal law requires the seller of any interest in residential property to provide the buyer with any information on lead based paint hazards from risk assessments or inspections in the seller's possession and notify the buyer of any known lead based paint hazards. Federal law also requires landlords to disclose the presence of known lead based paint hazards in the houses and apartments built before 1978. Also tenants/purchasers must receive a Federal approved pamphlet on lead poisoning prevention the pamphlet entitled ***Protect Your Family from Lead in Your Home*.**

Questions to be addressed to the occupant of the dwelling:

Was the presence of lead based paint and the potential/existing lead based paint hazards disclosed to you during the real estate transaction (purchase or rental agreement)?

Were you given the pamphlet entitled ***Protect Your Family from Lead in Your Home****?*

Are you aware of any recent remodeling, repair, or painting?

Target dwelling criteria (check all that apply)

_____ Code violations

_____ Judged to be in poor condition

_____ Presence of two or more children between ages of 6 months and 6 years

_____Serves as day-care facility

_____ Recent preparation for re-occupancy

_____ Random sampling

Sample number	Room	Building component	Lead (mg/cm2)

Sample all layers of paint, not just deteriorated paint layers.

Total number of samples on this page_____

Page _____ of _____

Date of sample collection____/____/____ Date shipped to lab____/____/____

Shipped by _____

(signature)

Received by _____

(signature)

Date results reported ____/____/____

Analyzed by_____

Approved by_____

Field Sampling Form for Deteriorated Paint (Continuation Page)

Sample number	Room	Building component	Lead (mg/cm2

Appendix D

Virginia Department of Health **Health District_____**

Field Sampling Form for Dust

(Single-Surface Sampling)

Name of risk assessor _____

Name of property owner _____

Property address _____ Apt. no._____

Disclosure of information on Lead Based Paint and Lead Based Paint Hazards:

Housing built before 1978 may contain lead based paint. Lead from paint, paint chips, and dust can pose health hazards if not taken care of properly. Lead exposure is especially harmful to young children and pregnant women. Federal law requires the seller of any interest in residential property to provide the buyer with any information on lead based paint hazards from risk assessments or inspections in the seller's possession and notify the buyer of any known lead based paint hazards. Federal law also requires landlords to disclose the presence of known lead based paint hazards in the houses and apartments built before 1978. Also tenants/purchasers must receive a Federal approved pamphlet on lead poisoning prevention the pamphlet entitled ***Protect Your Family from Lead in Your Home*.**

Questions to be addressed to the occupant of the dwelling:

Was the presence of lead based paint and the potential/existing lead based paint hazards disclosed to you during the real estate transaction (purchase or rental agreement)?

Were you given the pamphlet entitled ***Protect Your Family from Lead in Your Home****?*

Target dwelling criteria (check all that apply)

_____ Judged to be in poor condition
_____ Presence of two or more children between ages of 6 months and 6 years
_____ Serves as day-care facility
_____ Recent preparation for re-occupancy

Sample number	**Room (record name of room used by the owner or resident)**	**Surface type (circle the type)**	**Is surface smooth and cleanable?**	**Dimensions of sample area (inches x inches)**	**Area (ft2)**	**Result of lab analysis (µg/ft2)**
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		

Sample number	**Room (record name of room used by the owner or resident)**	**Surface type (circle the type)**	**Is surface smooth and cleanable?**	**Dimensions of sample area (inches x inches)**	**Area (ft2)**	**Result of lab analysis (µg/ft2)**
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		
		Interior window sill		____ x ____		
		Floor		____ x ____		

Appendix E

Virginia Department of Health
Health District_____

Field Sampling Form for Soil

(Composite Sampling Only)

Name of risk assessor _____

Name of property owner _____

Property address _____

Sample number	Location	Lab result (µg/g) = ppm)
	Play area 1 (describe)	
	Play area 2 (describe)	
	Play area 3(describe)	
	Remaining bare areas of yard which are not child play areas (describe)	

Collect only the top 1/2 inch of soil.

Total number of samples on this page_____

Page _____ of _____

Date of sample collection____/____/____ Date shipped to lab____/____/____

Shipped by _____

(signature)

Received by _____

(signature)

Appendix F

Virginia Department of Health **Health District_____**

Field Sampling Form for Water

Name of risk assessor _____

Name of property owner _____

Property address _____Apt. no._____

Date_____

Time/date faucet labeled "off"_____pm

Samples Required	Volume	Sample Time	Results (ug/kg = ppb)
First Draw ***Required** Sample #_____	250 cc		
Second Draw ***As needed*** Sample #_____	750 cc		
Third Draw ***As needed*** Sample #_____	250 cc		
Fourth Draw ***As needed*** Sample#_____	1 Liter		

Note: * Make sure to ask homeowner to cover the faucet with a bag the night before collection to avoid possible use. If water source is well, all samples must be collected due to potential contaminating sources closer to the well and pump.

Appendix G

Virginia Department of Health **Health District_____**

Field Sampling Form for Other Media

Name of risk assessor _____

Name of property owner _____

Property address _____
Apt. no._____

Date_____

Sample Type/Number	Sampling Technique (describe)	Results	Comments

Appendix H

Schneider Lab Sample/Chain of Custody Form

SCHNEIDER LABORATORIES GLOBAL, INC.

2512 West Cary Street, Richmond, Virginia 23220-5117
804-353-6778 • 800-785-LABS (5227) • Fax 804-359-1475
www.slabinc.com e-mail: info@slabinc.com

WO Label

Submitting Co.		Lab WO#		Phone	
		Acct #		Fax / Email	
		**State of Collection		**Cert. Required	☐ Yes ☐ No

Project Name:	
Project Location:	
Project Number:	
PO Number:	

Special Instructions [include requests for special reporting or data packages]

Turn Around Time

- ☐ 2 hours*
- ☐ Same day*
- ☐ 1 business day*
- ☐ 2 business day*
- ☐ 3 business days*
- ☐ 5 business days*

* not available for all tests

Schedule rush organics, multi-metals & weekend tests in advance.

Matrix / Sample Type (Select ONE)

All samples on form should be of SAME matrix type. Use additional forms as needed.

☐ Air	☐ Solid
☐ Aqueous	☐ Waste
☐ Bulk	☐ Wastewater
☐ Hi-Vol Filter (PM10)	☐ Water,Drinking
☐ Hi-Vol Filter (TSP)	☐ Compliance
☐ Oil	☐ Wipe
☐ Paint	☐ Wipe, Composite
☐ Sludge	☐ _____
☐ Soil	☐ _____

Tests / Analytes (Select ALL that Apply)

Asbestos in Air
- ☐ PCM (NIOSH 7400)
- ☐ TEM (AHERA)
- ☐ TEM (EPA Level II)

Miscellaneous Tests
- ☐ Total Dust (NIOSH 0500)
- ☐ Resp. Dust (NIOSH 0600)
- ☐ Silica - FTIR (NIOSH 7602)
- ☐ Silica - XRD (NIOSH 7500)

Other
- ☐ _____

Asbestos in Bulk
- ☐ PLM
- ☐ PLM (Point Count)
- ☐ PLM (Qualitative only)
- ☐ NYELAP
- ☐ CAELAP (Point Count)
- ☐ TEM (Chatfield)
- ☐ _____

FOR ASBESTOS AIR:
TYPE OF RESPIRATOR USED: _____

Metals-Total
- ☐ Lead
- ☐ RCRA Metals

TCLP
- ☐ TCLP / Lead
- ☐ TCLP / RCRA Metals
- ☐ TCLP / Full (w/ organics) 10 day

Microbiology
- ☐ BACT (MPN & P/A)
- ☐ Mold Direct Exam
- ☐ _____

Sample #	Date Sampled**	Time Sampled**	Sample Identification (Employee, SSN, Bldg, Material, Type[1])	Wiped Area (ft²)	pH / Temp *	Time[2] Start	Time[2] Stop	Flow Rate[3] Start	Flow Rate[3] Stop	Total[4] Air

[1]Type: A=Area B=Blank P-Personal E=Excursion [2]Beginning/End of Sample Period [3]Pump Calibration in Liters/Minute [4]Volume in Liters [time in min * flow in L/min]

All soil and aqueous samples must be sent in adequate quantity for duplicate analysis to be performed per EPA requirements. Failure to perform a sample duplicate analysis, due to a lack of sample quantity, will lead to a disclaimer on the report.

Sampled by	Relinquished to lab by
NAME _____	NAME _____
SIGNATURE _____	SIGNATURE _____
DATE/TIME _____	DATE/TIME _____

☐ Sample return requested ☐ Ambient temp ☐ Ice _____ Cl _____ ☐R ☐S ☐X

☐ Receive a physical copy of report.

Sample Disposal
If samples over req. weight (Refer to Fee Schedule)
- ☐ Return to Sender (Shipping fees)
- ☐ Disposal by lab ($50 fee)

Shipping Methods
☐ FX ☐ UPS ☐ USM
☐ HD ☐ DB
WB: _____

* Temperature taken with IR Gun A. **Required.

Chain-of-Custody documentation continued internally within lab. Terms and conditions page 2.

Appendix I

EXAMPLE OF AN ENVIRONMENTAL ELEVATED BLOOD LEAD LEVEL EVALUATION REPORT

Date of Evaluation:	June 10, 2004
Performed at:	1234 Popular Road Anywhere, VA 23804 File Case # 99-8018
Construction Year & Type:	1916; This two story unit is the left side of a duplex.
Owner of Property:	Martha D. Owner 123 Different Street Anywhere, VA 23804 (804) 555-1234
EPA NLLAP Accredited Laboratory:	
	Schneider Laboratories 2512 West Cary Street Richmond, VA 23220-5117 1-800-785-5227
Instrument Type:	RMD (Radiation Monitoring Devices) Model LPA-1 XRF TYPE ANALYZER Serial Number 1233
Performed by:	David B. Joe, E.H.S. Lead Inspector / Risk Assessor VA# 0000 000000 Any Health District 123 Healthy Street Anywhere, VA 23804 (804) 555-4321, ext. 123

SIGNED_____ DATE: _____

TABLE OF CONTENTS SECTION

SECTION 1

SUMMARY OF EVALUATION

An Environmental Elevated Blood Lead Level Evaluation was performed at the 1234 Popular Road, Anywhere, VA on June 10, 2004 by David B. Joe, licensed Lead Inspector and Risk Assessor. The EIBLL Evaluation was performed following the U S Environmental Protection Agency 403 Rule, *Lead, Identification of Dangerous Levels of Lead*, the U. S. Department of Housing and Urban Development (HUD) *Guidelines for the Evaluation and Control of Lead-Based Paint in Housing*, the Virginia Department of Professional and Occupational Regulation *Virginia Lead-Based Paint Activities Regulations*, and the U S EPA Model Curriculum for Inspections/Risk Assessments. These documents serve as the federal and state standard for lead-based paint activities. This investigation was the result of notification to the Health Department from Dr. Anyone Jones, revealing that the 3-year-old child residing herein has a confirmed blood lead level of 35 ug/dl. **Lead hazards were found that could continue to adversely affect the child's health, and the health of any child under six that may reside at this address.**

A RMD LPA-1 XRF lead analyzer was used to test all deteriorated surfaces both interior and exterior to the dwelling to identify lead-based paint. In addition, any deteriorated areas of the fence around the play area and the play equipment were also tested. Teeth marks were observed on the child's bed; therefore the bed varnish/stain was tested. (Although the 403 Rule only includes testing of components that are part of the structure, due to the presence of the lead-poisoned child, all potential sources must be considered. The bed was older, of indeterminate age.)

According to HUD Guidelines, any surface equal to or greater than 1.0 mg/cm^2 is considered to be lead based paint, and if the surfaces is also deteriorated, component is identified as a lead paint hazard. The highest level that the RMD LPA-1 XRF lead analyzer will read is 9.9 mg/cm^2. Precise locations of all components and surfaces tested are found in section 3 of this report.

Dust wipe samples were collected in accordance with the regulations/guidance listed above, and following the Standard Operating Procedure contained in the Virginia Department of Health's EIBLI manual. As required by the 403 Rule, dust wipes of the floor and window sill in each room occupied by the child were collected. Due to the confirmed presence of a lead-poisoned child, additional samples were taken on the outside porch floors, both front and back.

Soil samples were collected from the bare play areas around the tree in the NE corner of the yard, and from the area under and around the play equipment.

Water samples were collected in accordance with the EPA Model Curriculum and the Standard Operating Procedure included in the VDH EIBLI manual.

When investigating properties for potential lead hazard, sources of exposure other than the residence are investigated. According to the tenant, no one in the household uses or practices any traditional remedies or hobbies that would involve exposure to lead, works in a lead-related industry, or uses foreign or glazed pottery or crystal. No painted wooden or metal toys, fishing equipment, or collectibles were found. Some imported mini-blinds have been found to contain lead. Therefore, all mini-blinds present were tested using the XRF. From the questionnaire, the only other potential source of lead to the child was the mother's decorative key ring, which is frequently handled and mouthed by the child. The key ring was sent to the laboratory, where the

object was scrapped and the dust was analyzed.

A visual assessment of the unit was performed and the building is in Poor Condition. The EIBLL investigation identified lead hazards in the following locations:

Paint Lead Hazards

1. **Deteriorated lead based paint on the exterior side of the windows.**
2. **Deteriorated lead based paint on some of the interior window trim**
3. **Deteriorated lead based paint on all of the interior doors**
4. **Deteriorated lead based paint on exterior doors**
5. **Deteriorated lead based paint on interior hand railing**
6. **Deteriorated lead based paint on stairway treads**
7. **Deteriorated lead based paint on bathroom cabinets (upstairs bathroom only, not a friction/impact problems, only front & sides)**

Dust Lead Hazards

8. **Leaded dust on the floor of the child's bedroom**
9. **Leaded dust on stair treads.**

Soil Lead Hazards

10. **Bare soil under and around play equipment**

Other Sources of Lead

11. **Mother's lead containing key ring with bird ornament**

The exterior of the duplex appears to be the original wooden siding, which has been scraped and maintained throughout the years. The windows and doors, including trim, also appear to be original to the duplex. The interior floors are a combination of hardwood and linoleum (kitchen and bathroom). Wall and ceilings are plaster over lathing and were repaired and repainted more than five years previously.

The interior of the unit consists of a living room, half bathroom, dining room, hallway and kitchen downstairs, and three bedrooms, hallway and bathroom upstairs. There are covered, but not enclosed, front and back porches.

According to Virginia Lead-Based Paint Activities Regulations, our department shall maintain this report for no less than three years. This report is intended to inform the owner of the results of the investigation and to begin the process of lead based paint hazard **reduction or removal from the home. It is the owner's responsibility to make the final choice on a course of action. Section 5 of this report lists recommendations for this address.**

Effective October 1, 2003, it shall be unlawful for an owner to hire anyone to perform lead-based paint activities within the Commonwealth without that person obtaining a license from the Virginia Department of Professional and Occupational Regulation located in Richmond. Additionally, because the purpose of an EIBLL investigation is to identify and control lead-based paint hazards, an accredited, licensed abatement contractor must be used.
This disclosure advice is intended for protection to the homeowner as well as future owners and or tenants:

Effective December 2008, renovators/contractors are required to present Environmental Protection Agency (EPA)'s *"Renovate Right – Important Lead Hazard Information for Families, Child Care Providers and Schools"* pamphlet to property owners and tenants before renovating, repairing, or painting a child-occupied facility, built before 1978. Renovators/Contractors must document the disclosure and the acknowledgement of receipt by the property owners and/or tenants.

Effective April 22, 2010, any renovation, repair or painting activity to be performed on a residential dwelling built prior to 1978 or on a child-occupied facility, must be performed or supervised by a EPA certified renovator, if more than 6 sq. ft. of lead-based paint in the inside or more than 20 sq. ft. of lead based-paint on the outside will be disturbed due to the renovation, repair or painting activity. **There are exceptions to this regulation. Failure to comply may be penalized by a fine of up to $35,000 per violation**

The Federal Residential Lead-Based Paint Hazard Reduction Act of 1992, 42 U.S.C. 4852d, requires sellers and landlords of most residential housing built before 1978 to disclose all available and reports concerning lead-based paint and/or lead-based paint hazards, ***including the test results contained in this notice****, to purchasers and tenants at the time of sale or lease or upon lease renewal. This disclosure must occur even if the hazard reduction or abatement has been completed. Failure to disclose these test results is a violation of the U.S. Department of Housing and Urban Development and the U.S. Environmental Protection Agency regulations at 24 CFR Part 35 and 40 CFR Part 745 and can result in a fine of up to $11,000 per violation. To find out more information about your obligations under federal lead-based paint requirements, call 1-800-424-LEAD.*

Once you have had the time to review this report, please contact me to discuss which option that you have selected, and also notify me to return for "clearance testing" to assure no lead dust hazards remain.

SECTION 2

Diagram of the Unit

(Insert diagram of the residence)

SECTION 3

Deteriorated Paint Results (XRF and/or Paint Chip Data)

XRF DATA

XRF testing (X-ray fluorescence):

The RMD LPA-1 uses a Cobalt^{57} radioactive source and an advanced, solid-state radiation detector to generate an X-ray fluorescence spectrum of a painted surface. The microprocessor records the information and stores the data for a later download into a report generating software package. **Attached is the detailed XRF report data.**

The Cobalt source has a half-life of 9 months. As per the instrument's Performance Characteristics Sheet (PCS), calibration checks are taken in Standard mode (Std). The length of the calibration reading in standard mode must be adjusted to account for source decay. The calibration readings of this equipment are taken before, after, and if more than 4 hours has passed during the inspection. A yellow 1.9mg/cm^2 NIST traceable standard paint film is used to calibrate the equipment's accuracy. The LPA-1 also self calibrates every 5 minutes as an internal control mechanism. RMD performed a radiation leak test on (DATE) and the radioactivity level was found to be less than .005uCi and meets National Regulatory Commission (NRC) requirements.

The Quick mode (QM) setting is used for the actual testing. According to the manufacture this mode allows the user the highest range of precision. There is no substrate correction in the QM mode. As per the PCS, inconclusive ranges for metal painted surfaces are ranges of 0.9 to 1.3 mg/cm^2. For plaster painted surfaces the inconclusive range is 0.9 to 1.0 mg/cm^2. The Mode column at the end of the detailed XRF report shows which mode was used during operation.

Surface conditions are determined using the EPA 403 rule.

DETAILED REPORT OF ENVIRONMENTAL BLOOD LEAD LEVEL EVALUATION FOR: 1234 Popular Road

Inspection Date: 06/10/2010 1234 Popular Road
Report Date: 08/06/2010
Report No. S#01233 - 06/10/10 09:35
Total Readings: 126
Job Started: 06/10/2010 6:35
Job Finished: 06/10/2010 3:45

Calibration Readings

001	1.9	Std
002	1.9	Std
003	2.0	Std
124	1.7	Std
125	1.6	Std
126	1.8	Std

---- End of Readings ----

Field Sampling Form for Deteriorated Paint

Name of risk assessor: David B. Joe, E.H.S.
Lead Inspector / Risk Assessor VA# 0000 000000
Any Health District
123 Healthy Street
Anywhere, VA 23XXX
(804) 555-4321, ext. 123

Name of property owner: Martha D. Owner
123 Different Street
Anywhere, VA 23XXX
(804) 555-1234

Property address: 1234 Popular Road
Anywhere, VA 23XXX
File Case # 99-8018

Unit # 1

Dwelling selection protocol **N/A**_ All dwellings _____Targeted _____Worst case _____Random

Target dwelling criteria (check all that apply) **N/A**

_____ Code violations _____ Judged to be in poor condition _____ Presence of two or more children between ages of 6 months and 6 years _____ Serves as day-care facility _____ Recently prepared for re-occupancy _____ Random sampling

Disclosure of information on Lead Based Paint and Lead Based Paint Hazards:

Housing built before 1978 may contain lead based paint. Lead from paint, paint chips, and dust can pose health hazards if not taken care of properly. Lead exposure is especially harmful to young children and pregnant women. Federal law requires the seller of any interest in residential property to provide the buyer with any information on lead based paint hazards from risk assessments or inspections in the seller's possession and notify the buyer of any known lead based paint hazards. Federal law also requires landlords to disclose the presence of known lead based paint hazards in the houses and apartments built before 1978. Also tenants/purchasers must receive a Federal approved pamphlet on lead poisoning prevention the pamphlet entitled ***Protect Your Family from Lead in Your Home.***

Questions to be addressed to the occupant of the dwelling:

Was the presence of lead based paint and the potential/existing lead based paint hazards disclosed to you during the real estate transaction (purchase or rental agreement)? Y

Were you given the pamphlet entitled ***Protect Your Family from Lead in Your Home****? Y*

Are you aware of any recent renovation, repair, or painting? N

XRF READINGS (Deteriorated Surfaces only)

Sample number	Room	Building component /Wall	Lead (mg/cm2)
1-06102004vhh	1 /dwnstrs hallway	Front Door (to exterior of unit)	2.3
2-06102004vhh	1 /dwnstrs hallway	Front Door trim	0.00
3-06102004vhh	1 /dwnstrs hallway	Window trim	1.9
4-06102004vhh	10 /child's (3 yr old) bedroom	Window trim	2.1
5-06102004vhh	1 /dwnstrs hallway/	Door to bathroom	2.5
6-06102004vhh	1 /dwnstrs hallway	Door to kitchen	2.3
7-06102004vhh	1 /dwnstrs hallway	Door to living room	2.0
8-06102004vhh	1 /dwnstrs hallway	Door to dining room	2.4
9-06102004vhh	2 /Living room	Door to hallway	1.8
10-06102004vhh	3 /Kitchen	Door to hallway	2.1
11-06102004vhh	4 /Dining Room	Door to hallway	2.0
12-06102004vhh	5 /1/2 Bath	Door to hallway	2.5
13-06102004vhh	6 /Stairs	Hand railing	4.5
14-06102004vhh	6 /Stairs	Tread	1.1
15-06102004vhh	7 /Upstrs hallway	Door to bathroom	1.9
16-06102004vhh	7 /Upstrs hallway	Door to bedroom 1 (parents)	2.1
17-06102004vhh	7 /Upstrs hallway	Door to bedroom 2 (3 yr. old child's)	2.2
18-06102004vhh	7 /Upstrs hallway	Door to bedroom 3 (7 & 9 yr. old children's room)	2.0
19-06102004vhh	8 /Bedroom 1	Door to hallway	1.8
20-06102004vhh	9 /Bedroom 2	Door to hallway	1.8
21-06102004vhh	10 /Bedroom 3	Door to hallway	2.0
22-06102004vhh	11 /Bathroom	Door to hallway	2.1
23-06102004vhh	11 /Bathroom	Metal cabinets	4.8
EXTERIOR RESULTS			
24-06102004vhh	12 /Exterior	Window sash	3.3
25-06102004vhh	12 /Exterior	Front door	3.6
26-06102004vhh	12 /Exterior	Back door	1.6

SECTION 4

Dust Wipe Results

Form 5.4 Field Sampling Form for Dust

Name of risk assessor: David B. Joe, E.H.S.
Lead Inspector / Risk Assessor VA# 0000 000000
Any Health District
123 Healthy Street
Anywhere, VA 23XXX
(804) 555-4321, ext. 123

Name of property owner: Martha D. Owner
123 Different Street
Anywhere, VA 23XXX
(804) 555-1234

Property address 1234 Popular Road
Anywhere, VA 23XXX
File Case # 99-8018

Disclosure of information on Lead Based Paint and Lead Based Paint Hazards:

Housing built before 1978 may contain lead based paint. Lead from paint, paint chips, and dust can pose health hazards if not taken care of properly. Lead exposure is especially harmful to young children and pregnant women. Federal law requires the seller of any interest in residential property to provide the buyer with any information on lead based paint hazards from risk assessments or inspections in the seller's possession and notify the buyer of any known lead based paint hazards. Federal law also requires landlords to disclose the presence of known lead based paint hazards in the houses and apartments built before 1978. Also tenants/purchasers must receive a Federal approved pamphlet on lead poisoning prevention the pamphlet entitled ***Protect Your Family from Lead in Your Home.***

Questions to be addressed to the occupant of the dwelling:

Was the presence of lead based paint and the potential/existing lead based paint hazards disclosed to you during the real estate transaction (purchase or rental agreement)? Y

Were you given the pamphlet entitled ***Protect Your Family from Lead in Your Home****? Y*

Are you aware of any recent renovation, repair, or painting? N

(Single-Surface Sampling)

Sample number	**Room (record name of room used by the owner or resident)**	**Surface type (circle the type)**	**Is surface smooth and cleanable?**	**Dimensions of sample area (inches x inches)**	**Area (ft2)**	**Result of lab analysis (µg/ft2)**
27-06102004vhh	1 /Dwnstrs hallway	Floor	yes	12” x 12”	1	28
28-06102004vhh	1 /Dwnstrs hallway	Interior window sill (window does not open)	yes	3” x 12”	0.4	31
29-06102004vhh	2 /Living room	Floor	yes	12” x 12”	1	23
30-06102004vhh	2 /Living room	Interior window sill	yes	4” x 24”	0.6	226
31-06102004vhh	3 /Kitchen	Floor	yes	12” x 12”	1	31
32-06102004vhh	3 /Kitchen	Interior window sill	yes	4” x 24”	0.6	221
33-06102004vhh	4 /Dining room	Floor	yes	12” x 12”	1	36
34-06102004vhh	4 /Dining room	Interior window sill	yes	4” x 24”	0.6	136
35-06102004vhh	5 /Dwnstrs bathroom	Floor (no window in bathroom)	yes	12” x 12”	1	22
36-06102004vhh	6 /Stairs	Floor (treads)	yes	4” x 24”	0.6	**59**
37-06102004vhh	7 /Upstrs hallway	Floor (no window in hall)	yes	12” x 12”	1	33
38-06102004vhh	8 / Bedroom 1	Floor	yes	12” x 12”	1	BDL
39-06102004vhh	8 / Bedroom 1	Interior window sill	yes	4” x 24”	0.6	232
40-06102004vhh	9 /Bedroom 2	Floor	yes	12” x 12”	1	**69**
41-06102004vhh	9 /Bedroom 2	Interior window sill	yes	4” x 24”	0.6	213
42-06102004vhh	10 /Bedroom 3	Floor	yes	12” x 12”	1	38
43-06102004vhh	10 /Bedroom 3	Interior window sill	yes	4” x 24”	0.6	217
44-06102004vhh	11 /Bathroom	Floor	yes	12” x 12”	1	BDL
45-06102004vhh	11 /Bathroom	Interior window sill	Yes	4” x 12”	0.3	BDL
46-06102004vhh	13 /Front porch	Floor	Yes	12” x 12”	1	39
47-06102004vhh	14 /Back Porch	Floor	yes	12” x 12”	1	37

Laboratory Sample Sheet: Include Actual Result Forms From Lab

SECTION 5

SOIL SAMPLE RESULTS

Soil sampling:

Two composite soil samples of bare soil in child play areas were taken to determine the lead concentration in the soil: one under and around the play equipment and the other under the tree in the NE corner of the yard. Laboratory results of play equipment area sample exceeded levels established by EPA indicating the presence of a lead hazard and therefore requiring a hazard control option. (Soil sampling and guidance found in SOPs for soil sampling)

Field Sampling Form for Soil

Name of risk assessor: David B. Joe, E.H.S.
Lead Inspector / Risk Assessor VA# 0000 000000
Any Health District
123 Healthy Street
Anywhere, VA 23XXX
(804) 555-4321, ext. 123

Name of property owner: Martha D. Owner
123 Different Street
Anywhere, VA 23XXX
(804) 555-1234

Property address: 1234 Popular Road
Anywhere, VA 23XXX
File Case # 99-8018

(Composite Sampling Only)

Sample number	Location	Lab result (µg/g) = ppm)
48-06102004vhh	Play area 1 (describe) This area is under and around the play equipment (swing set, etc.) located very close to the house on the NE side of the back yard. The area is approximately 14’ x 5' in size.	5,022
49-06102004vhh	Play area 2 (describe) This is the area under a large tree with low branches which all of the children use as a climbing/play area.	301
THESE WERE THE ONLY TWO BARE AREAS OF THE YARD		

Collect only the top 1/2 inch of soil.

Total number of samples on this page___2_____

Laboratory Sample Sheet: Include Actual Result Forms From Lab

SECTION 6

Water Sample Results

Field Sampling Form for Water

Name of risk assessor: David B. Joe, E.H.S.
Lead Inspector / Risk Assessor VA# 0000 000000
Any Health District
123 Healthy Street
Anywhere, VA 23XXX
(804) 555-4321, ext. 123

Name of property owner: Martha D. Owner
123 Different Street
Anywhere, VA 23XXX
(804) 555-1234

Property address; 1234 Popular Road
Anywhere, VA 23XXX
File Case # 99-8018

Date:

Time/date faucet labeled "off"_____pm

Samples	Volume	Sample Time	Results (ug/kg = ppb)
First Draw ***Required*** Sample # DW -1-06102004vhh	250 cc	06:45	11 ppb
Second Draw Optional as needed Sample # DW -2-06102004vhh	750 cc	06:48	9 ppb
Third Draw Optional as needed Sample # DW -3-06102004vhh	250 cc	06:55	4 ppb
Fourth Draw Optional as needed Sample# DW -4-06102004vhh	1 Liter	07:08	BDL

Laboratory Sample Sheet: Include Actual Result Forms From Lab

SECTION 7

Other Media

Field Sampling Form for Other Media

Name of risk assessor: David B. Joe, E.H.S.
Lead Inspector / Risk Assessor VA# 0000 000000
Any Health District
123 Healthy Street
Anywhere, VA 23XXX
(804) 555-4321, ext. 123

Name of property owner: Martha D. Owner
123 Different Street
Anywhere, VA 23XXX
(804) 555-1234

Property address: 1234 Popular Road
Anywhere, VA 23XXX
File Case # 99-8018

Sample Type/Number	Sampling Technique (describe)	Results	Comments
50-A-06102004vhh Key chain with ornamental fish sent to lab to scrape	Scrapped part of ring	22 % lead (A)	The child frequently mouthed both of these items. It is reasonable to assume this item contributed to the poisoning of the child.
50-B-06102004vhh Key chain with ornamental fish sent to lab to scrape (same sample # because only one item is sent, although results will be split into A & B)	Scrapped part of fish	18 % lead (B)	

Laboratory Sample Sheet: Include Actual Result Forms From Lab

SECTION 8

Hazard Control Options:

Abatement

Abatement is a measure or measures designed to permanently eliminate lead-based paint hazards. These measures include the removal of lead-based paint, and lead contaminated dust, the permanent enclosure or encapsulation of lead-based paint, the replacement of lead based-painted surfaces and fixtures and the removal or permanent covering of lead contaminated soil. Abatement also includes all preparation, cleanup, disposal, and post-abatement clearance testing activities associated with such measures.

Abatement measures include:

- building component replacement;
- enclosure systems;
- paint removal (on-site or off-site);
- encapsulation (with patch test and a 20 year warranty);
- permanent soil covering (paving); and
- soil removal and replacement.

Building component replacement consist of removal of doors, windows, trim and other building items that are coated with lead-based paint and replacement with new lead-free components. This measure is appropriate when the component is mostly deteriorated since interim control measures are unlikely to be effective on unsound components (rotted windows sashes, door, etc.). The advantages of building component replacement are that it creates a permanent solution by removing all lead-based paint; it minimizes dust contamination to the property; and it minimizes worker and resident exposure. The disadvantages are that component replacement can be relatively expensive; in some historic preservation projects component replacement may not be permitted, and it requires personnel with carpentry skills to successfully complete the work. Also, when trim is removed, the openings can release large amounts of lead dust.

Using ***Enclosure Systems*** consists of mechanically attaching a rigid, durable barrier to building components, with all edges and seams sealed with caulk or other sealant. Enclosures are intended to prevent access and exposure to lead-based painted surfaces and provide a “dust-tight” system to trap any lead-contaminated dust. Some appropriate materials for enclosure are:

Interior finish	-	drywall, paneling, wainscot
Exterior finish	-	aluminum, vinyl siding
Exterior trim	-	aluminum or vinyl coil stick
Steps	-	vinyl or rubber tread and riser coverings
Floors	-	underlayment and vinyl or other sheet finish goods

The advantages of enclosure is it allows use of standard, locally available construction materials; it is highly reliable and may be more durable than encapsulation; and it generates minimal levels of lead dust. There are several disadvantages of enclosure. It does not permanently remove lead-based paint (it only makes the dwelling free of hazards). The systems are vulnerable to water and physical damage. Future renovations can result in exposure to surfaces and create hazards (note: it is important to label surfaces that have lead-based paint before they are enclosed.). It cannot be used on unsound structures. The owner should

monitor enclosures annually. And aluminum or vinyl exterior siding can conceal rotting wood.

On-Site Paint Removal consists of an on-site separation of paint from the substrate using a variety of methods. Appropriate methods include heat guns at temperatures not greater than 1,100 degrees F,

chemical removal, and mechanical (HEPA sanding, wet scraping, HEPA abrasive blasting, HEPA vacuum needle blasting). The advantage of on-site paint removal is it can be less costly than replacing or enclosing building components. The disadvantage of on-site paint removal is a significant amount of dust may be released; caustic chemicals such as Peel-Away may be used; chemical stripping can leave lead residues; certain mechanical methods are not effective on certain substrates; and specialized equipment is needed.

Off-Site Paint Removal consists or removing paint through chemical or other means at a facility not on the abatement site (chemical stripping/dipping operations). The advantage of using off-site paint removal is that it has a low reevaluation failure rate; it is appropriate for historic preservation; and minimal ongoing monitoring is needed. The disadvantages of using off-site paint removal are that it can be expensive; it may deteriorate glues or other elements of components which may cause components to disintegrate; and it does not remove lead from the wood, which may release lead dust if it is disturbed again.

Encapsulation is the process of rendering lead-based paint inaccessible by providing a barrier between the paint and the environment. The barrier is formed using a liquid-applied coating (with or without reinforcement materials) and/or an adhesively bonded covering material. Generally, encapsulants are attached to the surface by bonding the product directly to the surface or by using an adhesive. HUD Guidelines require that the manufacture provide a 20-year warranty on the effectiveness of the product if the product is considered a "permanent abatement" technique. The HUD Guidelines also require that the property owner must conduct visual monitoring at one and six months after application to be sure the encapsulant is still intact. The advantages of encapsulation are that lead dust is not generated (if surface preparation is minimal); it may be less costly compared to other abatement methods; and a variety of encapsulation products are available to meet different needs. The disadvantages of encapsulation are that it is inappropriate for use on friction, impact, chewable, or severely deteriorated surfaces; information on long term durability is limited; durability depends on the condition of previous paint layers; it is susceptible to water damage; and it may not be applied in extremely hot or cold weather conditions.

Permanent Soil Covering consists of permanently covering bare, lead contaminated soil with concrete, asphalt, or other permanent materials. The EPA 403 Rule requires either permanent soil covering or removal and replacement once a soil lead hazard (play areas $\geq$ 400 ppm, other bare areas averaging $\geq$ 1,200 ppm) has been identified. The advantage of permanent covering is that it is a permanent solution, provided that the source of lead in the soil has also been controlled; and it is less costly than removal and replacement of soil. The disadvantage of permanent covering is that it is not appropriate for certain land uses (backyards, sandboxes), and may be subject to regulations regarding storm water control.

Removal and Replacement of Bare Soil involves removing the top 2 – 6 inches of lead contaminated soil; and putting new soil in its place. As stated above, the EPA 403 Rule requires either permanent soil covering or removal and replacement once a soil lead hazard (play areas $\geq$ 400 ppm, other bare areas averaging $\geq$ 1,200 ppm) has been identified. The advantage of removal and replacement is that it permanently removes the source of lead by taking it off-site.

SECTION 9

Hazard Control Options: Interim Controls

Note: Effective April 22, 2010, the amended EPA Pre-Renovation Rule regulations (RRP), require that all renovation, repair, or painting on housing or child care facilities built before 1978 must be performed by a licensed lead worker. This directly targets any of these Interim Controls performed on housing built before 1978.

Because the cost of abatement can be prohibitively expensive, Interim Controls are another option to consider. Interim Controls are intended to make dwellings "lead safe" by temporarily controlling lead based paint hazards, as opposed to abatement, which is intended to permanently control lead hazards. Interim control measures are fully effective only if they are carefully monitored, maintained, and periodically reevaluated by a licensed risk assessor. If interim controls are properly maintained, they can be effective indefinitely. As long as surfaces are covered with lead based paint, however, they constitute potential hazards.

Note: Virginia's amended building code requires abatement or remediation of the lead hazard. Many Interim Controls do not meet the required code requirements.

Interim Control measures include:

- paint film stabilization
- friction–impact reduction treatments
- specialized cleaning (also called dust removal)
- education of tenants and landlords (on maintenance)

Paint film stabilization

Paint film stabilization repairs deteriorated paint and creates a new, intact painted surface. In the HUD "Lead Safe Work Practice Regulation" (24 CFR Part 35 et.al.), this technique is referred to as "Paint Stabilization". "Paint Stabilization" has a legal definition and specific guidance on what must be included:

(b) *Paint stabilization.*

(1) Interim control treatments used to stabilize deteriorated lead-based paint shall be performed in accordance with the requirements of this section. Interim control treatments of intact, factory applied prime coatings on metal surfaces are not required. Finish coatings on such
surfaces shall be treated by interim controls if those coatings contain lead based paint.

(2) Any physical defect in the substrate of a painted surface or component that is causing deterioration of the surface or component shall be repaired before treating the surface or component. Examples of defective substrate conditions include dry-rot, rust, moisture-related defects, crumbling plaster, and missing siding or other components that are not securely fastened.

(3) Before applying new paint, all loose paint and other loose material shall be removed from the surface to be treated. Acceptable methods for preparing the surface to be treated include wet scraping, wet

sanding, and power sanding performed in conjunction with a HEPA filtered local exhaust attachment operated according to the manufacturer's instructions.

(4) Dry sanding or dry scraping is permitted only in accordance with § 35.140(e) (i.e., for electrical safety reasons or for specified minor amounts of work).

(5) Paint stabilization shall include the application of a new protective coating or paint. The surface substrate shall be dry and protected from future moisture damage before applying a new protective coating or paint. All protective coatings and paints shall be applied in accordance with the manufacturer's recommendations.

(6) Paint stabilization shall incorporate the use of safe work practices in accordance with § 35.1350.

Certain paint removal practices are prohibited because they create excessive risks to workers and occupants, they are difficult to clean up, and effective substitutes are available. HUD in 24 CFR Part 35 prohibits most of these practices.

The advantages of paint film stabilization are that the cost is typically lower than abatement, and trained but relatively unskilled personnel can perform it. The disadvantages are that it is not an appropriate control for severely damaged substrates, or high wear areas, friction-impact surfaces. Surface preparation and repair of substrates may generate large amounts of leaded dust and on-going monitoring is essential to maintain a lead-safe environment.

Friction/Impact Surface Treatment

According to HUD, *Friction surface* means an interior or exterior surface that is subject to abrasion or friction, including, but not limited to, certain window, floor, and stair surfaces.

Friction surfaces can be treated either by covering the surfaces with an abrasion resistant material to eliminate the friction or by repairing the component to good working condition so that less dust is created. (See Chapter 11 of the HUD Guidelines.)

Impact surfaces can be protected by placing barriers in front of the impact surface (e.g., new shoe molding in front of baseboards; new chair rail to protect lead-based painted walls from jolts by the backs of chairs). Impact surfaces can also be covered with an impact resistant material (e.g., corner molding over outside comers of walls). Doorstops can be replaced.

If housing is HUD subsidized (ex. Section 8), HUD Lead Safe Work Practice Requirements must also be addressed:

(1) Friction surfaces are required to be treated only if:

(i) Lead dust levels on the nearest horizontal surface underneath the friction surface (e.g., the window sill, window trough, or floor) are equal to or greater than the standards specified in 35.1320(b);
(ii) There is evidence that the paint surface is subject to abrasion; and
(iii) Lead-based paint is known or presumed to be present on the friction surface.

(2) Impact surfaces are required to be treated only if:

(i) Paint on an impact surface is damaged or otherwise deteriorated;

(ii) The damaged paint is caused by impact from a related building component (such as a door knob that knocks into a wall, or a door that knocks against its door frame); and
(iii) (iii) Lead-based paint is known or presumed to be present on the impact surface.

(3) Examples of building components that may contain friction or impact surfaces include the following:

(i) Window systems;
(ii) Doors;
(iii) Stair treads and risers;
(iv) Baseboards;
(v) Drawers and cabinets; and
(vi) Porches, decks, interior floors, and any other painted surfaces that are abraded, rubbed, or impacted.

(4) Interim control treatments for friction surfaces shall eliminate friction points or treat the friction surface so that paint is not subject to abrasion.

Examples of acceptable treatments include rehanging and/or plaining doors so that the door does not rub against the doorframe, and installing window channel guides that reduce or eliminate abrasion of painted surfaces. Paint on stair treads and floors shall be protected with a durable cover or coating that will prevent abrasion of the painted surfaces. Examples of acceptable materials include carpeting, tile, and sheet flooring.

(5) Interim control treatments for impact surfaces shall protect the paint from impact. Examples of acceptable treatments include treatments that eliminate impact with the paint surface, such as a doorstop to prevent a door from striking a wall or baseboard.

(6) Interim control for impact or friction surfaces does not include covering such a surface with a coating or other treatment, such as painting over the surface, that does not protect lead based paint from impact or abrasion.

Advantages of friction-impact treatments are that the cost may be less than component replacement, and although dust is generated, it is less than for many other controls. The disadvantages are that the workers must have experience in the construction skills necessary and if windows are repaired, containment is usually required to control dust exposures.

Dust Removal/Specialized Cleaning

Dust removal/Specialized Cleaning are often used interchangeably and actually employ the same cleaning sequence. However, dust removal is when the cleaning is done as a stand alone Interim Control. Specialized Cleaning is performed at the end of all Lead Hazard Control and as part of “Lead Safe Work Practice” requirements. Both involve extensive and specialized cleaning. In general, they are most effective if the surfaces are "cleanable" (i.e., smooth and intact, thus making dust accessible for cleaning). Undertaking dust removal without controlling the source of the dust is not generally recommended, since removal only cleans up existing lead contaminated dust and does not prevent the dust problem from arising again. Dust removal, as the only control, may be appropriate when the lead source is no longer active (e.g., old lead smelter or nearby building demolition).

§ 35.1345.

(c) *Specialized cleaning.*

After hazard reduction activities have been completed, the worksite shall be cleaned using cleaning methods, products, and devices that are successful in cleaning up dust-lead hazards, such as a HEPA vacuum or other method of equivalent efficacy, and lead-specific detergents or equivalent. of such children.

(e) *Dust-lead hazard control.*

(1) Interim control treatments used to control dust-lead hazards shall be performed in accordance with the requirements of this section. Additional information on dust removal is found in the HUD Guidelines, particularly Chapter 11 (see § 35.1310).

(2) Dust control shall involve a thorough cleaning of all horizontal surfaces, such as interior window sills, window troughs, floors, and stairs, but excluding ceilings. All horizontal surfaces, such as floors, stairs, window sills and window troughs, that are rough, pitted, or porous shall be covered with a smooth, cleanable covering or coating, such as metal coil stock, plastic, polyurethane, or linoleum.

(3) Surfaces covered by a rug or carpeting shall be cleaned as follows:

(i) The floor surface under a rug or carpeting shall be cleaned where feasible, including upon removal of the rug or carpeting, with a HEPA vacuum or other method of equivalent efficacy.
(ii) An unattached rug or an attached carpet that is to be removed, and padding associated with such rug or carpet, located in an area of the dwelling unit with dust-lead hazards on the floor, shall be thoroughly vacuumed with a HEPA vacuum or other method of equivalent efficacy. Protective measures shall be used to prevent the spread of dust during removal of a rug, carpet or padding from the dwelling. For example, it shall be misted to reduce dust generation during removal. The item(s) being removed shall be wrapped or otherwise sealed before removal from the worksite.
(iii) An attached carpet located in an area of the dwelling unit with dust-lead hazards on the floor shall be thoroughly vacuumed with a HEPA vacuum or other method of equivalent efficacy if it is not to be removed

The advantages of dust removal are that normal supplies can be used, with the addition of a HEPA vacuum, and the cleaning can be completed relatively quickly and easily. Dust removal also directly removes the hazard implicated as the highest cause of childhood lead poisoning.
The disadvantages are that cleaning is only effective on fairly smooth, “cleanable” surfaces, and this technique will not be effective at reducing exposures for very long if the source of the dust is not controlled.

Education
Education of both the landlord and the tenant can be, in some cases, a very effective measure for reducing childhood exposures. If the landlord understands the implementation of lead safe work practices and necessary controls into his normal maintenance procedures, control of exposures can become routine. Additionally, if the tenant understands how hand-washing and attention to cleaning and condition of child play areas is important in reducing exposures, the two groups working towards the same goal can provide a safer living environment and higher property values.

Section 10

Lead Hazard Control Plan

The following information is on developing Lead Hazard Control Plans and will include the controls methods assigned to this particular EIBL Investigation.

(Note for EHS-The final product of the risk assessment is a report containing a workable lead hazard control plan. The plan will include a list of the lead hazards found in the dwelling unit (if any) and the control options that can be used for that specific property. In identifying the options, risk assessors should take into account both the lead hazards that are present at the dwelling unit and the owner's needs and resources. While the final decision about what action to take is up to the owner, the risk assessor will often play a prominent role in the decision making process.)
Building code, and state and federal regulations must be addressed for lead remediation of any identified hazards.

As previously explained in Sections 8 & 9, lead-based paint hazard controls generally fall into two categories:

Interim controls and abatement.

Interim controls (sometimes referred to as in-place management action) are viewed as short term measures to control the lead hazards, while abatement is a "permanent" solution. "Permanent" means any treatment that has an expected design life of at least 20 years.

General Description of Hazard Control Measures

Interim controls are measures designed to temporarily reduce human exposure or possible exposure to lead-based paint hazards. These measures include specialized cleaning, repairs, maintenance, painting, temporary containment, and educational programs for management and residents. Interim controls also include all preparation, cleanup, disposal, and post-abatement clearance testing activities associated with such measures.

Soil Treatments

Different technologies to treat contaminated soil are currently under development. Risk assessors may find it useful to check with local environmental officials to learn which methods are considered most effective in a given geographical area.

The EPA 403 Rule specifically requires abatement of soil if a soil lead hazard has been identified. The former EPA Guidance for lead-contaminated soil allowed the use of Interim Controls if soil levels were unacceptable but not over certain concentrations. **This is not longer permitted.**

The 403 Rule states:

(4) A soil-lead hazard is present:

(i) In a play area when the soil-lead concentration from a composite play area sample of bare soil is equal to or greater than 400 parts per million; or

(ii) In the rest of the yard when the arithmetic mean lead concentration from a composite sample (or arithmetic mean of composite samples) of bare soil from the rest of the yard (i.e., non-play areas) for each residential building on a property is equal to or greater than 1,200 parts per million.

The regulation also requires, when a soil hazard is identified:

(7) * * *
(i) If the soil is removed:

(A) The soil shall be replaced by soil with a lead concentration as close to local background as practicable, but no greater than 400 ppm.

(B) The soil that is removed shall not be used as top soil at another residential property or child-occupied facility. (ii) If soil is not removed, the soil shall be permanently covered, as defined in § 745.223.

Prohibited Hazard Control Practices

§ 35.140 Prohibited methods of paint removal**.**

The following methods shall not be used to remove paint that is, or may be, lead-based paint:

(a) Open flame burning or torching.

(b) Machine sanding or grinding without a high-efficiency particulate air (HEPA) local exhaust control.

(c) Abrasive blasting or sandblasting without HEPA local exhaust control.

(d) Heat guns operating above 1100 degrees Fahrenheit or charring the paint.

(e) Dry sanding or dry scraping, except dry scraping in conjunction with heat guns or within 1.0 ft. (0.30 m.) of electrical outlets, or when treating defective paint spots totaling no more than 2 sq. ft. (0.2 sq. m.) in any one interior room or space, or totaling no more than 20 sq. ft. (2.0 sq. m.) on exterior surfaces.

When to Avoid Interim Controls

Risk assessors should avoid identifying interim controls as an option when any of the following conditions exist.

- The property owner is subject to a court order and/or federal/state/local requirement of "abatement" of lead-based paint. In these cases, permanent abatement measures and not interim controls are required.

- The underlying structure is unsound due to moisture or other factors, and the underlying problems will not be repaired. Interim controls address the outermost layer of any surface and do not treat moisture or structural problems that can affect paint condition. Therefore, risk assessors should not identify interim controls as an option to stabilize deteriorated paint unless the causes (other than wear) of the deterioration (e.g., water leaks, moisture, structural cracks) have been fixed.

- Underlying substrate, moisture, or structural problems will likely cause the paint to deteriorate again.

- The building component requiring treatment is rotted or otherwise unsound. Risk assessors should not identify interim controls as an option to treat friction or impact surfaces (e.g., rehanging a door, covering a window sill or installing new tracks, covering a porch floor) if the wood is rotted or metal is rusted and will fall apart in a short time. One rule of thumb is that if more than 75 percent of the component is deteriorated, interim controls to stabilize paint or otherwise control a hazard are inappropriate, and the item should be replaced.

- The property has a poor maintenance history that is unlikely to change. Interim controls require regular upkeep; as a result, they are unlikely to succeed without good maintenance. If the property owners' track record indicates that they are unable to maintain the building/unit in good condition (e.g., free of peeling paint, no fundamental structural problems, basic systems working such as heat, plumbing), risk assessors should not recommend interim controls unless significant changes in maintenance and management practices will occur. In this case, risk assessors will need to judge if an owner can provide effective maintenance services.

Immediate Lead-Based Paint Hazards

Immediate lead based paint hazards include:

- Lead dust exceeding federal standards. Current EPA/DPOR regulations list the following concentrations as lead dust hazards:

  Floors: 40 ug/ft2
  Interior window sills: 250 ug/ft2

- Flaking, peeling, chipping or otherwise delaminating lead-based paint

- Floors or stairs with deteriorated lead-based paint tooth marks on surfaces covered with lead-based paint

- Lead soil levels in bare soil exceeding 400 ug/g in children's play areas (e.g., sandbox, digging areas, under swing sets)

Activities Accompanying Lead Hazard Control Work

(Note to EHS-When risk assessors identify available options for hazard control, they should be sure to tell property owners about other activities that occur as part of abatement or interim controls.)
The following activities, which vary depending on the specific hazard control method, will occur as part of the abatement or interim control activities.

- Clearance testing,
- Occupant protection and worksite preparation,
- Worker protection,
- Waste management, and
- Ongoing monitoring of hazard control measures.

Required Clearance Testing

Clearance testing is completed to ensure a unit is free of lead-based paint hazards once cleanup has been done

and hazard control activities are completed. It involves:

- Visual examination to determine that hazard control measures are complete and no new lead-based paint hazards exist;
- Dust sampling (and possibly soil sampling in the case of exterior work) to verify that levels are below applicable standards.

Clearance is required at the end of all abatement work, and also as part of Lead Safe Work Practices. The EPA 403 Rule requires:

(8) * * *

(ii) Following the visual inspection and any post-abatement cleanup required by paragraph (e)(8)(i) of this section, clearance sampling for lead in dust shall be conducted. Clearance sampling may be conducted by employing single-surface sampling or composite sampling techniques.

(v) * * *
(A) After conducting an abatement with containment between abated and unabated areas, one dust sample shall be taken from one interior window sill and from one window trough (if present) and one dust sample shall be taken from the floors of each of no less than four rooms, hallways or stairwells within the containment area. In addition, one dust sample shall be taken from the floor outside the containment area. If there are less than four rooms, hallways or stairwells within the containment area, then all rooms, hallways or stairwells shall be sampled.

(B) After conducting an abatement with no containment, two dust samples shall be taken from each of no less than four rooms, hallways or stairwells in the residential dwelling or child-occupied facility. One dust sample shall be taken from one interior window sill and window trough (if present) and one dust sample shall be taken from the floor of each room, hallway or stairwell selected. If there are less than four rooms, hallways or stairwells within the residential dwelling or child-occupied facility then all rooms, hallways or stairwells shall be sampled.

(vii) The licensed inspector or risk assessor shall compare the residual lead level (as determined by the laboratory analysis) from each single surface dust sample with clearance levels in paragraph (e)(8)(viii) of this section for lead in dust on floors, interior window sills, and window troughs or from each composite dust sample with the applicable clearance levels for lead in dust on floors, interior window sills, and window troughs divided by half the number of subsamples in the composite sample. If the residual lead level in a single surface dust sample equals or exceeds the applicable clearance level or if the residual lead level in a composite dust sample equals or exceeds the applicable clearance level divided by half the number of subsamples in the composite sample, the components represented by the failed sample shall be recleaned and retested.

(viii) The clearance levels for lead in dust are 40 µg/ft² for floors, 250 µg/ft² for interior window sills, and 400 µg/ft² for window troughs.

Occupant Protection

Care should be taken to ensure that occupants are protected during hazard control measures. Occupants can be at great risk of lead poisoning by remaining in the work area when the hazard control is occurring, because most such work typically generates leaded dust and paint chips.
Risk assessors should strongly recommend that occupants vacate the unit prior to the work beginning.

However, this is not always possible. Here are the requirement for Occupant Protection and Worksite Preparation (the two go hand in hand) from HUD:

§ 35.1345 Occupant protection and worksite preparation.

This section establishes procedures for protecting dwelling unit occupants and the environment from contamination from lead-contaminated or lead containing materials during hazard reduction activities.

(a) *Occupant protection.*
(1) Occupants shall not be permitted to enter the worksite during hazard reduction activities (unless they are employed in the conduct of these activities at the worksite), until after hazard reduction work has been completed and clearance, if required, has been achieved.

(2) Occupants shall be temporarily relocated before and during hazard reduction activities to a suitable, decent, safe, and similarly accessible dwelling unit that does not have lead-based paint hazards, except if:

(i) Treatment will not disturb lead based paint, dust-lead hazards or soil lead hazards;

(ii) Only the exterior of the dwelling unit is treated, and windows, doors, ventilation intakes and other openings in or near the worksite are sealed during hazard control work and cleaned afterward, and entry free of dust-lead hazards, soil-lead hazards, and debris is provided;

(iii) Treatment of the interior will be completed within one period of 8-daytime hours, the worksite is contained so as to prevent the release of leaded dust and debris into other areas, and treatment does not create other safety, health or environmental hazards (e.g., exposed live electrical wiring, release of toxic fumes, or on-site disposal of hazardous waste); or

(iv) Treatment of the interior will be completed within 5 calendar days, the worksite is contained so as to prevent the release of leaded dust and debris into other areas, treatment does not create other safety, health or environmental hazards; and, at the end of work on each day, the worksite and the area within at least 10 feet (3 meters) of the containment area is cleaned to remove any visible dust or debris, and occupants have safe access to sleeping areas, and bathroom and kitchen facilities. (3) The dwelling unit and the worksite shall be secured against unauthorized entry, and occupants' belongings protected from contamination by dust lead hazards and debris during hazard reduction activities. Occupants' belongings in the containment area shall be relocated to a safe and secure area outside the containment area, or covered with an impermeable covering with all seams and edges taped or otherwise sealed.

(b) *Worksite preparation*

(1) The worksite shall be prepared to prevent the release of leaded dust, and contain lead based paint chips and other debris from hazard reduction activities within the worksite until they can be safely removed. Practices that minimize the spread of leaded dust, paint chips, soil and debris shall be used during worksite preparation.

(2) A warning sign shall be posted at each entry to a room where hazard reduction activities are conducted when occupants are present; or at each main and secondary entryway to a building from which occupants have been relocated; or, for an exterior hazard reduction activity, where it is easily read 20 feet (6 meters) from the edge of the hazard reduction activity worksite. Each warning sign shall be as described in 29 CFR 1926.62(m), except that it shall be posted irrespective of employees' lead exposure and, to the extent practicable, provided in the occupants' primary language.

Worker Protection

OSHA regulations are enforced in Virginia by the Department of Labor and Industry (DOLI). The OSHA standards contain the legal performance requirements, which employers must follow. If any violations are observed please contact the state DOLI office or one of their regional offices. **http://www.doli.virginia.gov/**

Waste Management

Previous to the EPA letter verifying that residential waste is exempt from the EPA, Resource Conservation and Recovery Act (RCRA), risk assessors were encouraged to consider the waste management costs associated with each hazard control measure when identifying potential options. However, this is no longer an issue in most states, Virginia included, because Virginia regulations recognize residential waste as exempt, with a few exceptions. Virginia DEQ, Waste Division, still considers residential lead waste as subject to Subtitle C of RCRA if a LISTED HAZARDOUS WASTE such as the solvent, methylene chloride, is used for stripping. The entire list of "Listed Wastes can be found in 40 CFR Subtitle C "Listed Hazardous Wastes".

Ongoing Monitoring of Hazard Control Measures

Both interim control and abatement measures should be monitored on a regular basis to ensure that they are still intact and that lead-based paint hazards have not reappeared. In general, interim controls require more frequent monitoring than abatement since they are designed as short term measures. Only units that have undergone a complete unit abatement or are free of lead-based paint should be exempted from ongoing monitoring. On-going monitoring schedules should be provided and reviewed with the owner after Hazard Control Options have been chosen, and included in the Lead Hazard Control Plan.

HAZARDS IDENTIFIED DURING EIBL INVESTIGATION

Paint Lead Hazards

1. **Deteriorated lead based paint on the exterior side of the windows.**
2. **Deteriorated lead based paint on some of the interior window trim**
3. **Deteriorated lead based paint on all of the interior doors**
4. **Deteriorated lead based exterior doors**
5. **Deteriorated lead based interior hand railing**
6. **Deteriorated lead based stairway treads**
7. **Deteriorated lead based bathroom cabinets (upstairs bathroom only)**

Dust Lead Hazards

1. **Leaded dust on the floor of the child's bedroom**
9. **Leaded dust on stair treads.**

Soil Lead Hazards

10. **Bare soil under and around play equipment**

Other Sources of Lead

11. **Mother's lead containing key ring with bird ornament**

Appropriate Controls for Hazards
The range of options is listed below. When the "X" is in bold, this indicates the option chosen by the building owner based on his financial situation.

Risk Assessors' Menu of Available Hazard Control Options						
	Hazards Identified					
Treatment Option						
	Det. LBP on the ext. side of the windows.	Det. LBP on int. window trim (not all)	Det. LBP on all int. doors	Det. LBP on ext. doors	Det. LBP on int. hand railing	Det. LBP on stair treads
Dust removal						
Paint film stabilization		X				
Friction reduction treatments	X		X	X	X	X
Impact reduction treatments			X	X		
Encapsulation		X				
Enclosure		X			X	X
Paint removal by heat gun	X	X	X	X	X	X
Paint removal by chemical	X	X	X	X	**X**	**X**
Paint removal by contained abrasive (HEPA control)	X			X		
Component replacement Building component or article in question)	**X**	**X**	X	X	X	X
Off-site removal		X	**X**	**X**	X	
Soil paving						
Soil removal and replacement						

Risk Assessors' Menu of Available Hazard Control Options						
	Hazards Identified					
Treatment Option						
	Det. LBP on bathroom cabinets	Leaded dust on child's bedroom floor (lead poisoned child)	Leaded dust on stair treads	Bair soil under play equipment	Key ring	
Dust removal		**X**	**X**			
Paint film stabilization	X					
Friction reduction treatments						
Impact reduction treatments						
Encapsulation	X					
Enclosure						
Paint removal by heat gun	X					
Paint removal by chemical	X					
Paint removal by contained abrasive	X					
Component replacement Building component or article in question)	**X**				**X**	
Off-site removal	X					
Soil paving				X		
Soil removal and replacement				**X**		

Options Chosen

Mrs. Martha Owner and her husband have chosen the options indicated above. The doors are original to the structure and are substantial, and have aesthetic appeal. They first plan is to remove the interior doors, and take them offsite to strip the doors and reseal them, and re-hang the doors. Both Mrs. Owner and her husband have received training as Lead Supervisors, and currently, Virginia allows them to complete their own offsite work. They then plan to replace the doors, and as weather allows, remove the two exterior doors (supplying temporary doors) and to off-site strip, reseal and replace these doors also.

The owners plan to hire an abatement contractor to replace the windows and trim, remove the paint from the hand rail and stair treads, and to replace the bathroom cabinet. The work will involve worksite preparation, and the tenants will be out of town during the three-day weekend when the work is planned. The abatement contract calls for specialized cleaning and, due to the presence of an EIBLL child, the Health Department will conduct clearance sampling.

During the same weekend, the owners will remove the soil to a depth of at least 8” around the play equipment, take the soil away and replace it with sand, which has been verified as non-lead containing.

The mother of the child has agreed to give the key ring to the Health Department as an example of problem objects.

The owners have applied to the local Redevelopment and Housing Authority for help in paying for and/or financing these options.

On-Going Monitoring Schedule

The following is the schedule originally published by EPA and HUD, but modified to include changes from the EPA 403 Rule.

Table 6.1 Standard Reevaluation Schedules (See Notes to Table 6.1.)				
Schedule	Evaluation Results	Action Taken	Reevaluation Frequency	Visual Survey (by owner or owner's representative)
1	Combination risk assessment/inspection finds no leaded dust or soil and no lead-based paint.	None	None	None
2	No lead-based paint hazards found during risk assessment conducted before hazard control or at clearance (hazards include dust and soil).	None	3 years	Annually and whenever information indicates a possible problem
3	The average of leaded dust levels on all floors, interior window sills, or window troughs sampled exceeds the applicable standard, but by less than a factor of 10.	A. Interim Controls and/or hazard abatement (or mixture of the two), including but not necessarily limited to dust removal. This schedule does not include window B. Treatments specified in section A plus replacement of all windows with lead hazards C. Abatement of all lead based paint using encapsulation or enclosure D. Removal of all lead based paint	1 year, 2 years 1 year None None	Same as Schedule 2, except for encapsulants. The first visual survey of encapsulants should be done one month after clearance; the second should be done six months later and annually thereafter. Same as Schedule 3 above None
4	The average of leaded dust levels on all floors, interior window sills, or window troughs sampled exceeds the applicable standard by a factor of 10 or more.	A. Interim controls and/or hazard abatement (or mixture of the two), including, but not necessarily limited to, dust removal. This schedule does not include window replacement.	6 months, 1 year, 2 years	Same as Schedule 3
		B. Treatments specified in section A plus replacement of all windows with lead hazards	6 months, 2 years	Same as Schedule 3
		C. Abatement of all lead-based paint using encapsulation and enclosure,	None	Same as Schedule 3
		D. Removal of all lead-based paint	None	None

5	No leaded dust or leaded soil hazards identified, but lead-based paint or lead-based paint hazards are found.	A. Interim controls or mixture of interim controls and abatement (not including window replacement)	2 years	Same as Schedule 3
		B. B. Mixture of interim controls and abatement, including window replacement	3 years	Same as Schedule 3
		C. C. Abatement of all lead-based paint hazards, but not all lead-based paint	4 years	Same as Schedule 3
		D. Abatement of all lead-based paint using encapsulation or enclosure	None	Same as Schedule 3
		E. Removal of all lead-based paint	None	None
6	Bare leaded soil ≥ 400 ppm in child's play areas	ABATEMENT: Remove and Replace with clean soil <400 ppm lead or as close to background as possible, or Permanently pave area	None	During other visual assessments, look for new bare areas
7	Bare leaded soil ≥ 1200 ppm in residential areas not identified as child's play areas	ABATEMENT: Remove and Replace with clean soil <400 ppm lead or as close to background as possible, or Permanently pave area	None	None for removal, annually to identify new bare spots or deterioration of paving

Notes to Table 6.1:
1. When more than one schedule applies to a dwelling, use the one with the most stringent reevaluation schedule. Do not use the results of a reevaluation for Schedule 2.
2. A lead-based paint hazard includes deteriorated lead-based paint and leaded dust and soil above applicable standards.
3. The frequency of reevaluations and the interval between reevaluations depends on the findings at each reevaluation and the action taken. For example, a dwelling unit or common area falling under Schedule 3.A would be reevaluated one year after clearance. If no lead-based paint hazards are detected at that time, the unit or area would be reevaluated again two years after the first reevaluation. If no hazards are found in the second reevaluation, no further reevaluation is necessary, but annual visual monitoring should continue.
If, on the other hand, the unit or common area fails a reevaluation, a new reevaluation schedule should be determined based on the results of the reevaluation and the action taken. For instance, if the reevaluation finds deteriorated lead-based paint but no lead-contaminated dust, and the action taken is paint stabilization. Schedule 5.A would apply, which indicates that the next reevaluation should be in two years. If, however, the owner of this same property decides to abate all lead-based paint hazards instead of doing only paint stabilization, the property would move to Schedule 5.C, which calls for reevaluation four years from the date of clearance after the hazard abatement

All lead based paint on doors, hand rail and stair treads will be removed. The paint will also be removed from all doors. For these surfaces, the Monitoring Schedule is 3D. The lead-contaminated soil is also to be removed, and appears to be coming from the window trim near the play areas. The window trim will be replaced, and this should remove the source of the problem. The Monitoring Schedule for the soil is 6. The mother is encouraged to use care when selecting everyday objects (such as the key ring) that children may routinely handle and put into their mouths.

RECOMMENDATIONS ATTACHMENT

When your home **tests positive for lead-based paint** but no hazards are identified, keep in mind that the potential for hazards is great! **To keep hazards from becoming a problem remember:**

For property that tested positive for lead based paint and lead hazards, the following interim care to reduce lead hazards and lead exposure must be performed. These recommendations are not solutions to meeting lead-safe building compliance but to temporarily reduce lead hazard exposure. Appendix A of the report provides guidelines and options for meeting lead-safe building compliance:

- Keep children away from areas that were tested positive for lead and are in poor condition. These locations contain lead hazards and children must be kept away to prevent further exposure. **This includes soil and dust hazards.**

- All areas that tested positive for lead, are in poor condition (peeling /flaking /chipping/ or damaged), and are found to generate lead hazards will deposit lead dust or paint chips onto nearby horizontal surfaces. Therefore, these horizontal surfaces adjacent to sources of lead hazards must routinely be cleaned using damp cleaning methods (e.g. mops and damp cloths, etc.). DO NOT DRY DUST OR SWEEP! This only stirs the leaded dust up and creates more problems. **Throw away the cloths or mops after use. Do not use them in other areas of cleaning unless they are thoroughly rinsed clean to get rid of lead particles.**

- Inspect the areas that tested positive for lead-based paint and make sure the paint remains intact. If any damaged paint is noticed make sure it is repainted and kept intact. Before working on or repairing damaged painted area, consult lead safe work practices or with a licensed lead paint contractor to avoid generation or release of lead hazards/dust.

- If window components tested positive, are in poor condition (peeling /flaking /chipping/ or damaged) and are found to generate lead hazards (lead dust), be sure to frequently clean the window sills, window wells and the floors in front of the windows using the damp cleaning methods. If the window components (including sashes) test positive, the constant opening and closing of windows will generate leaded dust because of the friction causes by surfaces rubbing against each others.

- Avoid repetitive opening and closing of windows, as this will generate leaded dust from paint grinding against each other. If you have air conditioning system or central air units, please use them to control indoor temperature.

- If there is lead in soil, avoid opening windows to allow lead dust from blowing into the living quarters and keep young children away from the windows.

- If your porch components (column/post, rails, floor or ceiling) tested positive and in flaking/hazardous conditions, do not let children play, sit under the porch and touch peeling paint on and around the porch. Adults also should not sit on the porch, or touch the posts, rails, and/or walls.

- If your door components tested positive, make sure all the doors close easily without any rubbing, bumping or banging. This will cause the paint to chip and flake and will also cause leaded dust to

generate and fall to the floor. Mop often the floors on both sides of any doors that have leaded components.

- All trim that tested positive for leaded paint should also be inspected often to ensure the paint remains intact. This goes for any floors and walls that tested positive, as well. Walls and floors may also be "enclosed" to avoid lead exposure.

- If your porches are painted with leaded paint, inspect the paint often to ensure the paint remains intact. Paint when necessary. Have a door mat at the entry of the house to help avoid tracking lead dust into the house.

- Maintain exterior paint in good condition (keep it intact). If peeling or flaking of paint occurs, keep children and their toys away from areas where flaking paint has fallen. Remove the paint debris on ground as often as possible and dispose the debris safely in sealed container or bag. Consult lead safe work practices or with licensed lead paint contractor before working on/repairing peeling or flaking paint to avoid generating or releasing lead hazard/dust.

- If there are no bare soil areas in your yard try to maintain good grass coverage throughout the yard. For bare soil areas that tested positive for lead, these areas must be covered immediately, especially if it is a play area for children. This may be done with several options. One way is to simply re-grow grass in these areas. Make sure it re-establishes itself well prior to allowing play to continue in these areas. Other options are to cover the areas with at least 4 inches of mulch or some type of hardscape, such as a concrete or asphalt pad, paving stones or any semi-permanent or permanent ground cover. This places a barrier between the children and the contaminated soil. Any soil that tests for lead at 5,000ppm or greater MUST be removed, 4 to 6 inches deep, and replaced with uncontaminated soil. The new soil should be tested before replacing the old soil.

- It is a good practice to run the cold water tap for 1 – 3 minutes before first morning draw or after a long period of none usage (6 hour or longer) for drinking, cooking or washing food. This way, it will flush any potential lead leaching from pipe solders settling overnight in the house pipes. DO NOT use hot water from the tap for making baby formulas, juices or cooking. Use cold water for these items and warm them later, if desired. Hot water can cause lead to leach more easily from lead containing items.

- As always, before working on or repairing damaged (peeling or flaking) lead-based paint, consult lead safe work practices, seek advise and free training from Richmond City Health District, and/or hire licensed lead paint contractor to do the work properly to avoid generation or release of lead hazard/dust. By regulation, any lead-based paint related activities must be performed by state licensed lead paint contractor in a building structure where a child (children) has (have) been identified to be lead poisoned. Please check with Richmond City Health District for exception applicable to owner-occupied dwellings.

- As a good habit, always wash your child's (children's) hands frequently, especially if they come in frequent contact with window sills, floors, stairs, etc., through crawling or touching these areas or putting their hands/toys into their mouth. Lead dust can be generated, settle, and accumulate in those areas if lead-based paint is damaged and housekeeping is not sufficient to remove lead dust. If your child has hand-to-mouth or toy-to-mouth habit, constant hand washing and toy washing is a must.

For properties that tested positive for lead based paint and lead hazards:

- All areas that tested positive for lead and are found to generate lead hazards (in poor condition) must routinely be cleaned using damp cleaning methods (e.g. mops and damp cloths, etc.). DO NOT DRY DUST OR SWEEP! This only stirs the leaded dust up and creates more of a problem. Thoroughly rinse the damp cloths/mops to get rid of the lead before reusing.

- If window components tested positive and are found to generate lead hazards (in poor condition), be sure to frequently clean the window sills, window wells and the floors in front of the windows using the damp cleaning methods. If the window components (including sashes) test positive, the constant opening and closing of windows will generate more leaded dust because of the friction surfaces rubbing.

- If you have air conditioning, it is probably helpful to use it often during the summer to reduce the repetitive opening of windows which will generate leaded dust.

- If your porches are painted with leaded paint, inspect the paint often to ensure the paint remains intact. Paint when necessary. Have a door mat at the entry of the house to help avoid tracking lead dust into the house.

- If your door components tested positive and are found to generate lead hazards (in poor condition), make sure all the doors close easily without any rubbing, bumping or banging. This will cause more paint to chip and flake and will also cause leaded dust to generate and fall to the floor. Damp mop often on both sides of any doors that have leaded components.

- For floors that tested positive for leaded paint, you may cover with carpet and carpet padding, linoleum, vinyl tile, ceramic tile or any floor covering that is meant for permanent use.

- For walls, you may enclose them with paneling, sheetrock or wall paper. Enclosing leaded components makes it easy to remedy lead exposure and is considered permanent unless removed. Stencil "Lead Paint" on leaded items prior to enclosing these areas.

- If your water tests positive for lead (15 PPB or greater), you should try to identify what is contaminating the water to see if fixing the problem is something that can be remedied easily. If tested properly, you may be able to identify if the faucet fixture, the water lines in the house or the supply line (if municipal water) is the source of contamination.

- If the house water lines or the faucet is(are) the source of the contamination(s) then you should allow the cold water from the tap to run 1-3 minutes before using the water for drinking, cooking or washing dishes, until you can remedy the problem. DO NOT use hot water from the tap for making baby formulas, juices or cooking. Use cold water for these items and warm them later, if desired. Hot water can cause lead to leach more easily from lead containing items.

- If the water supply/source is where the contamination is coming from then you should notify proper authorities of the problem. You should also immediately begin using bottled water or buy a water filtration device or system that will effectively filter out lead.

- As always, before working on or repairing damaged (peeling or flaking) lead-based paint, consult lead safe work practices, seek advise and free training from Richmond City Health District and/or hire licensed lead paint contractor to do the work properly to avoid the generation or release of leaded dust. By regulation, any lead-based paint related activities must be performed by a state licensed lead paint contractor in a building or structure where a child (children) has (have) been identified to be lead poisoned. Please check with Richmond City Health District for exceptions applicable to owner-occupied dwellings.

- As a good habit, always wash your child's (children's) hands frequently, especially if they come in frequent contact with window sills, floors, stairs, etc., through crawling or touching these areas or putting their hands/toys into their mouth. Lead dust can be generated, settle and accumulate in those areas if lead-based paint is damaged and housekeeping is not sufficient to remove lead dust. If your child has a hand-to-mouth or toy-to-mouth habit, constant hand washing and toy washing is a must to prevent exposure to lead.

- If there are lead hazards outside the house, make sure your child wears shoes when playing outdoors. Remove their shoes before entering the house. If you allow your child to be barefooted around, in and out of the house, make sure his toes and soles of his feet are washed clean frequently to prevent tracking lead dust in and around the house and to prevent lead ingestion via hand/toe-to-mouth activity.

Appendix J

Questions to Ask When Reviewing Risk Assessment Reports

1) Does the risk assessor have a valid and up to date license through the Department of Profession al and Occupational Regulation (DPOR)? Check the DPOR Web site.

2) Can it be verified that the risk assessor visited the site and collected all samples personally? Did the risk assessor indicate someone else (not certified as a risk assessor) collected the dust samples? Who signed the sheets delivering the samples to the laboratory for analysis ("chain of custody" forms)? What date does the chain of custody form indicate the samples were taken/delivered?

3) Some XRF instruments have the capability to measure lead just in the surface layers and all the way to the substrate. If the XRF results are listed as K-shell and L-shell readings, does the risk assessor explain what they mean? K-shell readings evaluate the lead content in all layers of paint down to the substrate. The L-shell readings evaluate the lead content in surface layers of paint.

4) Does the risk assessor point out that even if XRF results are "negative," that is, below 1.0 mg/cm2, paint containing lead can create significant dust when disturbed during rehabilitation and worker/occupant exposures can be an issue. OSHA requires employee exposure assessments/monitoring if there is any level of lead in the paint - no matter what the XRF results are (positive or negative). Also on handout #4, RA Report checklist from previous edition of CPD manual.

5) If the risk assessor could not access all surfaces for testing, does he indicate the surfaces that were inaccessible and not tested?

6) Does the risk assessor include instructions on how the read the test data sheets?

7) Does the report or floor plan clearly indicate where the LBP and LBP hazards are? If the paint content is similar between components within a room but the condition is different, can you identify the hazard control options to use?

8) Does the risk assessment report indicate the XRF calibrations were checked before work, every 4 hours and at the end of sampling?

9) Did the risk assessor sample all deteriorated varnish, stains, and other coatings that are deteriorated or to be disturbed, in addition to the paint?

10) Does the risk assessment indicate the likely source of all dust-lead hazards? Do high lead dust levels have an obvious source? If paint in a location was tested and is positive, did the risk assessor take dust samples to see if associated hazards are present (in living areas where the occupants spend time)?

11) Does the risk assessor clearly indicate the overall condition of all components indicated as hazardous? Remember, <u>to be a hazard, a friction or impact surface must also have dust lead above the HUD/EPA levels.</u> If lead hazard reduction is recommended for windows, for example, is it clear from the report

the actual condition of the windows? The condition of components weighs heavily when deciding between performing interim controls vs. abatement. Ex: If the risk assessor indicates doors or windows are chipped, did the risk assessor also take dust samples? What is the overall condition of the windows?

12) Did the risk assessor send sample blanks to the lab with the actual samples to check the laboratory's accuracy?

13) For dust wipe samples on window sills or other curved or irregular surfaces, did the risk assessor accurately measure the sampling area and report it to the laboratory or does the risk assessor state the surface area wiped for every dust sample taken 12 X 12 inches?

14) If the risk assessor indicates window trough samples show hazards, this is incorrect. There is no hazard identification for window troughs since 3/6/01. The window trough level of 400 ug/ft^2 is used only for clearance.

15) Can it be verified that the risk assessor visited the site and collected all samples personally? Did the risk assessor indicate someone else (not certified as a risk assessor) collected the dust samples? Who signed the sheets delivering the samples to the laboratory for analysis ("chain of custody" forms)? What date does the chain of custody form indicate the samples were taken/delivered?

16) Some XRF instruments have the capability to measure lead just in the surface layers and all the way to the substrate. If the XRF results are listed as K-shell and L-shell readings, does the risk assessor explain what they mean? K-shell readings evaluate the lead content in all layers of paint down to the substrate. The L-shell readings evaluate the lead content in surface layers of paint.

17) Does the risk assessor point out that even if XRF results are "negative," that is, below 1.0 mg/cm^2, paint containing lead can create significant dust when disturbed during rehabilitation and worker/occupant exposures can be an issue. OSHA requires employee exposure assessments/monitoring if there is any level of lead in the paint - no matter what the XRF results are (positive or negative). Also on handout #4, RA Report checklist from previous edition of CPD manual.

18) If the risk assessor could not access all surfaces for testing, does he indicate the surfaces that were inaccessible and not tested?

19) Does the risk assessor include instructions on how to the read the test data sheets?

20) Does the report or floor plan clearly indicate where the LBP and LBP hazards are? If the paint content is similar between components within a room but the condition is different, can you identify the hazard control options to use?

21) Does the risk assessment report indicate the XRF calibrations were checked per protocol?

22) Did the risk assessor sample all varnish, stains, and other coatings that are deteriorated or to be disturbed, in addition to the paint?

23) Does the risk assessment indicate the probable source of all dust-lead hazards? Do high lead dust levels have an obvious source? If paint in a location was tested and is positive, did the risk assessor take dust samples to see if associated hazards are present (in living areas where the occupants spend time)?

24) Does the risk assessor clearly indicate the overall condition of all components indicated as hazardous?

Remember, <u>to be a hazard, a friction or impact surface must also have dust lead above the HUD/EPA levels.</u> If lead hazard reduction is recommended for windows, for example, is it clear from the report the condition of the windows? The condition of components weighs heavily when deciding between performing interim controls vs. abatement. Ex: If the risk assessor indicates doors or windows are chipped, did the risk assessor take dust samples also? What is the overall condition of the windows?

25) Did the risk assessor send sample blanks to the lab with the actual samples to check the laboratory's accuracy?

26) For dust wipe samples on window sills or other curved or irregular surfaces, did the risk assessor accurately measure the sampling area and report it to the laboratory or does the risk assessor state the surface area wiped for every dust sample taken 12 X 12 inches?

27) If the risk assessor indicates window trough samples show hazards, this is incorrect. There is no hazard identification for window troughs since 3/6/01. The window trough level of 400 ug/ft^2 is used only for clearance.

28) Were additional samples taken that would pick up secondary sources of exposure determined from the nursing assessment?

Appendix K

Risk Assessment Report Checklist

1. Summary

Identification Information

- Full address of property and unit (if applicable)
- Property owner's address and telephone number
- Name, address, and telephone number of risk assessor and firm
- Certification/license number of risk assessor and firm

Basic Inspection Information

- Date of risk assessment and start and stop time
- Brief description of procedures used or reference to documented methods
- Brief description of the type of risk assessment conducted
- Make, model, serial number, and source date (if applicable) for XRF machine

Summary of Results

- Brief history of renovation, repairs, and painting at property and discussion of building condition
- List of lead hazards identified including location and in rank order
- Summary of optional sampling results such as water tests (if applicable)
- Brief summary analysis of previous XRF testing reports (if applicable)

Other Information

- Statement on property owner's responsibility to disclose lead-based paint information
- Notice that deteriorated or disturbed painted surfaces may still contain lead-based paint and may pose a hazard, especially during renovation.

2. Full Explanation of Methodology and Results

Results

- History of renovation, repairs, and painting at property
- Discussion of building condition
- List of lead hazards: location, type, priority hazards indicated
- Complete paint sample results
- Complete dust testing results
- Complete soil sampling results
- Optional sampling results such as water tests (if applicable)

Test Methods

- Full description of procedures used or reference to documented methods
- Full description of the type of risk assessment conducted
- Full description of quality control procedures for XRF machine
- Analysis of previous XRF testing reports (if applicable)

3. Lead Hazard Control Plan

- Recommended interim control and/or abatement options
- Reevaluation schedule
- Risk assessor's signature and date

4. Forms to be Included

- Laboratory analysis result forms
- All laboratory and XRF raw data

APPENDIX L-1

EXAMPLE TENANT LETTER

COMMONWEALTH of VIRGINIA

In Cooperation With The
State Department of Health

Date

Ms. Mary A. Tenant
1234 Popular Road
Anywhere, VA 23XXX

Dear Ms. Tenant:

The final report for the environmental elevated blood lead investigation performed at your home on <date> has been completed. The owner has been made aware of the areas that need addressing. The report has been sent to the local building code official and to the owner:

Martha D. Owner
123 Different Street
Anywhere, VA 23XXX
(804) 555-1234

Lead-based paint hazards were found that could adversely affect any child's health under six that may reside at this address. A environmental elevated blood lead investigation was performed on (date). The following surfaces and situations are lead hazards:

<u>Paint Lead Hazards</u>

1) **Deteriorated lead based paint on the exterior side of the windows.**
2) **Deteriorated lead based paint on some of the interior window trim**
3) **Deteriorated lead based paint on all of the interior doors**
4) **Deteriorated lead based paint on exterior doors**
5) **Deteriorated lead based paint on interior hand railing**
6) **Deteriorated lead based paint on stairway treads**
7) **Deteriorated lead based paint on bathroom cabinets (upstairs bathroom only, this is not a friction/impact problems, only front & sides)**

Dust Lead Hazards

8) **Leaded dust on the floor of the child's bedroom**
9) **Leaded dust on stair treads.**

Soil Lead Hazards

10) **Bare soil under and around play equipment**

Other Sources of Lead

11) **Mother's lead containing key ring with bird ornament**

The owner of the property has agreed to correct these problems. However, until the work is completed, it is very important that you immediately thoroughly wet clean all floors, including the stairs, and window sills in the house. Also wet wipe the hand rail to the stairs. Please use the information found in the pamphlet *Protect Your Family from Lead, which* was provided for you. Cleaning these areas with a wet clean rag wrung from a warm water solution with a ¼ cup of automatic dishwasher detergent or an all-purpose cleaner can be very effective in reducing the levels of lead dust. It has also been found that method and physical effort are more important in obtaining good results than the use of a particular type of detergent or cleaner. It is important to wash mops and rags thoroughly after each use to prevent recontamination.

An ordinary household vacuum cleaner and dry dusting and sweeping are not recommended for lead dust cleaning. They contribute to the spreading of lead dust by causing the particles to become airborne. A high-efficiency particulate air (HEPA) filter equipped vacuum cleaner should be used should any vacuuming take place. This is a special type of vacuum that can remove very small lead particles from floors, window sills, and carpets and keep them inside the vacuum cleaner. If this type of vacuum is not available, the floors should not be vacuumed, only mopped, until the owner completes the control activities.

The children should not be playing in the bare areas under the play equipment until the bare soil has been controlled. After the owner has completed activities on the bare area under the play equipment, thoroughly wash the equipment down with the hose and allow the area to dry before using the play equipment.

As per our agreement, the health department now has the key ring in our possession. Thank you for understanding the need to remove this object from the child's environment. If you have any questions or concerns about this information, please contact us at_____.

(Address other items that may have been sampled)

Once again, please feel free to contact me should you have any questions. Thank you for your cooperation.

Sincerely,

David B. Joe
Environmental Health Specialist
(804) 555-4321, ext. 123

APPENDIX L-2

EXAMPLE OWNER LETTER

COMMONWEALTH of VIRGINIA

In Cooperation With The
State Department of Health

Date

RE: Lead-Based Paint Risk Assessment Report
1234 Popular Road
Anywhere, VA 23XXX

Martha D. Owner
123 Different Street
Anywhere, VA 23XXX

Dear Property Owner:

A lead based paint risk assessment was performed at your property located at the above referenced address. This assessment was conducted by_____, Licensed Lead Inspector and Risk Assessor.

This investigation was prompted by a medical referral to the nursing department at the Bedford Health Department. This property is an address a child lives or frequently visits with an elevated blood lead level. Lead-based paint hazards were found that could adversely affect any child's health under six that may live or frequently visit at this address.

According to Virginia Lead-Based Paint Activities Regulations, our department must maintain this report for no less than three years. This report is intended to inform the owner of the results of our investigation and to begin the process of lead based paint hazard reduction or removal from the home. It is the owner's responsibility to make the final choice on a course of action. The attached report gives recommendations for this action.

A copy of the report is also being sent to the local building official.

Effective October 1, 1995 it is unlawful for an owner to hire anyone to perform lead-based paint activities within the Commonwealth without that person obtaining a certification from the Virginia Department of Professional and Occupational Regulation located in Richmond. Should you hire someone or intend to perform lead based paint activities or any type of renovations on the above listed property, please contact Lead-Safe Virginia Program for safety guidelines following the EPA Renovation, Repair and Painting Rule (RRP). **Precautions are needed when performing this type of work.** Work must follow Lead Safe Work Practices and if you choose to hire a professional, you can contact DPOR at (804) 367-8595 for a listing of certified contractors.

"*A copy of this summary must be provided to new leases (tenants) and purchasers of this property under Federal law (24 CFR part 35 and 40 CFR part 745) before they become obligated under a lease or sales contract. The completed report must also be provided to new purchasers and it must be made available to new tenants. Landlords (lessors) and sellers are also required to distribute an educational pamphlet approved by the U. S. Environmental Protection Agency and include standard warning language in their leases or sales contracts to ensure that parents have the information they need to protect their children from lead based paint hazards.*"

If you need any assistance in interpreting this report or have any questions you may contact the Lead-Safe Virginia Program at 804-864-7692. Technical assistance regarding this code is available by contacting the state building code technical assistance at 804-371-7140

Sincerely,

David B. Joe
Environmental Health Specialist
(804) 555-4321, ext. 123

Cc: County Building Code Official
Tenant
County Health Department

APPENDIX L-3

EXAMPLE BUILDING CODE OFFICIAL LETTER

COMMONWEALTH of VIRGINIA

In Cooperation With The
State Department of Health

Date

Town of Anywhere
Building Code Official
PO Box XXXX
City or Locality, VA 23XXX

Dear Mr. Building Code Official:

This letter is in reference to a residence in your locality that has potentially violated the building code. Code of Virginia §36-106 articulates that all risk assessments performed in response to an elevated blood lead level in a child where the residence has been found to be the source of the exposure, or lead hazards are identified in the process of performing an investigation, should be reported to the local building code official. A copy of the risk assessment where the source(s) of lead exposure were identified is attached and has been provided to the family and the owner.

The intention of this code is to: 1) develop regulatory authority to require abatement or remediation of lead hazards in housing units containing children with elevated blood lead levels, and 2) provide statutory protection for clients form retaliatory eviction or discrimination related to disclose of lead hazards.

If you need additional information regarding this code you may contact the state building code technical assistance at 804-371-7140. Thank you for your time and effort in this public health initiative.

Sincerely,

David B. Joe
Environmental Health Specialist
(804) 555-4321, ext. 123

Enclosure(s)

APPENDIX M

COMMONWEALTH of VIRGINIA

In Cooperation With The
State Department of Health

EXAMPLE
SCOPE OF ABATEMENT WORK

August 15, 1999

Prepared for the Property Owner: Mr. Martin E. Owns
357 Different Street
Somewhere, VA 23800
(804) 555-2468

For the Property of: 1234 Busy Street, Somewhere, VA 23800

Prepared by: David B. Joe, E.H.S.
Risk Assessor VA # 0000 000000
Any Health District
123 Healthy Street
Somewhere, VA 23800
(804) 555- 4321, ext. 123

It shall be unlawful for an owner to hire anyone to perform lead-based paint activities within the Commonwealth without that person obtaining a license from the Virginia Department of Professional and Occupational Regulation located in Richmond. Should the owner hire someone or intend to perform lead based paint activities or any type of renovations on the above listed property, please contact the health department for safety guidelines. Precautions are needed when performing this type of work. If you choose to hire a professional, you can contact DPOR at (804) 367-8595 for a listing of licensed contractors.

Risk assessors should strongly recommend that occupants vacate the unit prior to the work beginning. Here are the requirement for Occupant Protection and Worksite Preparation (the two go hand in hand) from HUD:

Occupant protection and worksite preparation.

This property participates in the HUD Section 8 rental-based tenant assistance program, therefore the following HUD requirements apply for occupant protection and worksite preparation. This section establishes procedures for protecting dwelling unit occupants and the environment from contamination from lead-contaminated or lead containing materials during hazard reduction activities.

(a) *Occupant protection.*
(1) Occupants shall not be permitted to enter the worksite during hazard reduction activities (unless they are employed in the conduct of these activities at the worksite), until after hazard reduction work has been completed and clearance, if required, has been achieved.

(2) Occupants shall be temporarily relocated before and during hazard reduction activities to a suitable, decent, safe, and similarly accessible dwelling unit that does not have lead-based paint hazards, except if:

i. Treatment will not disturb lead based paint, dust-lead hazards or soil lead hazards;

ii. Only the exterior of the dwelling unit is treated, and windows, doors, ventilation intakes and other openings in or near the worksite are sealed during hazard control work and cleaned afterward, and entry free of dust-lead hazards, soil-lead hazards, and debris is provided;

iii. Treatment of the interior will be completed within one period of 8-daytime hours, the worksite is contained so as to prevent the release of leaded dust and debris into other areas, and treatment does not create other safety, health or environmental hazards (e.g., exposed live electrical wiring, release of toxic fumes, or on-site disposal of hazardous waste); or

iv. Treatment of the interior will be completed within 5 calendar days, the worksite is contained so as to prevent the release of leaded dust and debris into other areas, treatment does not create other safety, health or environmental hazards; and, at the end of work on each day, the worksite and the area within at least 10 feet (3 meters) of the containment area is cleaned to remove any visible dust or debris, and occupants have safe access to sleeping areas, and bathroom and kitchen facilities. (3) The dwelling unit and the

v. Worksite shall be secured against unauthorized entry, and occupants' belongings protected from contamination by dust lead hazards and debris during hazard reduction activities. Occupants' belongings in the containment area shall be relocated to a safe and secure area outside the containment area, or covered with an impermeable covering with all seams and edges taped or otherwise sealed.

(b) *Worksite preparation*

(1) The worksite shall be prepared to prevent the release of leaded dust, and contain lead based paint chips and other debris from hazard reduction activities within the worksite until they can be safely removed. Practices that minimize the spread of leaded dust, paint chips, soil and debris shall be used during worksite preparation.

(2) A warning sign shall be posted at each entry to a room where hazard reduction activities are conducted when

occupants are present; or at each main and secondary entryway to a building from which occupants have been relocated; or, for an exterior hazard reduction activity, where it is easily read 20 feet (6 meters) from the edge of the hazard reduction activity worksite. Each warning sign shall be as described in 29 CFR 1926.62(m), except that it shall be posted irrespective of employees' lead exposure and, to the extent practicable, provided in the occupants' primary language.

Specific Worksite Preparation:

Doors will be moved offsite for paint removal. Contractor is not responsible for this activity, but should coordinate other activities with building owner. This will ensure that lead control activities performed by the contractor will not adversely affect the areas completed by the building owner and vice versa.

In rooms where windows will be replaced, contractor shall build mini enclosures around the window area or otherwise protect the area surrounding the window. Furniture that has not been removed shall be cleaned, moved to the center of the room, covered with plastic sheeting, and sealed to the floor with duct tape. Floor areas should be cleaned prior to covering to prevent recontamination when uncovering takes place.

Window Treatment:

Install vinyl thermal replacement windows through out according to manufacturers' recommendation with all appropriate trims and molding. Window trim will be replaced inside. Exterior window trim was replaced three years previously and is not deteriorated but should be included in the specialized cleaning prior to clearance testing.

Interior Friction Surfaces:

Peel Away 1 will be used on the stair treads and hand rail to remove the lead based paint. This method will be very effective for these smooth surfaces. It will generate the least amount of leaded dust during removal. However, the surrounding areas must be protected with 6 mil poly while the work is under way. After the Peel Away has removed the paint, the wood will be neutralized with the Peel Away neutralizer. The wood will then be scrubbed with nylon brushes and detergent, rinsed and washed. After the wood is completely dry, the wood will be sealed with 2 layers of acrylic sealer.

(i) Doors;
(ii) Stair treads and risers;
(iii) Baseboards;
(iv) Drawers and cabinets; and
(v) Porches, decks, interior floors, and any other painted surfaces that are abraded, rubbed, or impacted.

Interim control treatments for friction surfaces shall eliminate friction points or treat the friction surface so that paint is not subject to abrasion. Examples of acceptable treatments include rehanging and/or planning doors so that the door does not rub against the door frame, and installing window channel guides that reduce or eliminate abrasion of painted surfaces. Paint on stair treads and floors shall be protected with a durable cover or coating that will prevent abrasion of the painted surfaces. Examples of acceptable materials include carpeting, tile, and sheet flooring.

Interim control treatments for impact surfaces shall protect the paint from impact. Examples of acceptable treatments include treatments that eliminate impact with the paint surface, such as a door stop to prevent a door from striking a wall or baseboard.
Interim control for impact or friction surfaces does not include covering such a surface with a coating or other treatment, such as painting over the surface, that does not protect lead based paint from impact or abrasion.

(d) *Chewable surfaces.*

(1) Chewable surfaces are required to be treated only if there is evidence that a child of less than 6 years of age has chewed on the painted surface, and lead-based paint is known or presumed to be present on the surface.

(2) Interim control treatments for chewable surfaces shall make the lead based paint inaccessible for chewing by children of less than 6 years of age. Examples include enclosures or coatings that cannot be penetrated by the teeth of such children.

Interior Non-Friction Surfaces: (Site Specific)

The bathroom cabinet in the upstairs bathroom will be removed and replaced with a new component. All personal removable items, including towels, shower curtain, toiletries, etc. should be removed from the bathroom and cleaned by the tenant prior to cabinet replacement. The floor around the cabinet should be protected with 6 mil poly. The area where the cabinet contact the wall will be misted and scored prior to disturbing the cabinet. The cabinet will also be misted. The cabinet will be gently pried from the wall. If nails or screws holding the cabinet in place can be removed prior to removing the cabinet, this will be done before trying to loosen the cabinet from the wall. After removal, the cabinet will be wrapped while in the bathroom and taken to the transportation vehicle.

Interior Non-Friction Surfaces: (general scope of work information not specific for the EIBLI example)

Stabilize paint film surfaces on all non-friction surfaces as identified as lead containing according to the EIBLI report prepared the Local Health District on (date).HUD requires that Paint Stabilization include the following steps:

(1) Interim control treatments used to stabilize deteriorated lead-based paint shall be performed in accordance with the requirements of this section. Interim control treatments of intact, factory applied prime coatings on metal surfaces are not required. Finish coatings on such surfaces shall be treated by interim controls if those coatings contain lead based paint.
(2) Any physical defect in the substrate of a painted surface or component that is causing deterioration of the surface or component shall be repaired before treating the surface or component. Examples of defective substrate conditions include dry-rot, rust, moisture-related defects, crumbling plaster, and missing siding or other components that are not securely fastened.
(3) Before applying new paint, all loose paint and other loose material shall be removed from the surface to be treated. Acceptable methods for preparing the surface to be treated include wet scraping, wet sanding, and power sanding performed in conjunction with a HEPA filtered local exhaust attachment operated according to the manufacturer's instructions.
(4) Dry sanding or dry scraping is permitted only in accordance with § 5.140(e) (i.e., for electrical safety reasons or for specified minor amounts of work).
(5) Paint stabilization shall include the application of a new protective coating or paint. The surface substrate shall be dry and protected from future moisture damage before applying a new protective coating or paint. All protective coatings and paints shall be applied in accordance with the manufacturer's recommendations.
(6) Paint stabilization shall incorporate the use of safe work practices in accordance with § 35.1350.

Lead safe work practices are required for all lead hazard control activities performed on this property using licensed workers. This includes training (the worker/supervisor training completed by the abatement contractor is in compliance), worksite preparation and occupant protection as described above, specialized cleaning, and clearance testing.

Miscellaneous Interior Components: (general scope of work information not specific for the EIBLI example)

- Dispose of existing mini-blinds and replace with new lead-free mini-blinds.
- Carpeting in the living room needs replacing.
- All remaining carpets and rugs should be vacuumed and shampooed.

Exterior & Siding Treatment: (general scope of work information not specific for the EIBLI example)

Stabilize and prime all deteriorated paint surfaces via a wet method to include the exterior siding (including the foundation), exterior window trim, soffit/fascia assembly, and the porch columns, railings, ceiling, and skirt board. Encapsulate with two coats of lead specific encapsulant paint and repaint with a premium grade exterior paint.

Soil Treatment: (Site Specific)

Remove and replace bare soil under play equipment. Six mil plastic should be used to protect the surrounding ground during removal of the bare contaminated soil. The container or vehicle used for soil transport should be located close to the removal area and the ground under the container or vehicle should also be protected so that the other areas of the yard are not contaminated during soil removal. After 8" of soil is removed, 2" of crush and run gravel or clay soil should be tamped into the bare hole to help prevent children accessing the soil below. Property owners will then place 8-10" of clean sand under the play equipment and surrounding area. No hard landscaping material will be placed around the sand because of the potential for injuries if the children fall onto hard surfaces.

Interior Clean-up:

Upon completion of abatement activities, all rooms will be cleaned. Clean all horizontal surfaces thoroughly, starting from the ceiling down to the floor, using a HEPA vacuum, then a water and cleaner solution, and then go over surfaces again with a final rinse. When surfaces are dry, finish with a second HEPA vacuuming to make ready for clearance testing.

Exterior Preparation and Cleanup

The ground under the windows must be protection with 6 mil poly during window replacement. Care should be taken not to leave paint chips or debris in the yard when removing and disposing of the old windows. In order to prevent release of debris, windows should be wrapped in plastic prior to transporting. All used poly should be carefully folded and disposed upon completion of window replacement. Any paint debris will be carefully removed so that the yard is safe for the children.
Porch floors will be cleaned with the HEPA vacuum, wet mop, HEPA vacuum sequence described above at the end of all abatement and interior cleaning.

Appendix N

EXAMPLE

Clearance Evaluation & Summary

1234 Busy Street, Somewhere, VA 23XXX

COMMONWEALTH of VIRGINIA

In Cooperation With The
State Department of Health

Date

Prepared for the Property Owner: Mr. Martin E. Owns
357 Different Street
Somewhere, VA 23XXX
(804) 555-2468

Prepared by: David B. Joe, E.H.S.
Lead Inspector/Risk Assessor VA # 0000 000000
Any Health District
123 Healthy Street
Somewhere, VA 23XXX
(804) 555- 4321, ext. 123

Clearance testing has been completed for 1234 Busy Street, Somewhere, VA 23XXX. The clearance evaluation included a preliminary and final visual inspection for post abatement clearance followed by dust wipe sampling. Dust wipe samples were collected in accordance with the *EPA 403 Rule: Lead; Identification of Dangerous Levels of Lead; Final Rule* and Virginia DPOR *Lead-Based Paint Activities Regulations.*

Lead control activities were conducted throughout this residence without containment. As required by both EPA and DPOR, for an abatement without a containment area, two dust samples (one from a window sill or well and one floor) were collected from each of no less than four rooms, hallways or stairwells in the residential dwelling.

The current Federal (EPA) and Virginia clearance standards for lead in surface dust for single wipe samples are as follows:

FLOORS: 40 micrograms per square fool (ug/ft^2)
WINDOW SILLS: 250 micrograms per square foot (ug/ft^2)
WINDOW TROUGH (WELLS): 400 micrograms per square fool (ug/ft^2).

Samples results greater than or equal to the standards represent a failure. If any floor sample concentration is $\geq$40 (ug/ft2), then the floor which failed clearance and all unsampled floors must be recleaned and clearance sampling must be performed again until all floor surfaces tested pass. This requirement is the same for any window sill or window trough, which fails clearance.

Initial clearance testing was performed on (DATE). All window trough and sill samples were below clearance and therefore passed. The floor sample collected from the kitchen failed clearance. The floor samples collected upstairs in the 3 year old child's bedroom and the older children's bedroom both passed clearance. Floors in the upstairs hall, the parent's bedroom and the upstairs bathroom (none of these floors were sampled in the first clearance sample collection) were re-cleaned, as well as all floors downstairs. A second and final clearance was performed on (DATE). and laboratory analysis indicated lead dust levels were below established criteria. The visual inspection noted no immediate hazards. The property of 1234 Busy Street has met Virginia and EPA clearance criteria for re-occupancy. Enclosed are the dust sample results and lab data as well as the diagrams indicating where samples were taken.

All lead hazards identified during the EIBL investigation have been completed. All windows and trim have been replaced with new components, and the lead-based paint on all doors was removed, as well as the paint on the stair treads and hand rail. The soil lead hazard (bare lead-contaminated soil under and around the play equipment) was removed. However, owner and tenant both should periodically monitor the yard near the house for bare areas, which could also be contaminated with lead.

The Federal Residential Lead-Based Paint Hazard Reduction Act of 1992, 42 U.S.C. 4852d, requires sellers and landlords of most residential housing built before 1978 to disclose all available and reports concerning lead-based paint and/or lead-based paint hazards, **including the test results contained in this notice**, to purchasers and tenants at the time of sale or lease or upon lease renewal. This disclosure must occur even if the hazard reduction or abatement has been completed. Failure to disclose these test results is a violation of the U.S. Department of Housing and Urban Development and the U.S. Environmental Protection Agency regulations at 24 CFR Part 35 and 40 CFR Part 745 and can result in a fine of up to $11,000 per violation. To find out more information about your obligations under federal lead-based paint requirements, call 1-800-424-LEAD.

Appendix O

Commonwealth of Virginia
Radiation Protection Regulatory Guide

ORH-720 A-1

Virginia Department of Health
Radioactive Materials Program
109 Governor Street, Room 730
Richmond, VA 23219
Phone (804) 864-8150

EXECUTIVE SUMMARY

Virginia Regulatory Guide (VAREGS**) are issued to describe and make available to the applicant or licensee acceptable methods of implementing specific parts of** 12VAC5-481 'Virginia Radiation Protection Regulations' **to delineate techniques used by the staff in evaluating past specific problems or postulated accidents, and to provide guidance to applicants, licensees, or registrants. VAREGS are not substitutes for** 12VAC5-481 'Virginia Radiation Protection Regulations'**; therefore, compliance with them is not required. Methods and solutions different from those set forth in this guide will be acceptable if they provide a basis for the Virginia Department of Health (VDH), Radioactive Materials Program, to determine if a radiation protection program meets the current rule and protects health and safety.**

Comments and suggestions for improvements in this VAREG are encouraged at all times and it will be revised, as appropriate, to accommodate comments and to reflect new information or experience. Comments should be sent to **Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219**.

Requests for single copies of this guide (which may be reproduced) can be made in writing to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219. This guide is also available on our website: http://www.vdh.virginia.gov/Epidemiology/RadiologicalHealth/.

This VAREG 'Guidance for XRF Devices' has been developed to streamline the application process for a XRF License. A copy of the VDH Form, 'Application for Radioactive Material License Authorizing the use of XRF Devices', is located in **Appendix A** of this guide.

Appendix B through **L** provides examples, models and additional information that can be used when completing the application.

It typically takes 60-90 days for a license to be processed and issued if the application is complete. When submitting the application be sure to include the appropriate application fee listed in **12VAC5-491**.

In summary, the applicant will need to do the following to submit an application for an XRF license:

- Use this regulatory guide to prepare the VDH Form, 'Application for Radioactive Material License Authorizing the use of XRF Devices' (**Appendix A**).

- Complete the VDH Form, 'Application for Radioactive Material License Authorizing the use of XRF Devices' (**Appendix A**). See 'Contents of Application' of the guide for additional information.

- Include any additional attachments.
  All supplemental pages should be on a 8 ½" x 11" paper.
  Please identify all attachments with the applicant's name and license number (if a renewal).

- **Avoid submitting proprietary information unless it is absolutely necessary. If submitted, proprietary information and other sensitive information should be clearly identified and a request made to withhold from public disclosure.**

- Submit an original signed application along with attachments (if any). This submission can be made via scanned copies forwarded via facsimile or electronic mail or via postal mail of the documents.

- Submit the application fee (for new licensees only).

- Retain one copy of the licensee application and attachments (if any) for your future reference. You will need this information because the license will require that radioactive material be possessed and used in accordance with statements, representation, and procedures provided in the application and supporting documentation.

If you have any questions about the application process, please contact this office at (804) 864-8150.

CONTENTS

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

ALARA	as low as reasonably achievable
ALI	annual limit on intake
Bkg	background
Bq	Becquerel
CFR	Code of Federal Regulations
Ci	Curie
cc	centimeter cubed
cm^2	centimeters squared
cpm	counts per minute
DOE	United States Department of Energy
DOT	United States Department of Transportation
dpm	disintegrations per minute
GM	Geiger-Mueller
GPO	Government Printing Office
hr	hour
IN	Information Notice
mCi	millicurie
mR	milliroentgen
mrem	millirem
mSv	millisievert
NIST	National Institute of Standards and Technology
NRC	United States Nuclear Regulatory Commission
NVLAP	National Voluntary Laboratory Accreditation Program
OSL	optical stimulated luminescent dosimeters
RG	Regulatory Guide
RQ	Reportable Quantities
RSO	Radiation Safety Officer
SI	International System of Units (abbreviated SI from the French Le Système Internationale d'Unites)
SS&D	Sealed Source and Devices Bulletin Board System (BBS)
SSD	Sealed Source and Device
SSDR	Sealed Source and Device Registration
Sv	Sievert
TEDE	total effective dose equivalent
TLD	thermoluminescent dosimeters
TI	Transportation Index
VDH	Virginia Department of Health
XRF	X-ray Fluorescence Analyzer
μCi	microcurie
%	percent

PURPOSE OF GUIDE

This document provides guidance to an applicant in preparing a license application for an XRF license. It also provides guidance on VDH's criteria for evaluating an XRF license application. It is not intended to address the research and development of gauging devices or the commercial aspects of manufacturing, distribution, and service of such devices. Within this document, the phrases, 'XRF' and 'gauge', may be used interchangeably.

This guide addresses the variety of radiation safety issues associated with XRFs of many designs. In addition, with XRFs of varying designs, the sealed sources may be oriented in different locations within the devices, resulting in different radiation safety problems.
This guide describes the information needed to complete VDH Form**,**
'Application for Radioactive Material License Authorizing the Use of XRF Devices', (*Appendix A*).

The format for each item number in this guide is as follows:

- *Rule* ***- references the requirements of*** *12VAC5-481 'Virginia Radiation Protection Regulations'* ***applicable to the item;***
- *Criteria* ***- outlines the criteria used to judge the adequacy of the applicant's response; and***
- *Discussion* ***- provides additional information on the topic sufficient to meet the needs of most readers.***

The information submitted in the application must be sufficient to demonstrate that proposed equipment, facilities, personnel, and procedures are adequate to protect the health and safety of the citizens of the Commonwealth of Virginia in accordance with agency guidelines. Submission of incomplete or inadequate information will result in delays in the approval process for the license. Additional information will be requested when necessary to ensure that an adequate radiation safety program has been established. Such requests for additional information will delay completion of the application's review and may be avoided by a thorough study of the rule and these instructions prior to submitting the application.

12VAC5-481 'Virginia Radiation Protection Regulations' requires the applicant and/or licensee to develop, document, and implement procedures that will ensure compliance with the rule. The appendices describe radiation protection procedures. Each applicant should read the rule and procedures carefully and then decide if the procedure addresses specific radiation protection program needs at the applicant's facility. Applicants may adopt a procedure included in this VAREG or they may develop their own procedures to comply with the applicable rule.

In this guide, "dose" or "radiation dose" means absorbed dose, dose equivalent, effective dose equivalent, committed dose equivalent, committed effective dose equivalent, or total effective dose equivalent (TEDE). These terms are defined in the **12VAC5-481-10.** Rem and Sievert (Sv), its SI equivalent (1 rem = 0.01 Sv), are used to describe units of radiation exposure or dose. These units are used because **12VAC5-481 'Virginia Radiation Protection Regulations', Part IV, 'Standards for Protection Against Radiation',** sets dose limits in terms of rem, not rad or roentgen. Furthermore, radioactive materials commonly used in medicine emit beta and photon radiation, for which the quality factor is 1; a useful rule of thumb is an exposure of 1 roentgen is equivalent to an absorbed dose of 1 rad and dose equivalent of 1 rem.

This VAREG provides the latest guidance, shows the requirements in terms of the **12VAC5-481 'Virginia Radiation Protection Regulations',** and provides a user-friendly format to assist with the preparation of a license application.

LICENSES

Applicants should study this document, related guidance, and all applicable regulations carefully before completing the VDH Form, '***Application for Radioactive Material License Authorizing the Use of XRF Devices***' (**Appendix A**). VDH expects licensees to provide requested information on specific aspects of their proposed radiation protection program in attachments to the application. When necessary, VDH may ask the applicant for additional information to gain reasonable assurance that an adequate radiation protection program has been established.

After a license is issued, the licensee must conduct its program in accordance with the following:

- Statements, representations, and procedures contained in the application and in correspondence with VDH;
- Terms and conditions of the license; and
- **12VAC5-481 'Virginia Radiation Protection Regulations'**.

THE 'AS LOW AS IS REASONABLY ACHIEVABLE (ALARA)' CONCEPT

12VAC5-481-630, Radiation protection programs, states that *"each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities"* and *"the licensee shall use, to the extent practical, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are...ALARA."* This section also requires that licensees review the content of the radiation protection program and its implementation annually.

Applicants should consider the ALARA philosophy detailed in these reports when developing plans to work with licensed radioactive materials.

WHO REGULATES FACILITIES IN THE COMMONWEALTH OF VIRGINIA

In the special situation of work at federally controlled sites in the Commonwealth of Virginia, it is necessary to know the jurisdictional status of the land to determine whether the Nuclear Regulatory Commission (NRC) or VDH has regulatory authority. The NRC has regulatory authority over land determined to be under "exclusive federal jurisdiction," while VDH has jurisdiction over non-exclusive federal jurisdiction land (see **Table 1**). Applicants and licensees are responsible for finding out, in advance, the jurisdictional status of the specific areas where they plan to conduct licensed operations. VDH recommends that applicants and licensees ask their local contacts for the federal agency controlling the site (e.g., contract officer, base environmental health officer, district office staff) to help determine the jurisdictional status of the land and to provide the information in writing, so that licensees can comply with VDH or NRC regulatory requirements, as appropriate. The following table lists examples of regulatory authority.

Table 1: Who Regulates the Activity?

Applicant and Proposed Location of Work	Regulatory Agency
Federal agency regardless of location (except that Department of Energy [DOE] and, under most circumstances, its prime contractors are exempt from licensing [**10 CFR 30.12**])	NRC
Non-federal entity in non-Agreement State, U.S. territory, or possession	NRC
Non-federal entity in Virginia at non-federally controlled site	VDH
Non-federal entity in Virginia at federally-controlled site not subject to exclusive federal jurisdiction	VDH
Non-federal entity in Virginia at federally-controlled site subject to exclusive federal jurisdiction	NRC

A current list of Agreement States (states that have entered into agreements with the NRC that give them the authority to license and inspect radioactive material used or possessed within their borders), including names, addresses, and telephone numbers of responsible officials are maintained by the NRC Office of Federal and State Materials and Environmental Management Programs and is available on their website: http://nrc-stp.ornl.gov/.

MANAGEMENT RESPONSIBILITY

VDH endorses the philosophy that effective radiation protection program management is vital to safe operations that comply with VDH regulatory requirements.

"Management" refers to the chief executive officer or other individual having the authority to manage, direct, or administer the licensee's activities or that person's delegate or delegates.

To ensure adequate management involvement, a management representative (i.e., chief executive officer or delegate) must sign the submitted application acknowledging management's commitments to and responsibility for all the following:

- **Radiation protection, security and control of radioactive materials, and compliance with rule;**
- **Knowledge about the contents of the license application;**
- **Compliance with current VDH and United States Department of Transportation (DOT) regulations and the licensee's operating and emergency procedures;**
- **Provision of adequate resources (including space, equipment, personnel, time and, if needed, contractors) to the radiation protection program to ensure that public, and workers are protected from radiation hazards;**
- **Appointment of a qualified individual who has agreed in writing to work as the RSO.**

Management may delegate individuals (i.e., an RSO or other designated individual) to submit amendment requests to VDH. A correspondence delegation letter must be completed, signed by management and submitted to VDH. A sample letter has been included in **Appendix L**.

SAFETY CULTURE

Nuclear safety culture is defined as the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment. Individuals and organizations performing regulated activities bear the primary responsibility for safely handling and securing these materials. Experience has shown that certain personal and organizational traits are present in a positive safety culture. A trait, in this case, is a pattern of thinking, feeling, and behaving that emphasizes safety, particularly in goal conflict situations (e.g., production versus safety, schedule versus safety, and cost of the effort versus safety). **Table 2** show traits of a positive nuclear safety culture.

Table 2: Traits of a Positive Nuclear Safety Culture

Trait	Result
Leadership: Safety Values and Actions	Leaders demonstrate a commitment to safety in their decisions and behaviors
Problem Identification and Resolution	Issues potentially impacting safety are promptly identified, fully evaluated, and promptly addressed and corrected commensurate with their significance
Personal Accountability	All individuals take personal responsibility for safety
Evaluating Work Processes	The process of planning and controlling work activities is implemented so that safety is maintained
Continuous Learning	Opportunities to learn about ways to ensure safety are sought out and implemented
Environment for Raising Concerns	A safety conscious work environment is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination
Effective Safety Communications	Communications maintain a focus on safety
Respectful Work Environment	Trust and respect permeate the organization
Questioning Attitude	Individuals avoid complacency and continually challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action

Individuals and organizations performing regulated activities are expected to establish and maintain a positive safety culture commensurate with the safety and security significance of their activities and the nature and complexity of their organizations and functions. This applies to all licensees, holders of quality assurance programs approvals, vendors, and suppliers of safety-related components, and applicants for a license or quality assurance program approval, subject to VDH authority. More information relating to safety culture can be found at: http://www.nrc./about-nrc/regulatory/enforcement/safety-culture.html

APPLICABLE RULE

It is the applicant's or licensee's responsibility to obtain, read, and follow 12VAC5-481 'Virginia Radiation Protection Regulations'**.**

The following Parts of 12VAC5-481 'Virginia Radiation Protection Regulations' **contain requirements applicable to Devices or XRFs licensees:**

- Part I, 'General Provisions'
- Part III, 'Licensing of Radioactive Materials'
- Part IV, 'Standards for Protection Against Radiation'
- Part X, 'Notices, Instructions and Reports to Workers; Inspections
- Part XIII, 'Transportation of Radioactive Material'

An electronic copy can be found on our web site at:
http://www.vdh.virginia.gov/Epidemiology/RadiologicalHealth/.

HOW TO FILE

Applicants for a materials license should do the following:

- Be sure to use the most current guidance from VDH in preparing an application.
- Complete VDH Form, 'Application for Radioactive Material License Authorizing the Use of XRF Devices' (Appendix A).
- For each separate sheet, other than submitted with the application, identify and key it to the item number on the application, or the topic to which it refers.
- Submit all documents on 8 ½ x 11 – inch paper.
- Avoid submitting proprietary information unless it is absolutely necessary. If submitted, proprietary information and other sensitive information should be clearly identified and a request made to withhold from public disclosure.
- Submit an original, signed application. This submission can be made using scanned copies forwarded via facsimile or electronic mail or via postal mail of the documents.
- Retain one copy of the license application for your future reference.

Deviations from the suggested wording of responses as shown in this VAREG or submission of alternative procedures will require a more detailed review.

Note: Personal employee information (i.e., home address, home telephone number, Social Security Number, date of birth, and radiation dose information) should not be submitted unless specifically requested by VDH.

WHERE TO FILE

Applicants wishing to possess or use radioactive material in the Commonwealth of Virginia are subject to the requirements of 12VAC5-481 'Virginia Radiation Protection Regulations' **and must file a license application with:**

Virginia Department of Health
Radioactive Materials Program
109 Governor Street, Room 730
Richmond, VA 23219

LICENSE FEES

The appropriate fee must accompany each application or license amendment request. Refer to 12VAC5-490 to determine the amount of the fee. VDH will not issue the new license prior to fee receipt. Once technical review has begun, no fees will be refunded. Application fees will be charged regardless of the VDH's disposition of an application or the withdrawal of an application.
Licensees are also subject to annual fees; refer to 12VAC5-490.

Direct all questions about the VDH's fees or completion of Item 10 **of VDH Form, '***Application for Radioactive Material License Authorizing the Use of XRF Devices'* **(**Appendix A**) to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, Virginia 23219 or (804) 864-8150.**

CONTENTS OF AN APPLICATION

Item 1: Type of Application

Obtain the correct application form for either a new license or a renewal, check the appropriate box and, if appropriate, list the license number for a renewal.

This guide is written to instruct a new licensee in the process of applying for a radioactive material license. Not all discussions will be appropriate to a licensee renewing an existing license.

Item 2: Applicant's Name and Mailing Address

List the legal name of the applicant's corporation or other legal entity with direct control over use of the radioactive material; a division or department within a legal entity may not be a licensee. An individual may be designated as the applicant only if the individual is acting in a private capacity and the use of the radioactive material is not connected with employment in a corporation or other legal entity. Provide the mailing address where correspondence should be sent.

Notify the agency of changes in mailing address.

The licensee must also provide sufficient information for the agency to ensure the proposed corporation or controlling legal entity is a valid entity. Verification of this identity can be accomplished by submitting a copy of the company's license from the NRC or another Agreement State or a government contract or certification, etc.

Note: The agency ***must be notified immediately in the event of change of ownership or control and bankruptcy proceedings; see below for more details.***

Timely Notification of Change of Ownership or Control

Rule: 12VAC5-481-330, 12VAC5-481-450, 12VAC5-481-500

Criteria: *Licensees must provide full information and obtain* the agency's *written consent prior to transferring ownership or control of the license, or, as some licensees call it, 'transferring the license'.*

Discussion: *Transfer of control may be the results of mergers, buyouts, or majority stock transfers. Although it is not VDH's intent to interfere with the business decisions of licensees, it is necessary for licensees to obtain prior VDH written consent.*

This is to ensure the following:

- *Radioactive materials are possessed, used, or controlled only by persons who have valid licenses issued by VDH;*
- *Materials are properly handled and secured;*
- *Persons using these materials are competent and committed to implementing appropriate radiological controls;*
- *A clear chain of custody is established to identify who is responsible for final disposal of the possessed material; and*
- *Public health and safety are not compromised by the use of such materials.*

Appendix C *identifies the information to be provided about changes of ownership or control.*

Notification of Bankruptcy Proceedings

Rule: 12VAC5-481-500

Criteria: 12VAC5-481-500 states: "*Each licensee shall notify the agency in writing immediately following the filing of a voluntary or involuntary petition for bankruptcy under any Chapter of Title 11 (Bankruptcy) of the United States Code by or against: 1. The licensee 2. An entity (as that term is defined in 11 USC §101 (15)) controlling the licensee or listing the license or licensee as property of the estate; or 3. An affiliate (as that term is defined in 11 USC §101 (2)) of the licensee*" and "*...shall indicate the bankruptcy court in which the petition for bankruptcy was filed and the date of filing of the petition*".

Discussion: Even though a licensee may have filed for bankruptcy, the licensee remains responsible for compliance with all regulatory requirements. VDH needs to know when licensees are in bankruptcy proceedings in order to determine whether all licensed material is accounted for and adequately controlled and whether there are any public health and safety concerns (e.g., contaminated facility). VDH shares the results of its determinations with other entities involved (e.g., trustees) so that health and safety issues can be resolved before bankruptcy actions are completed.

Licensee must notify VDH in writing immediately of the filing of a bankruptcy petition.

Item 3: Contact Person

Criteria: Identify the individual who can answer questions about the application and include his or her telephone number. Also include business cell phone numbers and e-mail addresses.

Discussion: This is typically the proposed radiation safety officer, unless the applicant has named a different person as the contact. The agency will contact this individual if there are questions about the application.

Notify the agency if the contact person or his or her telephone number changes so that the agency can contact the applicant or licensee in the future with questions, concerns, or information. This notice is 'for information only' and does not require a license amendment.

Item 4: Address(es) Where Licensed Material Will Be Used or Possessed

Rule: **12VAC5-481-450, 12VAC5-481-500**

Criteria: Most applicants need to provide two types of information in response to **Item 4**:

- Description of storage, use, and dispatch locations
- Specification of whether they intend to use the XRF at temporary job sites

Discussion: Specify the street address, city, and state or other descriptive address (such as on Highway 58, 5 miles east of the intersection of Highway 58 and State Route 19, Anytown, VA, Zip) for each permanent facility used as a location of storage or use, and each facility from which the applicant will dispatch XRF users to job sites for more than one customer. If XRFs will NOT be stored at a dispatch site, so indicate. The descriptive address should be sufficient to allow a VDH inspector to find the storage location. **A Post Office Box address is not acceptable.**

Being granted a VDH ***license does not relieve a licensee from complying with other applicable federal, state, or local regulations (e.g., local zoning requirements for storage locations).***

To conduct operations at temporary jobsites (i.e., locations where work is conducted for limited periods of time and from which XRF users are NOT dispatched to jobsites for other customers), specify "*temporary job sites anywhere in Virginia where VDH maintains jurisdiction*". The agency prohibits long-term or routine storage in vehicles or personal residences not listed on the license.

Note: As discussed later under 'Financial Assurance and Record Keeping for Decommissioning', licensees need to maintain permanent records on where licensed material was used or stored while the license was in force. This is important for making future determinations about the release of these locations for unrestricted use (e.g., before the license is terminated). For licensees, acceptable records are sketches or written descriptions of storage or use locations specifically listed on the license. Licensees do not need to maintain this information for temporary job sites or temporary storage locations where sources have never leaked.

Item 5: Radiation Safety Officer (RSO)

Rule: 12VAC5-481-450, 12VAC5-481-630

Criteria: *Radiation Safety Officers (RSOs) must have adequate training and experience. The agency will accept successful completion of one of the following as evidence of adequate training and experience:*

- *Device Manufacturer's course for users or for RSOs*
- *Equivalent course that meets Appendix D criteria*

Discussion: *The person responsible for the radiation protection program is called the* RSO. *The* RSO *needs independent authority to stop operations that he or she considers unsafe. He or she must have sufficient time and commitment from management to fulfill certain duties and responsibilities to ensure that radioactive materials are used in a safe manner. Typical* RSO *duties are described in* Appendix E. The agency *requires the name of the* RSO *on the license to ensure that licensee management has identified a responsible, qualified person and that the named individual knows of his or her designation as RSO.*

Note:

- *It is important to notify the agency, as soon as possible, of changes in the designation of the* RSO. *A correspondence delegation letter must be completed, signed by management and submitted to VDH. A sample letter has been included in Appendix L.*
- *Alternative responses will be reviewed against the criteria listed above.*

Item 6: Training for Individuals Working in or Frequenting Restricted Areas

Rule: 12VAC5-481-450, 12VAC5-481-630, 12VAC5-481-840, 12VAC5-481-2260, 12VAC5-481-2270, 12VAC5-481-2280, 12VAC5-481-2310

Criteria: *Authorized users (AUs) must have adequate training and experience. The agency finds that successful completion of one of the following as evidence of adequate training and experience:*

- *Device manufacturer's course for users*
- *Equivalent course that meets* Appendix D *criteria*

Discussion: *The individuals using XRFs are usually referred to as authorized users. Authorized users have the responsibility to ensure the surveillance, proper use, security, and routine maintenance of XRFs containing licensed material.*

Annual radiation safety training must be provided to individuals working in or frequenting restricted areas who receive or are likely to receive 100 mrem per year (**12VAC5-481-2270**).

Note:

- *Records of training shall be maintained.*
- *Alternative responses will be evaluated against the criteria listed above.*

Item 7: Radioactive Material

Item 7.1: Sealed Sources and Devices

Rule: 12VAC5-481-440, 12VAC5-481-450, 12VAC5-481-500

Criteria: *Licensees will only be authorized for the requested maximum limit of sealed sources and devices registered by the NRC or another Agreement State.*

Discussion: *A maximum possession limit, per isotope, is required to be requested; this should reflect the total number of sealed sources and devices containing a particular isotope (i.e., Cobalt-57) that would ever be possessed at any one time, including inactive sources being held for storage and devices awaiting shipment. This should also include sources and devices expected to be purchased at in the future. This limit is isotope specific (i.e., one limit for Cobalt-57 and another for Cadmium-109) and not allowed to be exceeded; that is, the total of all sources and devices in the licensee's possession cannot exceed this limit. An amendment request must be made and an amended license received prior to obtaining more sources and devices.*

Possession limits can be obtained from information provided by the manufacturer; specifically, the activity provided by the manufacturer on the sources and devices the licensee anticipates acquiring. This information will list each isotope with the activity for the source and device. A simple calculation can be performed with this information by totaling the number of each source and device, per isotope, that the licensee expects to possess at any one time. For example; a licensee anticipates possessing three devices, two Cobalt-57 devices and 1 Cadmium-109 device. The manufacturer states that each gauge has a maximum quality of 12 mCi of Cobalt-57 or 80 mCi of Cadmium-109. The licensee is able to perform the simple calculation (12 multiplied by 2 and 80 multiplied by 1) to request a 24 mCi maximum possession limit for Cobalt-57 and a 80 mCi maximum possession limit of Cadmium-109.

Licensees are also required to maintain a limit per device. This is separate from the maximum possession limit; this limit is applied to each source and device itself and is typically determined by the manufacturer's Sealed ***Source and Device Registration Certificate.***

NRC *or other Agreement States performs a safety evaluation of XRFs before authorizing a manufacturer to distribute the XRFs to licensees. The safety evaluation is documented in a Sealed Source and Device Registration (SSDR) Certificate, also called an* SSD*R Sheet. When issuing an XRF license,* VDH *usually provides a generic authorization to allow the licensee to possess and use any sealed source/device combination that has been registered by the* NRC *or another Agreement State. This method of authorization allows licensees flexibility in obtaining new source/device combinations without having to amend their licenses.*

Consult with the proposed supplier to ensure that sources and devices conform to the SSDR Certificates registered with NR*C or another Agreement State. Licensees may not make any changes to the sealed source, device, or source/device combination that would alter the description or specifications from those indicated in the respective registration certificates, without obtaining* VDH's *prior permission in a license amendment.*

SSDR Certificates contain sections on "*Conditions of Normal Use*" and "*Limitation and Other Considerations of Use*". These sections may include limitations derived from conditions imposed by the manufacturer or distributor, by particular conditions of use that would reduce radiation safety of the device, or by circumstances unique to the sealed source or device. For example, working life of the device or appropriate temperature and other environmental conditions are specified. Except as specifically approved by VDH, licensees are required to use gauges according to their respective SSDR Certificates. Applicants should obtain a copy of the certificate and review it with the manufacturer, distributor or with the agency, to ensure that they understand and comply with the requirements of the SSDR.

Note*:* If necessary and manufacturer cannot supply the certificate, SSDR certificates are also available by calling the agency at (804) 864-8150.

Item 7.2: Purpose(s) for Which Licensed Material Will Be Used

Rule: 12VAC5-481-440, 12VAC5-481-450, 12VAC5-481-500

Criteria: *Proposed activity is authorized by 12VAC5-481 'Virginia Radiation Protection Regulations' and devices will be used only for the purposes for which they were designed and according to the manufacturer's recommendations for use as specified in an approved* SSD*R* Certificate, and as authorized on a VDH license.

Discussion*: Specifically describe how each device will be used. The typical XRF license authorizes use "to perform lead in paint inspections." If the device(s) will be used for the purposes listed on the SSD registration certificate, or as recommended by the manufacturer, state this on the application. If the device(s) will be used for purposes other than those listed on the SSD registration certificate or manufacturer's instructions, specify these other purposes and include a safety analysis supporting the request.*

Note:

- A VDH license does not relieve a licensee from complying with other applicable federal, state, or local regulations.
- ***Unusual uses will be evaluated on a case-by-case basis and the authorized use condition will reflect approved uses.***

Item 7.3: Financial Assurance and Recordkeeping for Decommissioning

Rule: 12VAC5-481-100, 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-510, 12VAC5-481-570, 12VAC5-481-571, 12VAC5-481-1161

Criteria: *A licensee authorized to possess licensed material in excess of the limits specified in 12VAC5-481-450 C must meet the requirements for decommissioning financial assurance.*

All licensees are required to maintain, in an identified location, records of information important to decommissioning of the facility until the site, or any area, is released for unrestricted use. Licensees must transfer records important to decommissioning either to the new licensee before licensed activities are transferred or assigned in accordance with **12VAC5-481-500** *or to VDH before the license is terminated.*

Discussion: *VDH wants to ensure that decommissioning will be carried out with minimum impact on public and occupational health and safety and the environment. There are two parts to the rule: financial assurance that applies to SOME licensees, and recordkeeping that applies to ALL licensees.*

The requirements for financial assurance are specific to the types and quantities of radioactive material authorized on a license. Most XRF applicants and licensees do not need to comply with the financial assurance requirements. Thus, a licensee would need to possess hundreds of devices before the financial assurance requirements would apply. Applicants and licensees desiring to possess devices exceeding the threshold amounts must submit evidence of financial assurance.

The same regulation also requires that licensees maintain records important to decommissioning in an identified location. All licensees need to maintain records of structures and equipment where devices are used or stored at locations specifically listed on the license. As-built drawings with modifications of structures and equipment shown as appropriate fulfill this requirement. If drawings are not available, licensees may substitute

appropriate records concerning the areas and locations. In addition, if licensees have experienced unusual occurrences (e.g., leaking sources, other incidents that involve spread of contamination), they also need to maintain records about contamination that remains after cleanup or that may have spread to inaccessible areas.

For licensees whose sources have never leaked, acceptable records important to decommissioning are sketches or written descriptions of device(s) storage or use locations specifically listed on the license. Similar information need not be maintained for temporary job sites.

Reference: NRC Regulatory Guide 3.66, "*Standard Format and Content of Financial Assurance Mechanisms Required for Decommissioning Under 10 CFR Parts 30, 40, 70 and 72*", is available from the NRC upon request.

Item 8: Facilities and Equipment

Rule: 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-630, 12VAC5-481-640, 12VAC5-481-720, 12VAC5-481-730, 12VAC5-481-840, 12VAC5-481-850, 12VAC5-481-860

Criteria: Facilities and equipment must be adequate to protect health and to minimize danger to life or property.

Discussion: 12VAC5-481-450 A states that an application will be approved if, among other things, the applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to the public's health and safety. **12VAC5-481-840** states that sources of radiation shall be secured against unauthorized removal from the place of storage and, when in an unrestricted area and not in storage, shall be under the constant surveillance and immediate control of the licensee or registrant.

The key elements for XRF applicants are ensuring compliance with public dose limits and maintaining adequate security and control over the XRFs. These issues are covered under 'Public Dose' and 'Operating and Emergency Procedures'.

Provide the following on the facility diagrams:

- Drawings should be to scale, and indicate the scale used;
- Location, room numbers, and principal use of each room or area where radioactive material is used or stored;
- Location, room numbers, and principal use of each adjacent room (e.g., office, file, toilet, closet, hallway), including areas above, beside, and below; and,
- If multiple locations of storage, indicate address on diagram.

Item 9: Radiation Safety Program

Item 9.1: Audit Program

Rule: 12VAC5-481-450, 12VAC5-481-490, 12VAC5-481-500, 12VAC5-481-630, 12VAC5-481-990

Criteria: Licensees must review the content and implementation of their radiation protection programs annually to ensure the following:

- Compliance with the VDH and DOT *regulations, and the terms and conditions of the license;*
- *Occupational doses and doses to members of the public are as low as reasonably achievable (*ALARA*) (*12VAC5-481-630)*; and*
- *Records of audits and other reviews of program content are maintained for 3 years.*

Discussion: *Appendix F contains a suggested audit program that is specific to the use of XRFs and is acceptable to the agency. All areas indicated in* Appendix F *may not be applicable to every licensee and may not need to be addressed during each audit.*

Currently the agency's emphasis in inspections is to perform actual observations of work in progress. As a part of their audit programs, applicants should consider performing unannounced audits of gauge users in the field to determine if, for example, operating and emergency procedures are available, are being followed, etc.

It is essential that once identified, problems be corrected comprehensively and in a timely manner. The agency will review the licensee's audit results and determine if corrective actions are thorough, timely, and sufficient to prevent recurrence. If violations are identified by the licensee and these steps are taken, the agency can exercise discretion and may elect not to cite a violation. The agency's goal is to encourage prompt identification and prompt, comprehensive correction of violations and deficiencies.

With regard to audit records, **12VAC5-481-990** *requires licensees to maintain records of audits and other reviews of program content and implementation. The agency has found audit records that contain the following information to be acceptable: date of audit, name of person(s) who conducted audit, persons contacted by the auditor(s), areas audited, audit findings, corrective actions, and follow-up.*

Item 9.2: Termination of Activities

Rule: 12VAC5-481-100, 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-510, 12VAC5-481-570, 12VAC5-481-571, 12VAC5-481-1161

Criteria:

- Notify the agency, in writing, within 60 days of:
  - The expiration of its license;
  - A decision to permanently cease licensed activity at the entire site or in any separate building or outdoor area if it contains residual radioactivity making it unsuitable for release according to VDH requirements;
  - No principal activities have been conducted at the entire site under the license for a period of 24 months; or
  - No principal activities have been conducted for a period of 24 months in any separate building or outdoor area if it contains residual radioactivity making it unsuitable for release according to VDH requirements.
- Submit a decommissioning plan, if required by **12VAC5-481-510;**
- Decommissioning, as required by **12VAC5-481-510 & 12VAC5-481-1161;**
- Submit to the agency, a completed VDH form 'Certificate of Disposition of Materials' (**Appendix M**) and demonstrate that the premises are suitable for release for unrestricted use (e.g. results of final survey); and

- Before a license is terminated, send the records important to decommissioning to the agency as required by **12VAC5-481-571**. If licensed activities are transferred or assigned in accordance with **12VAC5-481-500**, transfer records important to decommissioning to the new licensee.

Discussion: *For guidance on the disposition of licensed material, see the section on 'Waste Management – XRF Disposal or Transfer'. For guidance on decommissioning records, see the section under 'Radioactive Materials' on 'Financial Assurance and Record keeping for Decommissioning'.*

Licensees must use the VDH Form, 'Certificate of Disposition of Materials' (Appendix M) when submitting for termination of a license.

Item 9.3: Instruments

Rule: 12VAC5-481-450, 12VAC5-481-490, 12VAC5-481-630, 12VAC5-481-640, 12VAC5-481-720, 12VAC5-481-750, 12VAC5-481-1000

Criteria: *A radiation survey meter should:*

- *Be capable of detecting gamma radiation*
- *Be calibrated on an interval not to exceed 12 months and after each instrument servicing.*
- *Be checked for functionality before use (e.g., with the gauge or a check source)*

Discussion: *Licensees are required by* **12VAC5-481-450 A** *to have equipment, facilities, and procedures which are adequate to minimize danger to public health and safety. XRF licensees are not required to have a radiation survey instrument for use.*

Note*: Prior to non-routine maintenance that requires removing the source or source rod from the gauge a calibrated and operable radiation survey instrument will be required.*

Item 9.4: Material Receipt and Accountability

Rule: 12VAC5-481-100, 12VAC5-481-450, 12VAC5-481-490, 12VAC5-481-500, 12VAC5-481-570, 12VAC5-481-571, 12VAC5-481-630, 12VAC5-481-840, 12VAC5-481-900, 12VAC5-481-980, 12VAC5-481-1090, 12VAC5-481-3091, 12VAC5-481-3100

Criteria: *Licensees must do the following:*

- *Develop procedures for ordering and safely opening packages of licensed material;*
- *Maintain records of receipt, transfer, and disposal of XRFs and*
- *Conduct physical inventories at intervals not to exceed 6 months (or some other interval justified by the applicant) to account for all sealed sources.*

Discussion: *Licensed materials must be tracked from 'cradle to grave' in order to ensure gauge accountability, identify when XRFs could be lost, stolen, or misplaced, and ensure that, if the licensee possesses gauges exceeding threshold amounts, the licensee complies with financial assurance requirements in* **12VAC5-481-450 C**.

‘Cradle to Grave’ accountability refers to maintaining the radioactive material from the moment it becomes a part of your organization (receipt of, creation, etc) through performing the physical inventories (ensuring the material’s location, etc) until it leaves your organization (through transfer, return to manufacturer/distributor, or disposal to properly licensed facility).

Maintain inventory records that contain the following types of information:

- Radionuclide and amount (in units of Bq or curies) of radioactive material in each sealed source;
- Manufacturer's name, model number, and serial number of each sealed source;
- Manufacturer's name, model number, and serial number of each device containing depleted uranium or radioactive material;
- Location of each sealed source and device;
- Date of the inventory; and
- Name of individual performing inventory; and
- For materials transferred or disposed of, the date of the transfer or disposal, name and license number of the recipient, description of the affected radioactive material (e.g., radionuclide, activity, manufacturer’s (or distributor’s) name and model number, serial number).

Maintain a log book that contains the following types of information:

- Date(s) of use;
- Name(s) of the authorized users who will be responsible for the gauge;
- Temporary jobsite(s) where the gauge will be used.
- Log the XRF into the daily use log when it is returned to storage.

Item 9.5: Occupational Dosimetry

Rule: 12VAC5-481-630, 12VAC5-481-640, 12VAC5-481-700, 12VAC5-481-710, 12VAC5-481-750, 12VAC5-481-760, 12VAC5-481-770, 12VAC5-481-1040, 12VAC5-481-1130, 12VAC5-481-1140, 12VAC5-481-2280

Criteria: *Applicants must do either of the following:*

- *Provide dosimetry processed and evaluated by a National Voluntary Laboratory Accreditation Program (NVLAP) approved processor that is exchanged at a frequency recommended by the processor.*

OR

- *Maintain, for inspection by the agency, documentation demonstrating that unmonitored individuals are not likely to receive, in one year, a radiation dose in excess of 10 percent of the allowable limits as shown in Table 3.*

Discussion: *Under conditions of routine use, a personnel monitoring device (dosimetry) is not required. However a written evaluation demonstrating that users are not likely to exceed 10 percent of the applicable limits as shown in Table 3 is required. Appendix I Part 1 provides guidance on preparing this written evaluation.*

Licensees should reevaluate need for dosimetry upon significant program changes.

Licensees providing dosimetry should use either film badges or optically stimulated luminescent (OSLs) that are supplied by an NVLAP-approved processor. The exchange frequency for film badges is usually monthly due to technical concerns about film fading. Applicants should verify that the processor is NVLAP-approved. Consult the NVLAP-approved processor for its recommendations for exchange frequency and proper use.

Licensees requesting authorization for non-routine maintenance must provide users dosimetry.

Table 3: Occupational Dose Limits For Adults

Occupational Dose Limits for Adults (12VAC5-481-640)	
BODY LOCATION	Dose (Annual)
Total Effective Dose Equivalent (TEDE)	0.05 Sv (5 Rem)
Dose to the skin of the whole body or any extremity*	0.5 Sv (50 Rem)
Dose to lens of the eyes	0.15 Sv (15 Rem)
*Extremities includes the arms below the elbows and the legs below the knees	

Reference: *National Institute of Standards and Technology (NIST) Publication 810, "*National Voluntary Laboratory Accreditation Program Directory*", is published annually and is available for purchase from* United States Government Printing Office *and on the Internet at the following address: http://ts.nist.gov/ts/htdocs/210/214/dosim.htm*.

Item 9.6: Public Dose

Rule: 12VAC5-481-630, 12VAC5-481-720, 12VAC5-481-730, 12VAC5-481-840, 12VAC5-481-1050, 12VAC5-481-1100, 12VAC5-481-1110, 12VAC5-481-3070

Criteria: *Licensees must do the following:*

- *Ensure that licensed gauges will be used, transported, and stored in such a way that members of the public will not receive more than 1 millisievert (100 millirem) in one year, and the dose in any unrestricted area will not exceed 0.02 millisievert (2 millirem) in any one hour, from licensed operations.*
- *Control and maintain constant surveillance over gauges that are not in storage and secure stored gauges from unauthorized removal or use. Gauges should be stored away from occupied areas.*

Discussion: *Members of the public include persons who live, work, or may be near locations where s or XRFs are used or stored and employees whose assigned duties do not include the use of licensed materials and who work in the vicinity where XRFs are used or stored.*

*Operating, emergency, and security procedures for security and surveillance specified in **Item 9.7** should be sufficient to limit the exposure to the public during use or storage and after accidents. Public dose is controlled, in part, by ensuring that gauges not in use are stored securely (in a locked area) to prevent unauthorized access or use. If the gauges are not in storage, then authorized users must maintain constant surveillance to ensure that members of the public, who could be coworkers, do not get near the gauges or use them and thus receive unnecessary radiation exposure.*

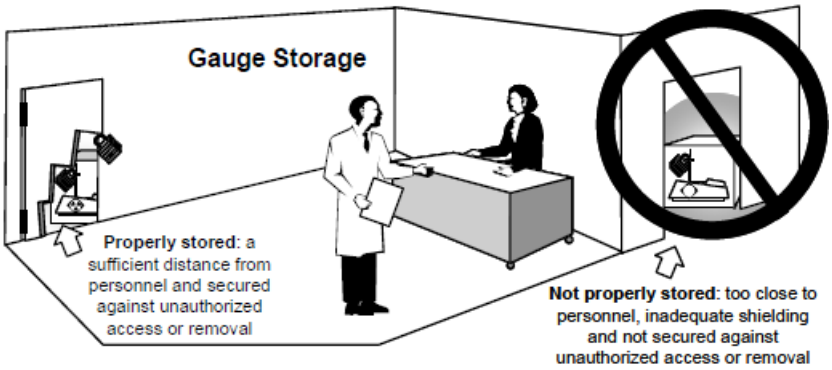


Figure 1: Gauge Storage

*Public dose is also affected by the choice of storage location and conditions (see **Figure 1**). Since a XRF presents a radiation field during storage, it must be stored so that the radiation level in an unrestricted area (e.g., an office or the exterior surface of an outside wall) does not exceed 1 mSv (100 mrem) in a year or 0.02 mSv (2 mrem) in any one hour. Use the concepts of time, distance, and shielding when choosing a permanent or temporary storage location. Decreasing the time spent near a XRF, increasing the distance from the XRF, and using shielding (i.e., brick, concrete, lead, or other solid walls) will reduce the radiation exposure. As a rule of thumb, XRFs should be stored as far away as possible from areas that are occupied by members of the public.*

*Information provided by the manufacturer or vendor on anticipated radiation levels of sealed sources and tracer materials, both inside their respective transport containers and outside the transport container at given distances, is the type of information needed to make public dose calculations. Licensees can determine the radiation levels adjacent to the storage location either by calculations or a combination of direct measurements and calculations using some or all of the following: typical known radiation levels provided by the manufacturer, the 'inverse square' law to evaluate the effect of distance on radiation levels, and occupancy factors to account for the actual presence of the member of the public and of the XRF(s). See **Part 2** of **Appendix I** for examples.*

If, after making an initial evaluation, a licensee makes changes affecting the storage area (e.g., changing the location of XRFs within the storage area, removing shielding, adding XRFs, changing the occupancy of adjacent areas, moving the storage area to a new location), then the licensee must ensure that the XRFs are properly secured, perform a new evaluation to ensure that the public dose limits are not exceeded, and take corrective action, as needed.

Item 9.7: Operating and Emergency Procedures

Rule: 12VAC5-481-450, 12VAC5-481-490, 12VAC5-481-630, 12VAC5-481-750, 12VAC5-481-840, 12VAC5-481-860, 12VAC5-481-880, 12VAC5-481-900, 12VAC5-481-1090, 12VAC5-481-1100, 12VAC5-481-1110, 12VAC5-481-1150, 12VAC5-481-2260, 12VAC5-481-3091

Criteria: Each applicant must develop, implement, and maintain operating and emergency procedures containing the following elements:

- Instructions for using the XRF and performing routine maintenance, according to the manufacturer's recommendations and instructions;
- Instructions for maintaining security during storage and transportation;
- Instructions to keep the XRF under control and immediate surveillance during use;
- Steps to take to keep radiation exposures ALARA*;*
- *Steps to maintain accountability during use;*
- *Steps to control access to a damaged XRF; and*
- *Steps to take, and whom to contact, when a XRF has been damaged.*

Provide copies of operating and emergency procedures to all XRF users and at each job site.

Discussion: *Lost or stolen XRFs and damaged XRFs during use at job sites are the most common occurrences that present a potentially significant radiation safety risk. Operating and emergency procedures shall be developed to minimize these risks. The agency considers security of XRFs extremely important and lack of security is a significant violation.*

To avoid lost or stolen XRFs, licensees must keep the gauges under constant surveillance (when in use or idle) or secured against unauthorized use or removal through leaving in secured position in a locked area (i.e.; trailer, shed, etc). Notify VDH when XRFs are lost, stolen, or certain other conditions are met.

See ***Appendix H*** *for sample operating and emergency procedures.*

Note: Telephone notifications shall be made to the agency at (804) 864-8150 during normal business hours (8 a.m. – 4:30 p.m.) For immediate notifications after normal business hours, the 24 hour emergency telephone number is (804) 674-2400 or (800) 468-8892. Identify the emergency as radiological.

Item 9.8: Leak Tests

Rule: 12VAC5-481-180, 12VAC5-481-740, 12VAC5-481-1010, 12VAC5-481-1150

Criteria*: VDH requires testing to determine whether there is any radioactive leakage from the source in the device. The agency finds testing to be acceptable if it is conducted by an organization approved by VDH, the NRC or another Agreement State or according to procedures approved by VDH. Licensees must maintain records of test results.*

Discussion: *12VAC5-481-740 requires performance of leak tests at intervals approved by the* NRC *or another Agreement State and specified in the* SSDR *Sheet. The measurement of the leak test sample is a quantitative analysis requiring that instrumentation used to analyze the sample must be capable of detecting 185 becquerels (0.005 microcurie) of radioactivity. Appendix J discusses leak testing and contains samples of performing leak tests.*

Manufacturers, consultants, and other organizations may be authorized by VDH, the NRC or another Agreement State to either perform the entire leak test sequence for other licensees or provide leak test kits to licensees. In the latter case, the licensee is expected to take the leak test sample according to the XRF manufacturer's and the kit supplier's instructions and return it to the kit supplier for evaluation and reporting

results. Licensees may also be authorized to conduct the entire leak test sequence themselves.

Note*: Requests for authorization to perform leak testing and sample analysis will be reviewed on a case-by-case basis and, if approved,* VDH *will authorize via a license condition.*

Item 9.9: Maintenance

Rule: 12VAC5-481-450, 12VAC5-481-490 B, 12VAC5-481-500, 12VAC5-481-630, 12VAC5-481-640, 12VAC5-481-980

Criteria: *Licensees must routinely clean and maintain XRFs according to the manufacturer's recommendations and instructions.*

Non-routine maintenance or repair (beyond routine cleaning and lubrication) that involves detaching the source from the device and any other activities during which personnel could receive radiation doses exceeding VDH limits must be performed by the gauge manufacturer or a person specifically authorized by VDH, the NRC or another Agreement State. XRF users are not allowed to perform non-routine maintenance, the XRF manufacturer must perform all non-routine maintenance.

Discussion: *VDH permits licensees to perform routine maintenance of the XRF provided that they follow the manufacturer's recommendations and instructions. Although manufacturers may use different terms, 'routine maintenance' includes, but is not limited to: cleaning, lubrication, changing batteries or fuses, repairing or replacing a handle. Routine maintenance does NOT include any activities that require removing the sealed source from the XRF.*

The licensee will state that any cleaning, maintenance, or repair of gauges that requires removing the source from the gauge shall be performed only by the manufacturer or other persons specifically licensed by VDH, the NRC or another Agreement State to perform such services.

Item 9.10: Transportation

Rule: 12VAC5-481-100, 12VAC5-481-570, 12VAC5-481-571, 12VAC5-481-630, 12VAC5-481-840, 12VAC5-481-2980, 12VAC5-481-3000, 12VAC5-481-3091, 12VAC5-481-3010, 12VAC5-481-3020, 12VAC5-481-3070, 12VAC5-481-3080, 12VAC5-481-3100, 12VAC5-481-3110, 12VAC5-481-3130, 49 CFR Parts 171-178

Criteria: *Applicants must develop, implement, and maintain safety programs for public transport of radioactive material to ensure compliance with DOT regulations.*

Discussion: *An* ***XRF device is an excepted package, thus neither shipping papers nor an emergency response plan is required.*** *See 49 CFR 173.424 for DOT requirements concerning Excepted packages for radioactive instruments and articles. See Appendix B for UN 2911 label to be placed on the XRF package.*

Item 9.11: Waste Management - XRF Disposal and Transfer

Rule: 12VAC5-481-100, 12VAC5-481-450, 12VAC5-481-500, 12VAC5-481-510, 12VAC5-481-570,

12VAC5-481-571, 12VAC5-481-630, 12VAC5-481-910, 12VAC5-481-980, 12VAC5-481-2980, 12VAC5-481-3100

Criteria: *Licensed materials must be disposed of in accordance with VDH requirements by transfer to an authorized recipient. Appropriate records must be maintained.*

Discussion: *When disposing of XRFs, licensees must transfer them to an authorized recipient. Authorized recipients are the original manufacturer of the device, a commercial firm licensed by VDH, the NRC or another Agreement State to accept radioactive waste from other persons, or another specific licensee authorized to possess the licensed material (i.e., their license specifically authorizes the radionuclide and the use).*

Before transferring radioactive material, a licensee must verify that the recipient is properly authorized to receive it using one of the methods described in 12VAC5-481-570 D. *In addition, all packages containing radioactive sources must be prepared and shipped in accordance with VDH and* DOT *regulations. Records of the transfer must be maintained as required by* 12VAC5-481-100 and 12VAC5-481-571.

Note: *Because of the difficulties and costs associated with disposal of some sources, applicants should preplan the disposal. Applicants may want to consider contractual arrangements with the source supplier as part of a purchase agreement.*

Item 10: Specific License Fee

For a listing of application fees, please see **12VAC5-490**. On VDH Form, **'**Application for Radioactive Material License Authorizing the Use of Sealed Sources in XRF Devices' ***enter the fee category and the amount.***

Item 11: Certification

Individuals acting in a private capacity are required to sign and date VDH Form, 'Application for Radioactive Material License Authorizing the Use XRF Devices' (Appendix A). *Otherwise, senior representatives of the corporation or legal entity filing the application should sign and date V*DH Form, 'Application for Radioactive Material License Authorizing the Use of XRF Devices' (Appendix A).

Representatives signing an application must be authorized to make binding commitments and sign official documents on behalf of the applicant. The agency will return all unsigned applications for proper signature.

Note:

- *It is a violation of 12VAC5-481-30 to make a willful false statement or representation on applications or correspondence.*
- *When the application references commitments, those items become part of the licensing conditions and regulatory requirements.*

Appendix A

VDH Form
‘Application For Radioactive Material License
Authorizing the Use of XRF Devices’

Virginia Department of Health
Radioactive Materials Program
(804) 864-8150

APPLICATION FOR A NEW RADIOACTIVE MATERIAL LICENSE AUTHORIZING THE USE OF XRF DEVICES

The Virginia Department of Health (VDH) is requesting disclosure of information. Completion of this form is required to obtain a Radioactive Material License. Failure to provide all requested information may result in denial or delay of a Radioactive Material License.

Instructions – Complete all items. Refer to VAREG 'Guidance for XRF Devices' for additional information. Use supplementary sheets if necessary.

Retain a copy and submit the original of the entire application to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219.

APPLICATION TYPE

Item 1 Type of Application (Check box)

☐ New License

CONTACT INFORMATION

Item 2 Applicant - Name and Mailing Address	*Item 3 Contact Person – Name*
, -	
Applicant - Telephone Number (Include area code) ( ) - x	Contact Person - Telephone Number (Include area code) ( ) - x

LOCATION OF RADIOACTIVE MATERIAL

Item 4 List all Address(es) where radioactive material(s) will be used or possessed. Attach additional pages if necessary.

	Address (Do not use Post Office box)	**Telephone Number (Include area code)**
☐ Used ☐ Stored ☐ Used/Stored	, -	( ) - x
☐ Used ☐ Stored ☐ Used/Stored	, -	( ) - x
☐ Used ☐ Stored ☐ Used/Stored	, -	( ) - x

Are XRFs used at temporary jobsites?: ☐ Yes ☐ No

RADIATION SAFETY OFFICER

Item 5 Radiation Safety Officer (RSO) *(check one box)*

Name – Radiation Safety Officer	Telephone Number (Include area code) ( ) - x

☐ Before obtaining radioactive material, the proposed RSO will have successfully completed one of the training courses described in the Criteria section titled 'Radiation Safety Officer (RSO)' in VAREG 'Guidance for XRF Devices'. ***OR***

☐ Alternative information demonstrating that the proposed RSO is qualified by training and experience is attached.

AUTHORIZED USERS

Item 6 Training for Individuals Working In or Frequenting Restricted Areas ***(check one box)***

☐ Before using radioactive material, authorized users will have successfully completed one of the training courses described in the Criteria section titled 'Training for Individuals Working In or Frequenting Restricted Areas' in VAREG 'Guidance for XRF Devices'.

NOTE: If using an in-house training program, submit copy of course content, sample course examination and course instructor qualifications. ***OR***

☐ Documentation of the training and experience for the proposed authorized user(s) is attached.

NOTE: THESE INDIVIDUALS WILL BE LISTED ON THE LICENSE AS AUTHORIZED USERS. AN AMENDMENT REQUEST IS REQUIRED TO ADD NEW AUTHORIZED USERS.

RADIOACTIVE MATERIAL

Item 7 Radioactive Material (Attach additional pages if necessary)

Element and mass number	Maximum activity per source and total maximum activity in possession (# of XRFs) at any one time
Device manufacturer and model number	Intended Use

FACILITIES AND EQUIPMENT

Item 8 Facilities And Equipment (Check box and attach diagram.)

☐ Diagrams of radioactive material storage area(s) are attached.

RADIATION SAFETY PROGRAM

Item 9 Radiation Safety Program

Item 9.1 Audit Program

The applicant is not required to submit its audit program to the agency for review during the licensing phase. This matter will be examined during an inspection.

Item 9.2 Termination Of Activities (Check box)

☐ We will notify VDH, in writing, within 60 days of the decision to permanently cease radioactive material use. (**12VAC5-481-510**)

Item 9.3 Instruments (Check one box)

☐ Not Applicable

Item 9.4 Material Receipt And Accountability (Check one box)

☐ We will conduct physical inventories, at intervals not to exceed 6 months, to account for all XRF devices received and possessed under the license.

OR

☐ We will submit a description of the frequency and procedures for ensuring that no XRF has been lost, stolen or misplaced. (Procedures are attached)

Item 9.5 Occupational Dosimetry (Check one box)

☐ We will provide dosimetry processed and evaluated by a NVLAP-approved processor that is exchanged at a frequency recommended by the processor.

OR

☐ We will maintain, for inspection by VDH, documentation demonstrating that unmonitored individuals are not likely to receive, in one year, a radiation dose in excess of 10 percent of the allowable limits in **12VAC5-481-640**. (See **Appendix I** in VAREG 'Guidance for XRF Devices'.)

Item 9.6 Public Dose

No response is required in this license application; however, the licensee's evaluation of public dose will be examined during an inspection.

Item 9.7 Operating and Emergency Procedures (Check one box)

☐ We will implement and maintain the operating and emergency procedures in **Appendix H** of VAREG 'Guidance for XRF Devices' and provide copies of these procedures to all XRF users and at each job site.

OR

☐ Operating and emergency procedures will be implemented, maintained and provided to all XRF users at each job site and will meet criteria in the section titled 'Radiation Safety Program - Operating and Emergency Procedures' in VAREG 'Guidance for XRF Devices'. (Procedures are attached)

Item 9.8 Leak Tests (Check one box)

☐ Leak tests will be performed by an organization authorized by VDH, the NRC or another Agreement State to provide leak testing services to other licensees; or by using a leak test kit supplied by an organization licensed by VDH, the NRC or another Agreement State to provide leak test kits to other licensees according to kit supplier's instructions.

List Name and License number of organization authorized to perform or analyze leak test: (Specify whether VDH, NRC, or another Agreement State)

Organization Name _____ License Number _____

Issuing Agency _____

NOTE: An alternate organization may be used to perform or analyze leak test, without amending the license, provided the organization is specifically authorized by VDH, the NRC, or another Agreement State.

OR

☐ We will perform leak testing and sample analysis and will follow the model procedures in **Appendix J** of VAREG 'Guidance for XRF Devices'.

OR

☐ We will submit alternative procedures. (Procedures are attached)

Item 9.9 Maintenance (Check one box for routine cleaning and lubrication and one for non-routine maintenance)

Routine cleaning and lubrication:

☐ We will implement and maintain procedures for routine maintenance of our XRF(s) according to each manufacturer's recommendations and instructions.

OR

☐ Alternative procedures are attached.

Non-routine maintenance:

☐ We will send the XRF(s) to the manufacturer or other person authorized by VDH, the NRC or another Agreement State to perform non-routine maintenance or repair operations that require the removal of the source or source from the XRF(s).

Item 9.10 Transportation

No response is needed during the license process; this issue will be reviewed during inspection.

Item 9.11 Waste Management - XRF Disposal And Transfer (Check box)

☐ We will transfer the XRF to the manufacturer for disposal or transfer the device to a specific licensee, authorized to receive radioactive material.

SPECIFIC LICENSE FEE

Item 10 License Fees (Refer to **12VAC5-490**.)

Application Fee Enclosed (For new applications):

☐ Yes ☐ No Amount Enclosed $ _____

CERTIFICATION (*To be signed by an individual authorized to make binding commitments on behalf of the applicant.)*

Item 11

I hereby certify that this application was prepared in conformance with 12VAC5-481 'Virginia Radiation Protection Regulations' **and that all information contained herein, including any supplements attached hereto, is true and correct to the best of my knowledge and belief.**

SIGNATURE - Applicant Or Authorized Individual	Date signed

Print Name and Title of above signatory

Virginia Department of Health
Radioactive Materials Program
(804) 864-8150

APPLICATION FOR RENEWAL OF A RADIOACTIVE MATERIAL LICENSE AUTHORIZING THE USE OF XRF DEVICES

The Virginia Department of Health (VDH) is requesting disclosure of information. Completion of this form is required to renew a Radioactive Material License. Failure to provide all requested information may result in denial or delay..
Instructions – Complete all items. Refer to VAREG 'Guidance for XRF Devices' for additional information. Use supplementary sheets if necessary.

Retain a copy and submit the original of the entire application to: Virginia Department of Health, Radioactive Materials Program, 109 Governor Street,

Room 730, Richmond, VA 23219.

APPLICATION TYPE

Item 1 Type of Application (Check box)

☐ Renewal License Number

CONTACT INFORMATION

☐ as listed on current license
OR

Item 2 Applicant - Name and Mailing Address	*Item 3 Contact Person – Name*
, -	
Applicant - Telephone Number (Include area code) ( ) - x	Contact Person - Telephone Number (Include area code) ( ) - x

LOCATION OF RADIOACTIVE MATERIAL

Item 4 List all Address(es) where radioactive material(s) will be used or possessed. Attach additional pages if necessary.

☐ as listed on current license
OR
☐ as listed on current license and please add the listed additional locations
OR
☐ see provided information for current information

	Address (Do not use Post Office box)	**Telephone Number (Include area code)**
☐ Used ☐ Stored ☐ Used/Stored	, -	( ) - x
☐ Used ☐ Stored ☐ Used/Stored	, -	( ) - x

Are XRFs used at temporary jobsites?: ☐ Yes ☐ No

RADIATION SAFETY OFFICER

Item 5 Radiation Safety Officer (RSO) *(check one box)*

☐ *as listed on current license*
OR
☐ proposed new RSO (include training certificate)

Name – Radiation Safety Officer

Telephone Number (Include area code)
( ) - x

AUTHORIZED USERS

Item 6 Training for Individuals Working In or Frequenting Restricted Areas ***(check one box)***

☐ Before using radioactive material, authorized users will have successfully completed one of the training courses described in the Criteria section titled 'Training for Individuals Working In or Frequenting Restricted Areas' in VAREG 'Guidance for XRF Devices'.

NOTE: If using an in-house training program, submit copy of course content, sample course examination and course instructor qualifications.

OR

☐ Current license lists all authorized users

OR

☐ Documentation of the training and experience for the proposed authorized user(s) is attached.

NOTE: THESE INDIVIDUALS WILL BE LISTED ON THE LICENSE AS AUTHORIZED USERS. AN AMENDMENT REQUEST IS REQUIRED TO ADD NEW AUTHORIZED USERS.

RADIOACTIVE MATERIAL

Item 7 Radioactive Material (Attach additional pages if necessary)

☐ Correct as listed on license
OR
☐ Correct as listed on license and see information below for additional material/devices
OR
☐ See below for all requested material/devices

Element and mass number	Maximum activity per source and total maximum activity in possession (# of XRFs) at any one time.
Device manufacturer and model number	Intended Use

FACILITIES AND EQUIPMENT

Item 8 Facilities And Equipment (Check box and attach diagram.)

☐ Diagrams of radioactive material storage area(s) are attached.

RADIATION SAFETY PROGRAM

Item 9 Radiation Safety Program

Item 9.1 Audit Program

The applicant is not required to submit its audit program to the agency for review during the licensing phase. This matter will be examined during an inspection.

Item 9.2 Termination Of Activities (Check box)

☐ We will notify VDH, in writing, within 60 days of the decision to permanently cease radioactive material use. (**12VAC5-481-510**)

Item 9.3 Instruments (Check one box)

☐ Not Applicable

Item 9.4 Material Receipt And Accountability (Check one box)

☐ We will conduct physical inventories, at intervals not to exceed 6 months, to account for all XRF devices received and possessed under the license

OR

☐ We will submit a description of the frequency and procedures for ensuring that no XRF has been lost, stolen or misplaced. (Procedures are attached)

Item 9.5 Occupational Dosimetry (Check one box)

☐ We will provide dosimetry processed and evaluated by a NVLAP-approved processor that is exchanged at a frequency recommended by the processor.

OR

☐ We will maintain, for inspection by VDH, documentation demonstrating that unmonitored individuals are not likely to receive, in one year, a radiation dose in excess of 10 percent of the allowable limits in **12VAC5-481-640**. (See **Appendix I** in VAREG 'Guidance for XRF Devices'.)

Item 9.6 Public Dose

No response is required in this license application; however, the licensee's evaluation of public dose will be examined during an inspection.

Item 9.7 Operating and Emergency Procedures (Check one box)

☐ We will implement and maintain the operating and emergency procedures in **Appendix H** of VAREG 'Guidance for XRF Devices' and provide copies of these procedures to all XRF users and at each job site.

OR

☐ Operating and emergency procedures will be implemented, maintained and provided to all XRF users at each job site and will meet criteria in the section titled 'Radiation Safety Program - Operating and Emergency Procedures' in VAREG 'Guidance for XRF Devices'. (Procedures are attached)

Item 9.8 Leak Tests (Check one box)

☐ Leak tests will be performed by an organization authorized by VDH, the NRC or another Agreement State to provide leak testing services to other licensees; or by using a leak test kit supplied by an organization licensed by VDH, the NRC or another Agreement State to provide leak test kits to other licensees according to kit supplier's instructions.

List Name and License number of organization authorized to perform or analyze leak test: (Specify whether VDH, NRC, or another Agreement State)

Organization Name _____ License Number _____

Issuing Agency _____

NOTE: An alternate organization may be used to perform or analyze leak test, without amending the license, provided the organization is specifically authorized by VDH, the NRC, or another Agreement State.

OR

☐ We will submit alternative procedures. (Procedures are attached)

Item 9.9 Maintenance (Check one box for routine cleaning and lubrication and one for non-routine maintenance)

Routine cleaning and lubrication:

☐ We will implement and maintain procedures for routine maintenance of our XRF(s) according to each manufacturer's recommendations and instructions.

OR

☐ Alternative procedures are attached.

Non-routine maintenance:

☐ We will send the XRF(s) to the manufacturer or other person authorized by VDH, the NRC or another Agreement State to perform non-routine maintenance or repair operations that require the removal of the source or source from the XRF(s).

Item 9.10 Transportation

No response is needed during the license process; this issue will be reviewed during inspection.

Item 9.11 Waste Management - XRF Disposal And Transfer (Check box)

☐ We will transfer the XRF to the manufacturer for disposal or transfer the device to a specific licensee, authorized to receive radioactive material.

SPECIFIC LICENSE FEE

Item 10 License Fees (ONLY REQUIRED WITH INITIAL APPLICATION**)**

CERTIFICATION (*To be signed by an individual authorized to make binding commitments on behalf of the applicant.)*

Item 11

I hereby certify that this application was prepared in conformance with 12VAC5-481 'Virginia Radiation Protection Regulations' **and that all information contained herein, including any supplements attached hereto, is true and correct to the best of my knowledge and belief.**

SIGNATURE - Applicant Or Authorized Individual	Date signed

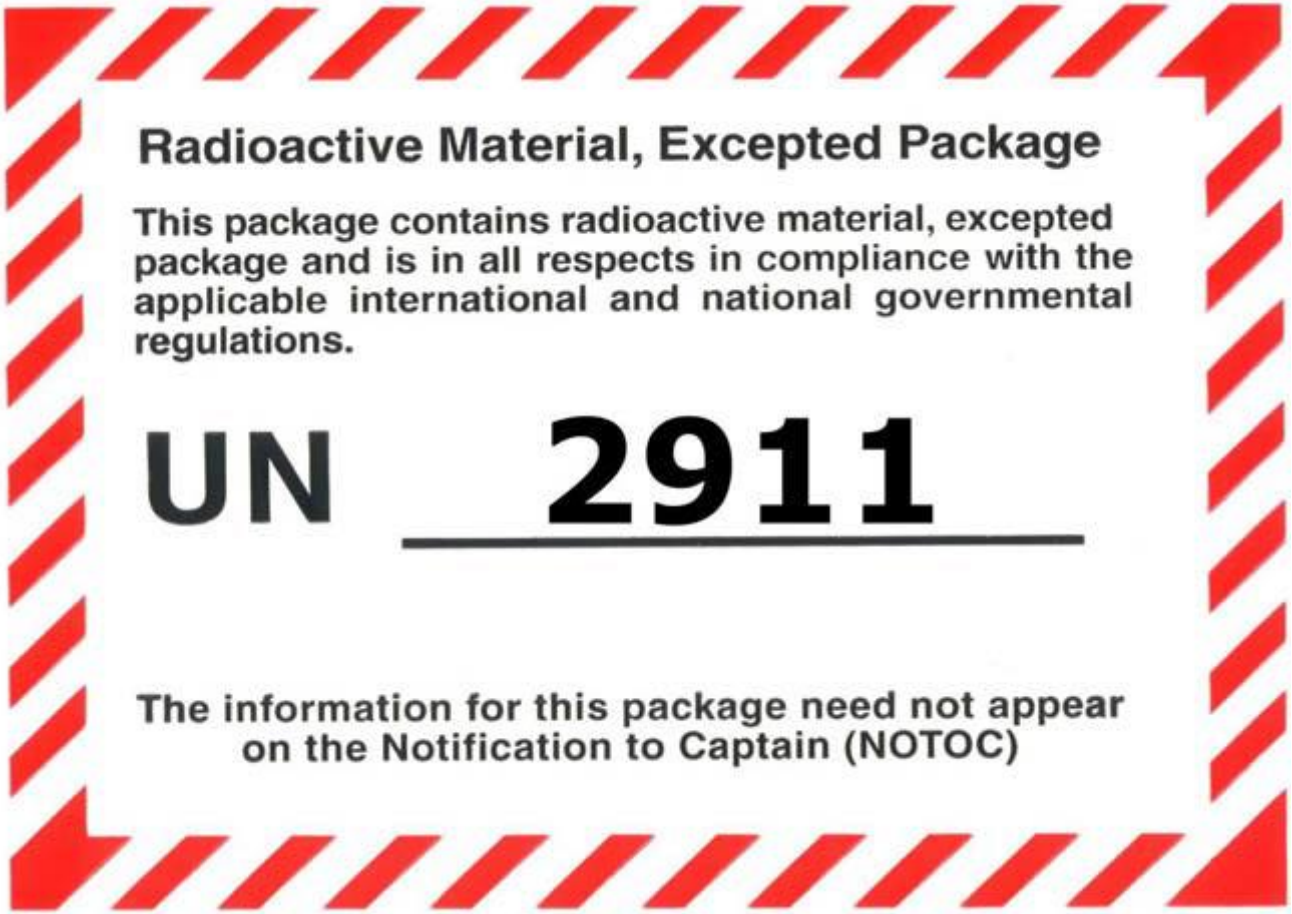
Print Name and Title of above signatory

Attachment A
XRF Applicant's Checklist

Yes	No	Item	Material Needed
		Application	Used the correct form (New for new licensees or Renewal for renewing licensees)
		Application	Checked at least one box and filled in all the required information, as needed, for all Items
		Item 5	Attached training information, as needed
		Item 6	Attached training information, as needed
		Item 8	Attached facility diagram
		Item 9.3	Checked box or attached alternate procedures
		Item 9.4	Checked box or attached alternate procedures
		Item 9.7	Checked box or attached alternate procedures
		Item 9.8	Checked at least one box and, if needed, attached alternate procedures including analysis instrumentation information
		Item 9.9	Routine: checked box or attached alternate procedure
		Item 9.9	Non-Routine: checked box

Appendix B

UN 2911 Label


Radioactive Material, Excepted Package
This package contains radioactive material, excepted package and is in all respects in compliance with the applicable international and national governmental regulations.
UN 2911
The information for this package need not appear on the Notification to Captain (NOTOC)

Appendix C

Information Needed for Transfer of Control Application

Information Needed for Transfer of Control Application

Licensees must provide full information and obtain VDH's **prior written consent** ***before transferring ownership or control of the license; some licensees refer to this as 'transferring the license'. Provide the following information concerning changes of ownership or control by the applicant (transferor and/or transferee, as appropriate). If any items are not applicable so state.***

Control: Control of a license is in the hands of the person or persons who are empowered to decide when and how that license will be used. That control is to be found in the person or persons who, because of ownership or authority explicitly delegated by the owners, possess the power to determine corporate policy and thus the direction of the activities under the license.

Transferee: A transferee is an entity that proposes to purchase or otherwise gain control of a VDH licensed operation.

Transferor: A transferor is a VDH licensee selling or otherwise giving up control of a licensed operation.

1. Provide a complete description of the transaction (transfer of stocks or assets, or merger). Indicate whether the name has changed and include the new name. Include the name and telephone number of a licensee contact who VDH may contact if more information is needed.

2. Describe any changes in personnel or duties that relate to the licensed program. Include training and experience for new personnel.

3. Describe any changes in the organization, location, facilities, equipment or procedures that relate to the licensed program.

4. Describe the status of the surveillance program (surveys, wipe tests, quality control) at the present time and the expected status at the time that control is to be transferred.

5. Confirm that all records concerning the safe and effective decommissioning of the facility will be transferred to the transferee or to VDH, as appropriate. These records include documentation of surveys of ambient radiation levels and fixed and/or removable contamination, including methods and sensitivity.

6. Confirm that the transferee will abide by all constraints, conditions, requirements and commitments of the transferor or that the transferee will submit a complete description of the proposed licensed program.

References: The information above is derived from Information Notice 89-25, Revision 1, "*Unauthorized Transfer of Ownership or Control of Licensed Activities*," which is available at the NRC's webpage at http://www.nrc.gov.

Appendix D

Criteria for Acceptable Training Courses for XRF Users

Criteria for Acceptable Training Courses for XRF Users

Course Content

The following are areas in which VDH considers it important that an individual have expertise for the competent operation of XRF devices using sealed sources of radioactive material. The course shall be at least 8 hours in length. Online training is acceptable if it includes all of the content indicated below and practical training.

I. PRINCIPLES AND FUNDAMENTALS OF RADIATION SAFETY

A. Types and Characteristics of Radiation
   1. Alpha, Beta, Gamma, X-ray and Neutron Radiation
   2. Exposure: Natural versus Man-made Radiation
   3. Irradiation versus Contamination/Internal vs. External
   4. Radioactive Material Used in XRF Devices

B. Units of Radiation Dose and Quantities of Radioactivity
   1. Curie, Rad, Rem and Roentgen
   2. Prefixes
   3. SI Units

C. Basic Math and Calculations Related to Radioactivity
   1. Radioactive Decay
   2. Dose Rates from the sources commonly used
   3. Inverse Square Law

D. Biological Effects of Radiation
   1. Acute, Chronic, and Genetic Effects of Exposure
   2. Radiation Protection Standards
   3. The ALARA Philosophy

E. Radiation levels from Radioactive Sealed Sources

F. Methods of Controlling Radiation Dose
   1. Time
   2. Distance
   3. Shielding

II. STATE AND FEDERAL REGULATIONS

A. **12VAC5-481 'Virginia Radiation Protection Regulations'**
B. Title 10, Code of Federal Regulations, US Nuclear Regulatory Commission
C. Title 49, Code of Federal Regulations, US Department of Transportation

III. LICENSING AND INSPECTION

A. License Items and Conditions
B. Notices, Instructions and Reports to Workers
C. Inspection by the Agency

IV. OPERATING AND EMERGENCY PROCEDURES

A. Operating Procedures
   1. Training and Supervision
   2. Personnel Monitoring
   3. Availability of Procedures
   4. Security of the Devices When Stored and At The Work Location
   5. ALARA Philosophy
   6. Transportation of the Devices and Security
   7. General Rules of Use
   8. Posting and Labeling Requirements
   9. Routine Maintenance
   10. Record Keeping

B. Emergency Procedures
   1. Preventive Measures
   2. Emergency Response
   3. Notification Requirements
   4. Case Histories

V. TRANSFER/ DISPOSAL REQUIREMENTS

A. State and NRC Regulations
B. Transportation Requirements

VI. PRACTICAL TRAINING

A. Transport/ Storage Containers
B. Hands-on Training Specific to the Device
   1. Proper Use
   2. Safe Handling
   3. Calibration of XRF Device Including Substrate Corrections
   4. Demonstration of Measurements of Various Materials

VII. Q&A SESSION

Course Examination

- 25-50 question, closed-book written test -- 70 percent grade

    - Emphasis on radiation safety of storage, use, sealed source location, maintenance, and transportation, rather than the theory and art of making measurements
    - Review of correct answers to missed questions with prospective gauge user immediately following the scoring of the test

Course Instructor Qualifications

Instructor should have either:

- Bachelor's degree in a physical or life science or engineering
- Successful completion of a XRF user course
- Successful completion of an 8 hour radiation safety course AND
- 8 hours hands-on experience with XRFs

OR

- Successful completion of user course
- Successful completion of 40 hour radiation safety course; AND
- 30 hours of hands-on experience with XRFs.

Note*: Licensees should maintain records of training.*

Appendix E

Typical Duties and Responsibilities of the Radiation Safety Officer

Typical Duties and Responsibilities of the Radiation Safety Officer

The RSO's ***duties and responsibilities typically include ensuring the following:***

- ***Stopping licensed activities that the*** RSO ***considers unsafe***
- ***Possession, use, storage, and maintenance of sources and XRFs are consistent with the limitations in the license, the Sealed Source and Device Registration sheet(s), and manufacturer's recommendations and instructions***
- ***Individuals using XRFs are properly trained***
- ***When necessary, personnel monitoring devices are used and exchanged at the proper intervals; records of the results of such monitoring are maintained***
- ***XRFs are properly secured***
- ***Proper authorities are notified in case of accident, damage to gauges, fire, or theft***
- ***Unusual occurrences involving the device(s) (e.g., accident, damage) are investigated, cause(s) and appropriate corrective action are identified, and corrective action is taken***
- ***Audits are performed at least annually and documented, and corrective actions taken***
- ***Licensed material is transported in accordance with all applicable*** DOT ***requirements***
- ***Licensed material is disposed of properly***
- ***Appropriate records are maintained***
- ***Up-to-date license is maintained and amendment and renewal requests submitted in a timely manner***
- ***Up-to-date operating, emergency, and security procedures are developed, maintained, distributed, and implemented***
- ***Non-routine operations are performed by the manufacturer***
- ***Documentation is maintained to demonstrate, by measurement or calculation, that public dose does not exceed the annual limit in*** *12VAC5-481-730*
- ***When violation(s) of regulations or license conditions are identified, corrective action(s) are developed, implemented, and documented***
- ***All posting requirements of*** *12VAC5-481* ***are met, include current notice to workers, in the appropriate location(s).***

Appendix F

XRF Audit Checklist

XRF Audit Checklist

NOTE*: All areas indicated in audit notes may not be applicable to every license and may not need to be addressed during each audit.*

Licensee's name:_____ License No._____
Auditor: _____Date of Audit _____Telephone No._____
Audit date Range: _____
_____
(Signature)

1. AUDIT HISTORY

a. ***Last audit of this location conducted on (date) _____***
b. ***Were previous audits conducted yearly?* (12VAC5-481-630)**
c. ***Were records of previous audits maintained?* (12VAC5-481-990)**
d. ***Were any deficiencies identified during last two audits or two years, whichever is longer?***
e. ***Were corrective actions taken? (Look for repeated deficiencies).***

2. ORGANIZATION AND SCOPE OF PROGRAM

a. ***If the mailing address or places of use changed, was the license amended?***
b. ***If ownership changed or bankruptcy filed, was VDH prior consent obtained or was*** the VDH ***notified?***
c. ***If the*** RSO ***was changed, was license amended? Does new*** RSO ***meet*** VDH ***training requirements?***
d. ***If the designated contact person changed, was agency notified?***
e. ***Does the license authorize all of*** the ***radionuclides contained in gauges possessed?***
f. ***Are the XRFs as described in the Sealed Source and Device Registration (SSDR) Certificate or Sheet? Have copies of (or access to)*** SSDR ***Certificates? Have manufacturers' manuals for operation and maintenance?***
g. ***Are the actual uses of gauges consistent with the authorized uses listed on the license?***
h. ***Is*** RSO ***fulfilling his/her duties?***

3. TRAINING AND INSTRUCTIONS TO WORKERS

a. ***Were all workers who are likely to exceed 100 mrem/yr instructed per*** *12VAC5-481-2270?* ***Refresher training provided, as needed* (12VAC5-481-2270)*?***
b. ***Did each XRF operator attend an approved course prior to using gauges?***
c. ***Are training records maintained for each XRF operator?***
d. ***Did interviews with operators reveal that they know the emergency procedures?***
e. ***Did this audit include observations of operators using the XRF in a field situation?***

f. ***Operating XRF? Performing routine cleaning and lubrication? Transporting XRF? Storing XRF?***

g. ***Did the operator demonstrate safe handling and security during transportation, use and storage?***

h. ***HAZMAT training provided as required?*** *[49 CFR 172.700; 172.701; 172.702; 172.703; 172.704]*

4. XRF INVENTORY AND ACCOUNTABILITY

A a. ***Is a record kept showing the receipt of each XRF?*** **(12VAC5-481-100, 12VAC5-481-571)**

b. ***Are all XRFs received physically inventoried every six month?***

c. ***Are records of inventory results with appropriate information maintained?***

d. ***Is the XRF log book completed as required each time of use?***

5. PERSONNEL RADIATION PROTECTION

a. ***Are*** ALARA ***considerations incorporated into the radiation protection program?*** (**12VAC5-481-630**)

b. ***Is documentation kept showing that unmonitored users receive <10% of limit?***

c. ***Did unmonitored users' activities change during the year which could put them over 10% of limit?***

d. ***If yes to c. above, was a new evaluation performed?***

e. ***Is external dosimetry required? (s users are required to have and XRF users receiving >10% of limit are required to have) Is dosimetry provided to users?***

1) ***Is the dosimetry supplier*** NVLAP ***approved?*** **(12VAC5-481-750)**

2) ***Are the dosimeters exchanged monthly for film badges and at industry recommended frequencies?***

3) ***Are dosimetry reports reviewed by the*** RSO ***when they are received?***

4) ***Are the records V***DH ***Forms or equivalent?*** (**12VAC5-481-1040**)

VDH Form, 'Cumulative Occupational Exposure History' completed?

VDH Form, 'Occupational Exposure Record for a Monitoring Period' completed?

5) ***If a worker declared her pregnancy, did licensee comply with*** **12VAC5-481-710*?***

Were records kept of embryo/fetus dose per **12VAC5-481-1040*?***

f. ***Are records of exposures, surveys, monitoring, and evaluations maintained? (****12VAC5-481-990, 12VAC5-481-1000, 12VAC5-481-1040, 12VAC5-481-1080****)***

g. Are annual exposure reports given to employees who receive greater than 100 mrem per year? (**12VAC5-481-2280**)

6. PUBLIC DOSE

a. ***Are XRFs stored in a manner to keep doses below 100 mrem in a year?*** *(12VAC5-481-720, 12VAC5-481-730)*

b. ***Has a survey or evaluation been performed per* 12VAC5-481-730*? Have there been any additions or changes to the storage, security, or use of surrounding areas that would necessitate a new survey or evaluation?***

c. ***Do unrestricted area radiation levels exceed 2 mrem in any one hour?* (12VAC5-481-720)**

d. ***Are XRFs being stored in a manner that would prevent unauthorized use or removal?* (12VAC5-481-840)**

e. ***Records maintained?* (12VAC5-481-1050)**

7. OPERATING AND EMERGENCY PROCEDURES

a. ***Have operating and emergency procedures been developed?***

b. ***Do they contain the required elements?***

c. ***Does each operator have a current copy (with current telephone numbers) of the operating and emergency procedures?***

8. LEAK TESTS

a. ***Was each sealed source leak tested every 6 months or at other prescribed intervals?***

b. ***Was the leak test performed as described in correspondence with*** the agency ***and according to the license?***

c. ***Are records of results retained with the appropriate information included?***

d. ***Were any sources found leaking and if yes, was*** VDH ***notified?***

9. MAINTENANCE OF GAUGES

a. ***Are manufacturer's procedures followed for routine cleaning and lubrication of XRF?***

b. ***Does the source remain attached to the XRF during cleaning?***

c. ***Is non-routine maintenance performed where the source is detached from the XRF performed only by the manufacturer or a licensee specifically authorized by the agency, NRC, or another Agreement States?***

10. TRANSPORTATION

a. ***If shipping papers are not required, is there a certification statement*** *(49 CFR 173.422(a)(2))* ***along with the name of the consignor or consignee included with (on the package or inside the package) the XFR when transported?***

11. AUDITOR'S INDEPENDENT SURVEY MEASUREMENTS (IF MADE)

a. ***Describe the type, location, and results of measurements. Do any radiation levels exceed regulatory limits (if applicable)?***

12. NOTIFICATION AND REPORTS

a. ***Was any radioactive material lost or stolen? Were reports made?* (12VAC5-481-1090)**

b. Did any reportable incidents occur? Were reports made? **(12VAC5-481-1100)**

c. Did any overexposures and high radiation levels occur? Reported? **(12VAC5-481-1110)**

d. If any events (as described in items a through c above) did occur, what was root cause? Were corrective actions appropriate?

13. POSTING AND LABELING

a. VDH Form, 'Notice to Employees' posted? **(12VAC5-481-2260 C)**

b. The agency regulations, license documents posted or a notice posted? **(12VAC5-481-2260 A)**

c. Other posting and labeling? **(12VAC5-481-850, 12VAC5-481-860, 12VAC5-481-880, 12VAC5-481-2260)**

14. RECORD KEEPING FOR DECOMMISSIONING

a. Records kept of information important to decommissioning? *(12VAC5-481-450 C)*

b. Records include all information outlined **(12VAC5-481-450 C)**

15. BULLETINS AND INFORMATION NOTICES

a. Are VDH's ***Information Notices received?***

b. Appropriate training and action taken in response?

16. SPECIAL LICENSE CONDITIONS OR ISSUES

a. Did auditor review special license conditions or other issues (e.g., non-routine maintenance)?

17. DEFICIENCIES IDENTIFIED IN AUDIT; CORRECTIVE ACTIONS

a. Summarize problems/deficiencies identified during audit.

b. If problems/deficiencies identified in this audit, describe corrective actions planned or taken. Are corrective actions planned or taken at ALL licensed locations (not just location audited)?

c. Provide any other recommendations for improvement.

d. Were any of the deficiencies brought to the attention of management?

18. EVALUATION OF OTHER FACTORS

a. Senior licensee management is appropriately involved with the radiation protection program and/or Radiation Safety Officer (RSO***) oversight?***

b. RSO has sufficient time to perform his/her radiation safety duties?

c. Licensee has sufficient staff to support the radiation protection program?

Appendix G

RESERVE

Appendix H

Operating and Emergency Procedures

Operating Procedures

- If personnel dosimetry is provided:
  - Always wear your assigned ***OSL, TLD, or film badge when using the XRF.***
  - ***Never wear another person's*** OSL, TLD, ***or film badge.***
  - ***Never store your*** OSL, TLD, ***or film badge near the gauge.***

- ***Sign out the XRF in a log book (that remains at the storage location) including the date(s) of use, name(s) of the authorized users who will be responsible for the gauge, and the temporary jobsite(s) where the gauge will be used.***

- ***Prior to transporting the XRF, ensure that, where applicable, the source is in the fully shielded position. Lock the case in the vehicle.***

- ***Use the XRF according to the manufacturer's instructions and recommendations.***

- ***Do not touch the unshielded source with your fingers, hands, or any part of your body.***

- ***Do not place hands, fingers, feet, or other body parts in the radiation field from an unshielded source.***

- ***Perform routine cleaning and maintenance according to the manufacturer's instructions and recommendations.***

- ***When the XRF is not in use at a temporary jobsite, place the XRF in a secured location (e.g., locked in the trunk of a car or locked in a storage shed).***

- ***Return the XRF to its proper locked storage location at the end of the work shift.***

- ***Log the XRF into the daily use log when it is returned to storage.***

- ***After making changes affecting the gauge storage area (e.g., changing the location of gauges within the storage area, removing shielding, adding XRFs, changing the occupancy of adjacent areas, moving the storage area to a new location), reevaluate compliance with public dose limits and ensure proper security of XRFs.***

Emergency Procedures

If the XRF is lost, damaged or stolen, or if any other emergency or other unusual event occurs arises:

- Immediately secure the area and keep people at least 15 feet away from the XRF until the situation is assessed and radiation levels are known. However, perform first aid for any injured individuals and remove them from the area only when medically safe to do so.
- XRF users and other potentially contaminated individuals should not leave the scene until emergency assistance arrives.
- Notify the persons in order listed below of the situation:

NAME*	WORK PHONE NUMBER*	HOME PHONE NUMBER*
_____	_____	_____
_____	_____	_____
	_____	_____

* Fill in with (and update, as needed) the names and telephone numbers of appropriate personnel (e.g., the Radiation Safety Officer (RSO***), or other knowledgeable licensee staff, licensee's consultant, XRF manufacturer) to be contacted in case of emergency.***

- ***Follow the directions provided by the person contacted above.***

Note: Telephone notifications shall be made to the agency at **(804) 864-8150 during business hours, (804) 674-2400** or **(800) 468-8892, which is staffed 24 hours/day. Identify the emergency as radiological.**

RSO and Licensee Management

* Arrange for a radiation survey to be conducted as soon as possible by a knowledgeable person using appropriate radiation detection instrumentation. This person could be a licensee employee using a survey meter located at the jobsite or a consultant. To accurately assess the radiation danger, it is essential that the person performing the survey be competent in the use of the survey meter.

* Make necessary notifications to local authorities as well as VDH as required***. (Even if not required to do so, you may report*** *ANY* ***incident to*** the agency ***by calling*** **(804) 864-8150** during normal business hours. For immediate notifications after normal business hours, the 24 hour emergency telephone number is **(804) 674-2400** or **800-468-8892.** Identify the emergency as a radiological emergency. VDH ***notification is required when gauges containing licensed material are lost or stolen (****12VAC5-481-1090****), when gauges are damaged or involved in incidents that result in doses in excess of limits (****12VAC5-481-1100, 12VAC5-481-1110).*

* Reports to VDH ***must be made within the reporting timeframes specified by the regulations.***

* ***Reporting requirements are found in*** **12VAC5-481-1090, 12VAC5-481-1100, 12VAC5-481-1110,** and **12VAC5-481-115**

Appendix I

Dosimetry-Related Guidance

Appendix I, Part 1

Worksheet for Demonstrating that Unmonitored Users Are Not Likely to Exceed 10 Percent of the Allowable Limits

Worksheet for Demonstrating that Unmonitored Individuals Are Not Likely to Exceed 10 Percent of the Allowable Limits

Instructions: To meet the requirement of **12VAC5-481-760** complete **Steps 1** through **6** and sign and date the evaluation on the line provided.

Disclaimer: If there is a change in workload or if a new source is acquired a new evaluation will need to be performed.

Step 1.

Determine the radiation level while the shutter is open in one of the following ways. Record the results below.

- Obtain from the manufacturer's specifications: the radiation level approximately 30 centimeters from the XRF when shutter is open, or
- Measure the radiation level with a calibrated survey meter.

  When making the radiation measurement while the shutter is open, place the survey instrument approximately 30 centimeters from the XRF while following good radiation safety practices.

_____ mrem per hour

Step 2.

Record the average number of minutes per week that the XRF is used with the shutter in open position.

_____ minutes per week

Step 3.

Divide the minutes per week (**Step 2.**) by 60 to determine hours per week and record below.

_____minutes per week (**Step 2.**) / 60

= _____ hours per week

= _____ hours per year

Step 4.

Multiply the hours per week (**Step 3.**) by 52 weeks to equal hours per year and record below.

_____hours per week (**Step 3**.) X 52 weeks

= _____ hours per year

Step 5.

Multiply hours per year (**Step 4.**) by mrem per hour (**Step 1.**) to equal mrem received per year and record below.

_____hours per year (**Step 4.**) X _____mrem per hour (**Step 1.**)

= _____ mrem per year

Step 6.

Is the # of mrem per year (**Step 5.**) greater than 500? ☐ Yes ☐ No

- If yes provide dosimetry as required by **12VAC5-481-760.**
- If no, proceed to **Step 7.**

Step 7.

Is the # of mrem per year (**Step 5.**) greater than 100? ☐ Yes ☐ No

- If yes, and you have an employee that is a declared pregnant worker, as defined by **12VAC5-481-10,** provide dosimetry to that individual. In addition, provide annual radiation safety training as required **by12VAC5-481-2270** to all employees that use the XRF.
- If no, you are not required under **12VAC5-481 'Virginia Radiation Protection Regulations'** to provide dosimetry to your employees.

_____ _____

Signature of Person Performing the Evaluation *Date*

Appendix I, Part 2

Guidance for Demonstrating that Individual Members of the Public will not Receive Doses Exceeding the Allowable Limits

Guidance for Demonstrating that Individual Members of the Public will not Receive Doses Exceeding the Allowable Limits

Licensees must ensure that:

- The radiation dose received by individual members of the public does not exceed 100 mrem (1 mSv) in one calendar year resulting from the licensee's possession and/or use of licensed materials.

Members of the public include persons who live, work, or may be near locations where s or XRFs are used or stored and employees whose assigned duties do not include the use of licensed materials and who work in the vicinity where XRFs are used or stored.

- The radiation dose in unrestricted areas does not exceed 2 mrem (0.02 mSv) in any one hour.

Typical unrestricted areas may include offices, shops, laboratories, areas outside buildings, property, and non-radioactive equipment storage areas. The licensee does not control access to these areas for purposes of controlling exposure to radiation or radioactive materials. However, the licensee may control access to these areas for other reasons such as security.

Licensees must show compliance with both portions of the regulation. Calculations or a combination of calculations and measurements (e.g., using an environmental film badge or OSL) are often used to prove compliance.

Calculation Method

Note: For ease of use by most licensees, the examples in this Appendix use conventional units. The conversions to SI units are as follows: 1 ft = 0.305 m; 1 mrem = 0.01 mSv.

The calculation method takes a tiered approach, going through a three-part process starting with a worst case situation and moving toward more realistic situations. It makes the following simplifications: (1) each gauge is a point source, (2) typical radiation levels encountered when the source is in the shielded position are taken from either the Sealed Source & Device Registration (SSDR) Sheet or the manufacturer's literature, and (3) no credit is taken for any shielding found between the gauges and the unrestricted areas. Part 1 of the calculation method is simple but conservative. It assumes that an affected member of the public is present 24 hours a day and uses only the ‘inverse square law’ to determine if the distance between the gauge and the affected member of the public is sufficient to show compliance with the public dose limits. Part 2 considers not only distance, but also the time that the affected member of the public is actually in the area under consideration. Part 3 considers distance and the portion of time that both the gauge and the affected member of the public are present. Using this approach, licensees make only those calculations that are needed to demonstrate compliance. In many cases licensees will need to use the calculation method through Part 1 or Part 2. The results of these calculations typically result in higher radiation levels than would exist at typical facilities, but provide a method for estimating conservative doses which could be received.

Example 1

To better understand the calculation method, we will look at Moisture-Density Measurements, Inc., a

licensee. Yesterday, the company's president noted that the new gauge storage area is very close to his

secretary's desk and he asked Joe, the Radiation Safety Officer (***RSO***), to determine if the company is complying with V***DH*** regulations.

The secretary's desk is near the wall separating the reception area from the designated, locked gauge storage area, where the company is storing its three gauges. Joe measures the distances from each gauge to the wall and looks up in the manufacturer's literature the radiation levels individuals would encounter for each gauge. Joe draws a sketch (see **Figure 2**) and summarizes his findings.

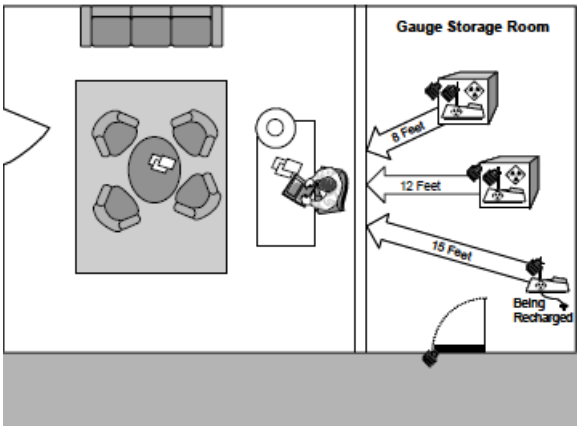


Figure 2: Public Dose Sketch

Findings:

Joe finds that gauge #1 and #2 are stored in transportation containers, gauge #3 is not in a transport container as it is always being recharged. Gauge #1 is documented as reading 2 mrem/hr at 1 ft and is 8 ft away from the secretary's desk. Gauge #2 is documented as reading 8 mrem/hr at 1 ft and is 12 ft away from the secretary's desk. Gauge #3 is documented as reading 2 mrem/hr at 3 ft and is 15 ft away from the secretary's desk.

Example 1: Part 1

Joe's first thought is that the distance between the gauges and the secretary's chair may be sufficient to show compliance with the regulation in **12VAC5-481-720.** ***So, taking a 'worst case' approach, he assumes: 1) the gauges are constantly present (i.e., 24 hr/d), 2) all three gauges remain in storage with no other use, and 3) the secretary is constantly sitting in the desk chair (i.e., 24 hr/d). Joe proceeds to calculate the dose she might receive hourly and yearly from each gauge as shown in*** **Tables 4**, *5, and 6* ***below.***

Table 4, Calculation Method, Part 1---Hourly and Annual Dose Received from Gauge 1			
		GAUGE 1	
Step No.	**Description**	**Input Data**	**Results**
1	Dose received in an hour at known distance from gauge (e.g., from manufacturer's data), in mrem/hr	2	2
2	Square of the distance (ft) at which the Step 1 rate was measured, in ft^2	$(1)^2$	1
3	Square of the distance (ft) from the gauge to the secretary's desk in an unrestricted area, in ft^2	$(8)^2$	64

4	Multiply the results of Step 1 by the results of Step 2 (this is an intermediate result)	2 x 1 =2
5	Divide the result of Step 4 by the result of Step 3 to calculate the dose received by an individual at the secretary's desk**, HOURLY DOSE RECEIVED FROM GAUGE 1**, in mrem in an hour.	2/64 = **0.031**
6	Multiply the result of Step 5 by 24 hr/d x 365 d/yr = **MAXIMUM ANNUAL DOSE RECEIVED FROM GAUGE 1**, in mrem in a year.	0.031 x 24 x 365 = 0.031 x 8760 = **272**

Table 5, Calculation Method, Part 1---Hourly and Annual Dose Received from Gauge 2

		GAUGE 2	
Step No.	**Description**	**Input Data**	**Results**
1	Dose received in an hour at known distance from gauge (e.g., from manufacturer's data), in mrem/hr	8	8
2	Square of the distance (ft) at which the Step 1 rate was measured, in ft^2	$(1)^2$	1
3	Square of the distance (ft) from the gauge to the secretary's desk in an unrestricted area, in ft^2	$(12)^2$	144
4	Multiply the results of Step 1 by the results of Step 2 (this is an intermediate result)	8 x 1 = 8	
5	Divide the result of Step 4 by the result of Step 3 to calculate dose received in an hour by an individual at the secretary's desk**, HOURLY DOSE RECEIVED FROM GAUGE 2**, in mrem in an hour	8/144 = **.056**	
6	Multiply the result of Step 5 by 24 hr/d x 365 d/yr = **MAXIMUM ANNUAL DOSE RECEIVED FROM GAUGE 2**, in mrem in a year	0.056 x 24 x 365 =0.056 x 8760 = **491**	

Table 6, Calculation Method, Part 1---Hourly and Annual Dose Received from Gauge 3

		GAUGE 3	
Step No.	**Description**	**Input Data**	**Results**
1	Dose received in an hour at known distance from gauge (e.g., from manufacturer's data), in mrem/hr	2	2
2	Square of the distance (ft) at which the Step 1 rate was measured, in ft^2	$(3)^2$	9
3	Square of the distance (ft) from the gauge to the secretary's desk in an unrestricted area, in ft^2	$(15)^2$	225
4	Multiply the results of Step 1 by the results of Step 2 (this is an intermediate result)	2 x 9 =18	
5	Divide the result of Step 4 by the result of Step 3 to calculate dose received by an individual at the secretary's desk, **HOURLY DOSE RECEIVED FROM GAUGE 3**, in mrem in an hour	18/225 = **0.08**	
6	Multiply the result of Step 5 by 24 hr/d x 365 d/yr = **MAXIMUM ANNUAL DOSE RECEIVED FROM GAUGE 3**, in mrem in a year	0.08 x 24 x 365 = 0.08 x 8760 = **701**	

To determine the total hourly and total annual dose received, Joe adds the pertinent data from the preceding tables.

Table 7, Calculation Method, Part 1---Total Hourly and Annual Dose Received from Gauge 1, 2, and 3					
Step No.	**Description**	**Gauge 1**	**Gauge 2**	**Gauge 3**	**Sum**
7	**TOTAL HOURLY DOSE RECEIVED** from Step 5 of Tables I-3, I-4, and I-5, in mrem in an hour	0.031	0.056	0.08	0.031 + 0.056 + 0.08 = **0.167**
8	**TOTAL ANNUAL DOSE RECEIVED** from Step 6 of Tables I-3, I-4, and I-5, in mrem in a year	272	491	701	272 + 491 + 701 = **1464**

Note*:* The Sum in Step 7 demonstrates compliance with the 2 mrem in any one hour limit. Reevaluate if assumptions change. If the Sum in Step 8 exceeds 100 mrem/yr, proceed to Part 2 of the calculation method.

At this point, Joe is pleased to see that the total dose that an individual could receive in any one hour is only 0.167 mrem, but notes that an individual could receive a dose of 1,464 mrem in a year, much higher than the 100 mrem limit.

Example 1: Part 2

Joe reviews his assumptions and recognizes that the secretary is not at the desk 24 hr/d. He decides to make a realistic estimate of the number of hours the secretary sits in the chair at the desk, keeping his other assumptions constant (i.e., the gauges are constantly present (i.e., 24 hr/d), all three gauges remain in storage with no other use). He then recalculates the annual dose received.

Table 8, Calculation Method, Part 2--Annual Dose Received from Gauges 1, 2, and 3		
Step No.	**Description**	**Results**
9	A. Average number of hours per day that individual spends in area of concern (e.g., secretary sits at desk 5 hr/day; the remainder of the day the secretary is away from the desk area copying, filing, etc.)	5
	B. Average number of days per week in area (e.g., secretary is part time and works 3 days/week)	3
	C. Average number of weeks per year in area (e.g., secretary works all year)	52
10	Multiply the results of Step 9.A. by the results of Step 9.B. by the results of Step 9.C. = **AVERAGE NUMBER OF HOURS IN AREA OF CONCERN PER YEAR**	5 x 3 x 52 = **780**
11	Multiply the sum in Step 7 by the results of Step 10 = **ANNUAL DOSE RECEIVED FROM GAUGES CONSIDERING REALISTIC ESTIMATE OF TIME SPENT IN AREA OF CONCERN**, in mrem in a year	0.167 x 780 = **130**

Note: If Step 11 exceeds 100 mrem in a year, proceed to Part 3 of the calculation method.

Although Joe is pleased to note that the calculated annual dose received is significantly lower, he realizes it still exceeds the 100 mrem in a year limit.

Example 1, Part 3

Again Joe reviews his assumptions and recognizes that the gauges are not always in storage when the secretary is seated at the desk. As he examines the situation, he realizes he must consider each gauge individually.

Summary of Information:

- ***Gauge #1 is located in the storage area continuously (24 hr/d).***
- ***Gauge #2 is located in the storage area continuously (24 hr/d) for 8 months of the year and at temporary job sites for the remaining 4 months of the year.***
- ***Gauge #3 is located in the storage area overnight only, it is used each day at temporary job sites and returned at the end of the day. The gauge is only present during the secretary's first and last hours of work each day.***
- ***The secretary is sitting at the desk 5 hours/day, 3 days/week, and 52 weeks/year.***

Table 9, Calculation Method, Part 3---Annual Dose Received from Gauges 1, 2, and 3

Step No.	Description	GAUGE 1	GAUGE 2	GAUGE 3
12	Average number of **hours per day** gauge is in storage while secretary is present	**5**	**5**	**2**
13	Average number of **days per week** gauge is in storage while secretary is present	**3**	**3**	**3**
14	Average number of **weeks per year** gauge is in storage while secretary is present	**52**	**32**	**52**
15	Multiply the results of Step 12 by the results of Step 13 by the results of Step 14 = **TOTAL HOURS EACH GAUGE IS STORED PER YEAR WHILE SECRETARY IS PRESENT**	5 x 3 x 52 = **780**	5 x 3 x 32 = **480**	2 x 3 x 52 = **312**
16	Multiply the results of Step 15 by the results of Step 7 = **ANNUAL DOSE RECEIVED FROM EACH GAUGE**, in mrem in a year	780 x 0.031 = **24**	480 x 0.056 = **27**	312 x 0.08 = **25**
17	Sum the results of Step 16 for each gauge = **TOTAL ANNUAL DOSE RECEIVED CONSIDERING REALISTIC ESTIMATE OF TIME SPENT IN AREA OF CONCERN AND TIME GAUGE IS IN STORAGE**, in mrem in a year	24 + 27 + 25 = **76**		

Note: If the result in Step 17 is greater than 100 mrem/yr, the licensee must take corrective actions.

Joe is pleased that the result in Step 17 shows compliance with the 100 mrem/yr limit. Had the result in Step 17 been higher than 100 mrem/yr, then Joe could have done one or more of the following:

- ***Consider whether the assumptions used to determine occupancy and the time each gauge is in storage are accurate, revise the assumptions as needed, and recalculate using the new assumptions***
- ***Calculate the effect of any shielding located between the gauge storage area and the secretarial workstation - such calculation is beyond the scope of this Appendix***
- ***Take corrective action (e.g., move gauges within storage area, move the storage area, move the secretarial workstation) and perform new calculations to demonstrate compliance***

- ***Designate the area outside the storage area as a restricted area and the secretary as an occupationally exposed individual. This would require controlling access to the area for purposes of radiation protection and training the secretary as required by* 12VAC5-481-2270.**

Note that in the example, Joe evaluated the unrestricted area outside only one wall of the gauge storage area. Licensees also need to make similar evaluations for other unrestricted areas and to keep in mind the* ALARA *principle, taking reasonable steps to keep radiation dose received below regulatory requirements. In addition, licensees need to be alert to changes in situations (e.g., moving any of the gauges closer to the secretarial workstation, adding a gauge to the storage area, changing the secretary to a full-time worker, or changing the estimate of the portion of time spent at the desk) and to perform additional evaluations, as needed.

Note: 12VAC5-481-1050 ***requires licensees to maintain records demonstrating compliance with the dose limits for individual members of the public.***

Combination Measurement-Calculation Method

This method, which allows the licensee to take credit for shielding between the gauge and the area in question, begins by measuring radiation levels in the areas, as opposed to using manufacturer-supplied rates at a specified distance from each gauge. These measurements must be made with calibrated survey meters sufficiently sensitive to measure background levels of radiation. However, licensees must exercise caution when making measurements with currently calibrated radiation survey instruments. A maximum dose of 1 mSv (100 mrem) received by an individual over a period of 2080 hours (i.e., a 'work' year of 40 hr/wk for 52 wk/yr) is equal to less than 0.5 microsievert (0.05 mrem) per hour.

This rate is well below the minimum sensitivity of most commonly available G-M survey instruments.

Instruments used to make measurements for calculations must be sufficiently sensitive. An instrument equipped with a scintillation-type detector (e.g., NaI(Tl)) or a micro-R meter used in making very low gamma radiation measurements should be adequate.

Licensees may also choose to use environmental film badges, TLDs, or OSLs ***in unrestricted areas next to the gauge storage area for monitoring. This direct measurement method would provide a definitive measurement of actual radiation levels in unrestricted areas without any restrictive assumptions. Records of these measurements can then be evaluated to ensure that rates in unrestricted areas do not exceed the 1 mSv/yr (100 mrem/yr) limit.***

Note: TLDs ***used for personnel monitoring may not have sufficient sensitivity for this purpose. Generally, the minimum reportable dose received is 0.1 mSv (10 mrem). Suppose a*** TLD ***monitors dose received and is changed once a month. If the measurements are at the minimum reportable level, the annual dose received could have been about 1.2 mSv (120 mrem), a value in excess of the 1 mSv/yr (100 mrem/yr) limit. If licensees use*** TLDs ***to evaluate compliance with the public dose limits, they should consult with their supplier and choose more sensitive*** TLDs to ***be used for environmental monitoring.***

Example 2

As in Example 1, Joe is the RSO ***for Lead-Free Measurements, Inc., a XRF licensee. The company has three gauges stored in a designated, locked storage area that adjoins an unrestricted area where a secretarial work station is located. See Example 1,*** *Figure 2* ***and Findings paragraph. Joe wants to see if the company complies with the public dose limits at the secretarial station. During the winter while all the gauges were in storage, Joe placed an environmental*** TLD ***in the secretarial work space for 30 days. Joe chose a winter month so he did not have to keep track of the number of hours that each gauge was in the storage area. The*** TLD ***processor sent Joe a report indicating the*** film badge ***received 100 mrem.***

Table 10, Combination Measurement-Calculation Method		
Step No.	**Description**	**Input Data and Results**
PART 1		
1	**Dose** received by TLD***, in mrem***	**100**
2	**Total hours** TLD ***exposed***	24 hr/d x 30 d/mo = **720**
3	Divide the results of Step 1 by the results of Step 2 to determine **HOURLY DOSE RECEIVED**, in mrem in an hour	**0.14**
4	Multiply the results of Step 3 by 365 d/yr x 24 hr/d = 8760 hours in one year = **MAXIMUM ANNUAL DOSE RECEIVED FROM GAUGES**, in mrem in a year	365 x 24 x 0.14 = 8760 x 0.14 = **1226**
NOTE: For the conditions described above, **Step 3** indicates that the dose received in any one hour is less than the 2 mrem in any one hour limit. However, if there are any changes, then the licensee would need to reevaluate the potential doses which could be received in any one hour. **Step 4** indicates that the annual dose received would be much greater than the 100 mrem in a year allowed by the regulations.		
PART 2		
At this point Joe can adjust for a realistic estimate of the time the secretary spends in the area as he did in Part 2 of Example 1.		
PART 3		
If the results of Joe's evaluation in Part 2 show that the annual dose received in a year exceeds 100 mrem, then he can make adjustments for realistic estimates of the time spent in the area of concern while the gauges are actually in storage as in Part 3 of Example 1. (Recall that the TLD ***measurement was made while all the gauges were in storage--i.e., 24 hr/d for the 30 days that the*** TLD ***was in place.)***		

Appendix J

Requests to Perform Leak Testing and Sample Analysis

Leak Test Program

Training

Before allowing an individual to perform leak testing, the RSO will ensure that he or she has sufficient classroom and on-the-job training to show competency in performing leak tests independently.

Classroom training may be in the form of lecture, videotape, or self-study, and will cover the following subject areas:

- Principles and practices of radiation protection;
- Radioactivity measurements, monitoring techniques, and the use of instruments;
- Mathematics and calculations basic to the use and measurement of radioactivity; and
- Biological effects of radiation.

Appropriate on-the-job-training consists of:

- Observing authorized personnel collecting and analyzing leak test samples;
- Collecting and analyzing leak test samples under the supervision and in the physical presence of an individual authorized to perform leak tests.

Facilities and Equipment

- To ensure achieving the required sensitivity of measurements, leak tests will be analyzed in a low-background area.
- Individuals conducting leak tests will use a calibrated and operable survey instrument to check leak test samples for gross contamination before they are analyzed.
- An NaI(Tl) well counter system with a single or multichannel analyzer will be used to count samples from XRFs containing gamma-emitters (e.g., Cd-109, Co-60).

Frequency for Conducting Leak Tests of Sealed Sources

- Leak tests will be conducted at the frequency specified in the respective SSDR Certificate.

Procedure for Performing Leak Testing and Analysis

- For each source to be tested, list identifying information such as gauge serial number, radionuclide, and activity.
- If available, use a survey meter to monitor exposure.
- Prepare a separate wipe sample (e.g., cotton swab or filter paper) for each source.
- Number each wipe to correlate with identifying information for each source.
- Wipe the most accessible area where contamination would accumulate if the sealed source were leaking.
- Select an instrument that is sensitive enough to detect 0.005 microcurie (185 Bq) of the radionuclide contained in the gauge.
- Using the selected instrument, count and record background count rate.

- Check the instrument's counting efficiency using standard source of the same radionuclide as the source being tested or one with similar energy characteristics. Accuracy of standards should be within +/-5 percent of the stated value and traceable to a primary radiation standard such as those maintained by the National Institutes of Standards and Technology (NIST).
- Calculate efficiency.

For example: $\frac{[(\text{cpm from std}) - (\text{cpm from bkg})]}{\text{activity of std in Bq}}$ = efficiency in cpm/Bq

where: cpm = counts per minute
std = standard
bkg = background
Bq = Becquerel

- Count each wipe sample; determine net count rate.
- For each sample, calculate and record estimated activity in Bq (or microcuries).

For example: $\frac{[(\text{cpm from wipe sample}) - (\text{cpm from bkg})]}{\text{efficiency in cpm/Bq}}$ = Bq on wipe sample

- Sign and date the list of sources, data, and calculations. Retain records for 5 years.
- If the wipe test activity is 0.005 microcurie (185 Bq) or greater, notify the RSO so that the source can be withdrawn from use and disposed of properly. Also notify VDH.

Appendix K

Major DOT Regulations

Major DOT Regulations

The major areas in the DOT ***regulations that are most relevant for transportation of Type A quantities are as follows:***

* ***Table of Hazardous Materials and Special Provisions* 49 CFR 172.101*, and App. A, Table 2: Hazardous materials table, list of hazardous substances and reportable quantities***

* ***Shipping Papers* 49 CFR 172.200-204: *general entries, description, additional description requirements, shipper's certification***

* ***Package Markings* 49 CFR 172.300, 49 CFR 172.301, 49 CFR 172.303, 49 CFR 172.304, 49 CFR 172.310, 49 CFR 172.324*: General marking requirements for non-bulk packagings, prohibited marking, marking requirements, radioactive material, hazardous substances in non-bulk packaging***

* ***Package Labeling* 49 CFR 172.400, 49 CFR 172.401, 49 CFR 172.403, 49 CFR 172.406, 49 CFR 172.407, 49 CFR 172.436, 49 CFR 172.438, 49 CFR 172.440*: General labeling requirements, prohibited labeling, radioactive materials, placement of labels, specifications for radioactive labels***

* ***Placarding of Vehicles* 49 CFR 172.500, 49 CFR 172.502, 49 CFR 172.504, 49 CFR 172.506, 49 CFR 172.516, 49 CFR 172.519, 49 CFR 172.556*: Applicability, prohibited and permissive placarding, general placarding requirements, providing and affixing placards: highway, visibility and display of placards, RADIOACTIVE placard***

* ***Emergency Response Information, Subpart G,* 49 CFR 172.600, 49 CFR 172.602, 49 CFR 172.604*: Applicability and general requirements, emergency response information, emergency response telephone number***

* ***Training, Subpart H,* 49 CFR 172.702, 49 CFR 172.704*: Applicability and responsibility for training and testing, training requirements***

* ***Radiation Protection Program for Shippers and Carriers, Subpart I,* 49 CFR 172.800, *etc.***

* ***Shippers - General Requirements for Shipments and Packaging, Subpart I,* 49 CFR 173.403, 49 CFR 173.410, 49 CFR 173.412, 49 CFR 173.415, 49 CFR 173.433, 49 CFR 173.435, 49 CFR 173.441, 49 CFR 173.475, 49 CFR 173.476*: Definitions, general design requirements, additional design requirements for Type A packages, authorized Type A packages, requirement for determining A_1 and A_2, table of A_1 and A_2 values for radionuclides, radiation level limit, quality control requirements prior to each shipment, approval of special form radioactive materials***

* ***Carriage by Public Highway* 49 CFR 177.816, 49 CFR 177.817, 49 CFR 177.834(a), 49 CFR 177.842*: Driver training, shipping paper, general requirements (secured against movement), Class 7 (radioactive) material***

XRFs are generally shipped either as excepted packages for limited quantities of radioactive material. Packages containing XRFs may be shipped as limited quantities if the radiation level at any point on the external surface of the package does not exceed 0.005 mSv/hour (0.5 mrem/hour). Packages with higher radiation levels are shipped as Type A packages. The following tables summarize labeling, marking, and shipping paper requirements for Type A packages.

Labeling Packages (49 CFR 172.400-450) NOTE: IAEA, ICAO, and IMO may require additional hazard communication information for international shipments. This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials.			
• Labeling is required to be: (1) placed near the required marking of the proper shipping name, (2) printed or affixed to the package surface, (3) in contrast with its background, (4) unobscured by markings or attachments, (5) within color, design, and size tolerance, and (6) representative of the HAZMAT contents of the package. • Two labels are required on opposite sides of the package, excluding the bottom.			
Determination of Required Label			
Size: *Sides:* ≥ 100 mm *Border:* 5-6.3 mm	 49 CFR 172.436	 49 CFR 172.438	 49 CFR 172.440
	WHITE-I	YELLOW-II	YELLOW-III
Required when:	Surface radiation level ≤ 0.005 mSv/hour (0.5 mrem/hour)	0.005 mSv/hour (0.5 mrem/hour) < surface radiation level ≤ 0.5 mSv/hour (50 mrem/hour)	0.5 mSv/hour (50 mrem/hour) < surface radiation level ≤ 2 mSv/hour (200 mrem/hour)
Or:	TI = 0 [1 meter dose rate < 0.5 mrem/hour]	TI ≤ 1 [1 meter dose rate ≤ 1 mrem/hour]	1 < TI ≤ 10 [1 meter dose rate ≤ 10 mrem/hour]
Content on Radioactive Labels			
RADIOACTIVE label must contain (entered using a durable, weather-resistant means): (1) The radionuclides in the package. Symbols (e.g., Cs-137) are acceptable. (2) The activity in SI units (e.g., Bq, TBq) or both SI units with customary units (e.g., Ci, mCi) in parenthesis. (3) The Transport Index (TI) in the supplied box. The TI is entered only on YELLOW-II and YELLOW-III labels.			
Some Special Considerations for Labeling Requirements			
• Radioactive material, excepted packages (e.g., Limited Quantity, Radioactive Instrument and Article) are excepted from labeling. • The "Cargo Aircraft Only" label is typically required for radioactive materials packages shipped by air [§172.402(c)]			

Marking Packages (49 CFR 172.300-308)		
NOTE: IAEA, ICAO, and IMO may require additional hazard communication information for international shipments. This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials.		
Always Required, Unless Excepted	**Sometimes Required**	**Optional**
• Proper shipping name • U.N. Identification Number • Name and address of consignor or consignee, unless: -Highway only and no motor carrier transfers, or -Part of truckload lot and entire contents of freight container are shipped from one consignor to one consignee (§172.301(d))	• If in excess of 50 kg, Gross Weight • If hazardous substance, "RQ" in association with the proper shipping name • The package type if Type A or Type B (1/2" or greater letters) • The specification-required markings (see §178.350-353) • For approved packages, the certificate ID number	• Both the name and address of consignor and consignee are recommended. • Other markings (e.g., advertising) are permitted, but must be sufficiently away from markings and labeling
Some Special Considerations for Marking Requirements		
• Marking is required to be (1) durable, (2) printed on a package, label, tag, or sign, (3) unobscured by labels or attachments, (4) isolated from other marks, and (5) be representative of the hazmat contents of the package. • Limited quantity packages (§173.421) must bear the marking "radioactive" on the outside of the inner package, or the outer package itself, and are excepted from other marking. • Empty (§173.428) and Radioactive Instrument and Article (§173.424) packages are excepted from marking.		

DOT Shipping Papers (49 CFR 172.200-205)	
NOTE: IAEA, ICAO, and IMO may require additional hazard communication information for international shipments. This table must not be used as a substitute for the DOT and NRC regulations on the transportation of radioactive materials.	
Always Required, Unless Excepted	**Sometimes Required**
• The basic description, in sequence Proper shipping name Hazard Class (7) U.N. Identification Number • 24 hour emergency response telephone number • Name of shipper • Proper page numbering (Page 1 of 4) • The total quantity (mass), in appropriate units • The name of each radionuclide and total package activity. The activity must be in SI units (e.g., Bq, TBq) or both SI units and customary units (e.g., Ci, mCi). • For each labeled package: - The category of label used - The transport index of each package with a Yellow-II or Yellow-III label - Shipper's certification (not required of private carriers)	• If hazardous substance, "RQ" as part of the basic description **Optional** • The type of packaging (e.g., Type A) • Other information is permitted (e.g., functional description of product), provided it does not confuse or detract from the proper shipping name or other required information • Emergency response hazards and guidance information (§§172.600-604) may be entered on the shipping papers, or may be carried with the shipping papers

Some Special Considerations/Exceptions for Shipping Paper Requirements
• Shipments of Radioactive Material, excepted packages, under UN2908-UN2911 (e.g., Limited Quantity, Empty, or Instrument and Article), are excepted from shipping papers. For limited quantities (§173.421), this is only true if the limited quantity is not a hazardous substance (RQ) or hazardous waste. • Shipping papers must be in the pocket on the left door, or readily visible to a person entering the driver's compartment and within arm's reach of the driver. • For shipments of multiple cargo types, any HAZMAT entries must appear as the first entries on the shipping papers, be designated by an "X" (or "RQ") in the hazardous material column, or be highlighted in a contrasting color.

Appendix L

Model Delegation of Authority (RSO)

Memo to: Radiation Safety Officer

From: Chief Executive Officer

Subject: Delegation of Authority

You, _____, have been appointed Radiation Safety Officer and are responsible for ensuring the safe use of radiation. You are responsible for managing the radiation protection program; identifying radiation protection problems; initiating, recommending, or providing corrective actions; verifying implementation of corrective actions; stopping unsafe activities; and ensuring compliance with the rule. You are hereby delegated the authority necessary to meet those responsibilities, including prohibiting the use of radioactive material by employees who do not meet the necessary requirements and shutting down operations where justified by radiation safety. You are required to notify management if staff do not cooperate and do not address radiation safety issues. In addition, you are free to raise issues with the Virginia Department of Health, Radioactive Materials Program at anytime. It is estimated that you will spend _____ hours per week conducting radiation protection activities.

_____

Signature of Management Representative

I accept the above responsibilities,

_____

Signature of Radiation Safety Officer

cc: Affected department heads.

Appendix M

VDH Form

‘Certificate of Disposition of Materials’

Virginia Department of Health
Radioactive Materials Program
(804) 864-8150

CERTIFICATE OF DISPOSITION OF MATERIALS

Completion of this form is required to complete termination of a Radioactive Material License as outlined in **12VAC5-481-500**. Failure to provide information will result in this request for termination of a specific license not being processed.

Instructions – Complete all items. Retain one copy and submit original to Virginia Department of Health, Radioactive Materials Program, 109 Governor Street, Room 730, Richmond, VA 23219.

CONTACT INFORMATION

Item 1 Name and Mailing Address of Applicant:	**Item 2 Virginia Radioactive Material License Number**
	Item 3 Contact Person – Name
, -	**Contact Person - Telephone Number** (Include area code) ( ) - x

TERMINATION AND DISPOSITION INFORMATION

The following information is provided in accordance with **12 VAC 5-481-510.** (Check all that apply)

☐ **Item 4** All use of radioactive material authorized under the above referenced license has been terminated.

☐ **Item 5** Radioactive contamination has been removed to the levels outlined in **12VAC5-481-1161 B.**

☐ **Item 6** All radioactive material previously procured and/or possessed under the authorization granted by the above referenced license has been disposed of as follows. (Check all that apply)

☐ Transferred to: Name Address

Who is (are) authorized to possess such material under Licensed Number:

Issued by (Licensing Agency):

☐ Decayed, surveyed and disposed of as non-radioactive waste.

☐ No radioactive material has ever been procured and/or possessed by the licensee under the authorization granted by the above referenced license.

☐ Other (Attach additional pages)

☐ **Item 7** Attached are radiation surveys or equivalent as specified in **12VAC5-481-510 L**. Specify the survey instrument(s) used and certify that each instrument is properly calibrated as required in **12VAC5-481-510 K**.

☐ **Item 8** Records required to be maintained for the license termination requested are available at the following location(s):

Name:

Address:

Contact Person Telephone Number: ( ) - x

Additional remarks (Attach additional pages if necessary.)

CERTIFICATION (To be completed by an individual authorized to make binding commitments on behalf of the applicant.)

Item 10.

The undersigned, on behalf of the licensee, hereby certifies that licensable quantities of radioactive material under the jurisdiction of the Virginia Department of Health are not possessed by the licensee. It is therefore requested that the above referenced radioactive material license be terminated.

SIGNATURE - Applicant or Authorized Individual	**Date signed**

Print Name and Title of above signatory

Section 6

Schneider Laboratories Inc.
Quality Assurance Plan

SCHNEIDER LABORATORIES GLOBAL, INCORPORATED
analyzing the world

Document #AD-002-15-003
Original Date: 9/16/2010
Revision Date: 08/06/2015
Effective Date: 08/14/2015

2512 West Cary Street ● Richmond, Virginia 23220-5117
804-353-6778 ● 800-785-LABS (5227) ● Fax 804-359-1475

Quality Manual

Authorized By:

Technical Director — Raja Abouzaki

General Manager — Fayez Abouzaki

Quality Assurance Director — Irma Faszewski

Schneider Laboratories Global, Inc.
Quality Assurance Manual
Table of Contents

Floor plans and organizational charts may be updated without issuing a new version of the Quality Manual.

SCHNEIDER LABORATORIES GLOBAL, INC.
MISSION STATEMENT

We require complete honesty and integrity in everything we do.

We respect the individual, and believe that individuals, who are treated with respect and given responsibility, respond by giving their best.

We love to compete, and believe that competition brings out the best in all of us.

We are frugal. We conserve the company's resources with the same diligence that we would conserve our own personal resources.

We insist on giving our best effort in everything we do.

Clarity in understanding our mission, our goals, and what we expect from each other is critical to our success.

We make commitments with care, then honor our commitments. We do what we say and say what we do.

We are believers in the Golden Rule. We treat others the way we want to be treated. In all our dealings we must strive to be friendly and courteous, as well as fair and compassionate.

We need to always listen and be responsive to our customers. We are a customer driven company.

We must never forget that we work in union with our customers to fulfill our ultimate goal, which is to make our world a cleaner and safer place for current and future generations to enjoy.

1. Introduction

1.1. Statement of Purpose

The Schneider Laboratories Global purpose is to meet the needs of our customers for high quality, cost-effective analytical services. Schneider Laboratories Global, Inc. (SLGI) is a commercial analytical testing laboratory located in Richmond, Virginia specializing in industrial hygiene and environmental analyses. SLGI performs airborne asbestos dust evaluation by Phase Contrast Microscopy (PCM) and asbestos analysis of bulk building materials by Polarized Light Microscopy (PLM). Metals analyses on air filter, dust wipe, paint chip, soil, wastewater, drinking water, and TCLP leachate samples are performed by Flame or Graphite Furnace Atomic Absorption Spectroscopy (FAA or GFAA) and/or by Inductively Coupled Plasma (ICP). Organics parameters are identified and quantified in industrial hygiene and environmental matrices by Gas Chromatography (GC), Gas Chromatography / Mass Spectrometry (GC/MS), High Performance Liquid Chromatography (HPLC) and Fourier-Transform Infra-Red Spectroscopy (FTIR). Silica testing is performed by FTIR and selected inorganic analytes are performed by Ion Chromatography (IC), and Flow Injection Analyzer (FIA, Lachat) and various classical wet chemistry methods. SLGI provides customer-centered service to government, private business, industry and individuals.

1.2. Management system Review

The management system established by the laboratory is reviewed annually to assure continued effectiveness, and to assure that it is up-to-date with all changes which occurred within that period. The objective of the management system and the commitment of management are to consistently provide our customers with data of known and documented quality that meets or exceeds their requirements. Review findings are used to update policies and protocols so that actual practice is reflected in laboratory documents. The laboratory ensures that personnel are free from any commercial, financial, and other undue pressures which might adversely affect the quality and objectivity of their work. Management's commitment to the Management system is stated in the Quality Policy, which is upheld through the application of related policies and procedures. All staff members have provided a signed commitment to adhere to the policies and procedures as documented in the Quality Manual. The Quality Assurance Director and Laboratory Director bear specific responsibilities for the maintenance of the Management systems. This includes defining roles and responsibilities to personnel, approving documents, providing required training, supporting a procedure for confidential reporting of data integrity issues, and an annual review of data, procedures, and documentation.

1.3. Control and Maintenance of Quality Manual

The SLGI Quality Manual outlines and describes aspects of operation which together build a reliable and accurate testing program. The manual addresses the structure of the organization directed toward ensuring quality performance. The

Quality Manual is a document summarizing policies that are detailed in SLGI Standard Operating Procedures (SOPs). The manual is updated as needed by the Quality Assurance Director to reflect actual laboratory practice in addition to annual review. Reviews, changes, additions, and deletions are noted on the Revisions Log located with the master copy of the manual in the company library.

Since every employee shall be aware of all quality assurance practices in use, the Quality Manual is circulated electronically annually to all technical employees for review. After refreshing their familiarity of the manual, employees sign the Employee Review Log located with the master copy of the manual in the company library The Quality Manual with its appendices is maintained in the company library and is available at all times to SLGI personnel. Copies of the controlled Quality Manual are located on the internal website as a read-only document whereas the controlled copy is maintained in the QA office.

This Quality Manual uses the references from ISO 17025, 2003 and NELAC Standard, as well as AIHA-LAP, LLC and NVLAP specific requirements.

2. Organization and Responsibility

2.1. Organization Structure

SLGI is an independent analytical laboratory dedicated to customer-centered service of the highest quality. The President/CEO works closely with the General Manager, Laboratory Director, QA Director, Department Managers, Data Systems Director, and the Director of Contracts and Social Media to set the goals for the laboratory and to design a strategic plan to reach these goals. SLGI does not perform any other activities beyond sample testing to insure complete integrity and impartiality in its findings. The General Manager is responsible for the day to day operation and management of the laboratory. All staff members are accountable for portions of the management system according to the nature and responsibilities of their positions. Responsibilities include accountability to all stated quality assurance policies, including all policies that assure compliance with certifying and accrediting agencies and applicable ISO/IEC 17025 standards, and adherence to all policies described in the laboratory's Employee Manual and Standard Operating Procedures Manuals. All staff members interact to communicate specific customer requests and provide service that meets customers' needs.

Day to day functions are supervised by the General Manager. In the absence of the General Manager, the Laboratory Director, or Quality Assurance Director is the back-up in that order.

.

The chain of command for day to day functions is as follows:

General Manager
Laboratory Director
Quality Assurance Director

Designated alternates are appointed by the General Manager, Laboratory Director or Quality Assurance Director during their absence and always if the absence is more than 15 days.

2.2. Personnel Responsibilities to Quality Assurance

All personnel are responsible for complying with all quality assurance and quality control requirements that pertain to their organizational and/or technical function. Each technical staff member must have a combination of education and experience appropriate for the position as defined by the Laboratory Director and the QA Director. He or she must adequately demonstrate the specific knowledge of his/her particular function and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures and records management as relevant to the position. Laboratory management is responsible for ensuring that all technical laboratory staff has demonstrated capability in the activities which they perform and is responsible for providing appropriate documentation.

2.3. Organizational Chart

The attached organizational chart outlines the SLGI structure and chain of command. Maintaining and up-dating the organizational chart is the responsibility of the on-site VP for Contracts & Marketing. See Appendix A.

2.4. Job Descriptions and Responsibilities

2.4.1. General Manager

The General Manager is the coordinator of all laboratory areas and holds the responsibility for overall effective laboratory operations. He/she is knowledgeable about all laboratory practices and services, and is heavily involved in building customer relationships as a company representative. The General Manager works closely with the Laboratory Director and Quality Assurance Director on day-to-day matters as well as long-range planning. The General Manager shall ensure that the integrity of the management system is maintained if and when changes to the management system are planned and implemented. The General Manager oversees staff, testing, training, and quality assurance practices within the laboratory. The General Manager is available during at least 50 percent of the lab's operating hours to address technical issues for laboratory staff and customers.

2.4.2. Laboratory Director

The Laboratory Director exercises day-to-day supervision of the laboratory operation. The duties of the Laboratory Director include, but are not limited to, monitoring the validity of the analyses performed and the data generated in the laboratory to assure reliable data. The Laboratory Director is an approved signatory for the departments, and may designate others who are qualified to review and

release reports. The Laboratory Director shall ensure that adequate supervision is provided for all laboratory technical personnel.

The Laboratory Director must be advised by analysts of any non-routine or special customer requests, sample quantities, or submitted samples. Any departures from standard operating procedure must be approved beforehand by the Laboratory Director, General Manager and/or the Quality Assurance Director. Although the Laboratory Director will not be involved in every analysis, he must monitor the work being done and oversee quality and service to customers.

The Laboratory Director is available during at least 50 percent of the lab's operating hours to address technical issues for laboratory staff and customers. The Laboratory Director shall possess a bachelor's degree in an applicable physical or biological science. The general requirement for minimum experience for a Laboratory Director is three years relevant nonacademic analytical chemistry experience, with a minimum of two years in industrial hygiene analyses within the scope of accreditation. The Laboratory Director works closely with the General Manager, Quality Assurance Director, Department Managers and Supervisors, Data Systems Manager, and Project Managers, and Team Leaders on a daily basis to coordinate all aspects of sample analysis for that department.

2.4.3. Quality Assurance Director

The Quality Assurance Director is responsible for the development, implementation, and on-going assessment of a Quality Assurance Program. He/She shall possess a college degree in a basic science and have at least one year of non-academic analytical chemistry experience, or in lieu of a degree, 4 years of nonacademic analytical chemistry experience. Documented training in statistics is required; training in quality control procedures is strongly encouraged. The Quality Assurance Director has direct access to the laboratory and functions independent of the operations of the laboratory. The QAD shall ensure and document that personnel with appropriate education and/or technical background perform all analyses for which the laboratory is accredited. The Laboratory Director shall ensure that adequate supervision is provided for all laboratory technical personnel. The Quality Assurance Director is available during at least 50 percent of the lab's operating hours to address technical issues for laboratory staff and customers.

The QA program conforms to the recommendations and requirements of SLGI accrediting and standard-setting agencies including, but not limited to, NELAC, AIHA, ELLAP, NVLAP, and ISO/IEC 17025. The program is continually evaluated and modified to conform to all requirements of certifying and accrediting agencies. The QAD oversees and/or accomplishes the design and implementation of a quality assurance (QA) program, the establishment of frequency and type of quality control (QC) samples to be analyzed, the summary and analysis of QC data, the correction of problems indicated by QC, the proper storage and integrity of analytical and QC data, the appropriate audits of analysis results and the overall

program, and the documentation of management system deficiencies. The QAD may be a designee for many of the tasks administrated by the TM, and in turn may delegate certain duties to staff with appropriate skills, knowledge, and resources for efficient implementation. Often, the tasks defined for the QAD are initiated by analytical staff as analyses are developed and validated in direct accordance with published methods.

In addition to a minimum of one (1) annual audit by the QAD, ongoing reviews include examination of all proficiency testing data, preparation and/or review of monthly and/or quarterly control chart summaries, and review of any corrective actions taken by analysts to counteract unacceptable internal quality standards. The QAD may elect to audit the lab or an individual department or analyst at any time. The QAD's reviews are summarized quarterly in a report submitted to the management staff.

The QAD is responsible for coordinating, overseeing, and/or accomplishing the establishment and review of Standard Operating Procedures and the administration and maintenance of accreditation. The QAD coordinates document control of SOPs, MDLs, and Control Limits. He/She reviews a percentage of all final reports for internal consistency. The COC, correspondence with the initial request, QC and data package requirements and any relevant corrective actions are reviewed.

The QAD has access to the highest level of management. The QAD is responsible for working with technical managers to educate all analysts and other associated employees about evaluation of standard quality control measures. The QAD works as an information liaison between the departments and accrediting authorities and oversees the distribution and return of all proficiency samples within the required time frames. In the absence of the Quality Assurance Director, a quality assurance officer or technical manager may serve as a deputy.

2.4.4. Research & Development Director

The Research & Development Director is responsible for pursuing additional testing avenues when brought to his attention by either Customer Services, the VP of Contracts & Social Media, or senior management. This may consist of a feasibility study and it requires working directly with the department supervisors, Quality Assurance, and the Laboratory Director.

2.4.5. Director of Contracts and Social Media

The Director of Contracts and Social Media works closely with the General Manager, Quality Assurance Director, Project Managers, and customers to administrate contracts and bids on behalf of the laboratory. The contracts and bids are reviewed with respect to the laboratory's accreditations, certifications, and technical capabilities to perform the services required. The Director is responsible

for the information and advertising through social media outlets such as Facebook, Twitter and Linked-In.

2.4.6. Project Manager

The Project Manager (PM) acts as a liaison between the customer and the laboratory. Each customer is assigned to a PM who handles all communication from the initiation of a project until its completion. The PM knows the customer, understands his/her needs, and communicates these needs to the laboratory staff, allowing the laboratory to perform specialized services for the customer. The PM relates technical concerns about sample condition or acceptability to the customer and documents customer instructions. The PM is involved with special requests, accelerated turn-around times, reporting requests, and project details to assure that the customer receives the requested testing services to meet his/her needs.

2.4.7. Department Supervisor

The Department Supervisor exercises actual day-to-day supervision of the designated laboratory department. The laboratory may appoint multiple Department Supervisors in order to supply the most qualified staff supervision for each technical area. The Department Supervisor is qualified to perform the testing done in the department. The duties of the Department Supervisor include, but are not limited to, monitoring the validity of the analyses performed and the data generated in the laboratory to assure reliable data. The Dept. Supervisor oversees staff, testing, training, and quality assurance practices within his/her designated department. In the absence of a Department Supervisor, his/her duties are

2.4.8. Quality Assurance Officer

The laboratory may employ a Quality Assurance Officer (QAO) or assign specific QAO duties to an experienced analyst who continues to work at the bench. The QAO works under the supervision of the QAD and assists in carrying out the duties described for the QAD. Additionally, the QA Officer administrates the application and renewal processes for laboratory certifications and accreditations. Duties of the QA Officer will vary, as this position supports and assists the QA Director in day-to-day tasks relating to quality assurance and quality control in the laboratory.

2.4.9. Analysis Staff

Specific duties of analysis staff personnel vary by department, methods, and workload testing needs. Technical personnel are responsible for strict adherence to laboratory protocols as established in published methods and laboratory standard operating procedures. All analysis staff personnel are trained through the in-house training program, regardless of external qualifications and experience. The laboratory retains documentation of analysts' training and demonstration of capability.

2.4.9.1. Chemist

Chemists employed by the laboratory possess a minimum of a bachelor's degree in chemistry, or a bachelor's degree in another science with a minimum of one year of relevant experience, or 5-7 years of relevant experience and evidence of superior technical knowledge in the field.

Chemists may perform tasks in addition to routine sample analysis, including but not limited to research and development projects and method validation studies under the direction of the Technical Manager. Chemists may supervise the work of Analysts in day-to-day situations. Much of the work done by a Chemist falls under the description of tasks done by an Analyst. The Chemist completes the in-house training program defined for an Analyst, and is capable of carrying out all duties outlined for an Analyst.

2.4.9.2. Analyst

Analysts employed by the laboratory possess a minimum of a bachelor's degree, or an associate's degree with one year of relevant supervised experience, or a high school diploma with three years of relevant supervised experience. An Analyst with less than three (3) years experience works under the direct supervision of a Technical Manager, a Chemist, or an Analyst with greater than three years experience. Analysts shall have completed a training course administered within SLGI, including sample preparation and analysis techniques, and have demonstrated the ability to produce reliable results using established laboratory protocol. Analysts and technicians shall have a minimum of twenty business days of hands-on experience conducting analyses in an industrial hygiene laboratory before initiation of independent work on customer samples.

An Analyst is responsible for accurate and timely turn-around of customer samples. Every analysis must be performed according to established protocol using all quality control guidelines. The Analyst is responsible for prioritizing all samples and facilitating their preparation and analysis to meet required sample holding times and deadlines specified by the customer. The Analyst is also responsible for keeping clear, understandable records of maintenance, quality control, and customer sample data. He/She is responsible for instrument maintenance, cleaning, and upkeep, as well as maintenance and quality control monitoring of all auxiliary equipment. Analysts keep abreast of inventory needs, advise the Technical Manager of workload, and ensure proper cleanliness and order of the working area to avoid unnecessary confusion, error in sample processing, or safety hazard. Analysts shall be self-motivated. Although he/she works under the guidance of the Technical Manager, the analyst shall be competent at performing his/her typical duties without direct supervision.

2.4.9.3. Technician

Technicians employed by the laboratory possess a minimum of a high school or equivalent degree, or one year of relevant supervised experience. Technicians shall have completed a training course administered within SLGI for his/her specified duties and shall have demonstrated the ability to produce reliable results using established laboratory protocol. Analysts and technicians shall have a minimum of twenty business days of hands-on experience conducting analyses in an industrial hygiene laboratory before initiation of independent work on customer samples.

A Technician assists in the preliminary sample handling. Technicians are capable of preparing customers' and quality control samples for analysis. Although Technicians work closely with Analysts, they shall be self-starters and capable of handling routine samples without direct supervision. All Technicians shall show careful attention to detail and accuracy.

2.4.9.4. Microscopist

A Microscopist employed by the laboratory is trained to perform either micro analysis, mold analysis, airborne asbestos dust evaluations and/or asbestos identification in bulk building materials. All Microscopists performing work on air samples have taken the NIOSH 582 course (or equivalent) for sampling and evaluating airborne asbestos dust. Similarly, analysts performing asbestos identification in bulk building materials have taken an approved course of instruction in the identification of asbestos given by McCrone Institute or equivalent. In-house training continues until full proficiency is established. All analysts participate in proficiency analysis tests and inter-laboratory round robins.

The Microscopist is responsible for accurate and timely turn-around of customer samples. Every analysis must be performed according to established protocol using all quality control guidelines. Samples are prioritized so that deadlines specified by the customer are met. The Microscopist must be self-motivated and capable of working independently.

2.4.10. Supervisor; Team Leader

The General Manager or Laboratory Director may appoint members of the staff as Supervisors or Team Leaders within a department. Designation of Supervisors is done to provide adequate staff management in the work areas. Supervisors and Team Leaders have demonstrated the ability to lead their peers in the workplace and have successfully performed the tasks they are assigned to supervise. Supervisors and Team Leaders provide a point-of-contact for other staff members and often communicate information from another work area to the staff members they supervise. Supervisors and Team Leaders work closely with the Technical Lab Director on a day-to-day basis.

2.4.11. Data Systems Director

The Data Systems Director oversees the computerized data handling and storage procedures. Responsibilities include supervising the backup of data, incorporation of new tests and procedures into an electronic format, maintenance of data tables which comprise the operational structure of the informational database, maintenance and updates of hardware and software, and training of employees on use of the data management systems. The Data Systems Manager works closely with all laboratory departments to assist in the use of computer features helpful to their tasks. The Data Systems Director is responsible for assuring the integrity of the data storage and planning for future growth.

2.4.12. Data Technician

A Data Technician is responsible for sample receipt, login, labeling, and reporting. The Data Technician prioritizes samples according to holding times and customer-requested turn around times and uses the LIMS system to record customer, project, work order, and sample data to allow efficient handling, tracking, and unique identification of samples. A Data Technician shows careful attention to detail and accuracy.

2.4.13. Customer Services Technician

A Customer Services Technician assists with sample receipt, front desk assistance to customers, media supply to customers, and shipping concerns of staff members and customers.

2.4.14. Hazardous Waste Coordinator

The Hazardous Waste Coordinator reports directly to the Laboratory Director. She is responsible for staying current with local, state, and federal guidelines. She conducts new hire health and safety training and annual follow-ups. She works with the department supervisors and senior management in an attempt to minimize the volume of hazardous waste generated.

2.5 Training Policies

Department Managers, Supervisors, or Team Leaders are responsible for identifying training needs and ensuring that staff members are appropriately trained for their designated duties. Staff members who are undergoing training are provided with appropriate supervision. Department Managers, Supervisors, or Team Leaders evaluate the effectiveness of training and authorize its completion.

Each department has designated training protocols and authorization and qualification forms appropriate for the specific tasks within the department. The dates of training are documented on each training form. The training also includes a minimum of 20 business days of supervised training. In addition an Initial

Demonstration of Capability is performed using certified reference materials as documented in the NVLAP, 2003 NELAC and the ISO/IEC 17025 standards for analysts and technicians. Training records containing signed authorizations to perform analysis as well as initial and continuing demonstrations of capability performed every six months are maintained in the employee binders in the QA office.

3. Facilities

3.1. Location

Schneider Laboratories Global, Inc. is located in Richmond, Virginia at its independent facility at 2512 W. Cary Street. SLGI has no other branches or testing locations.

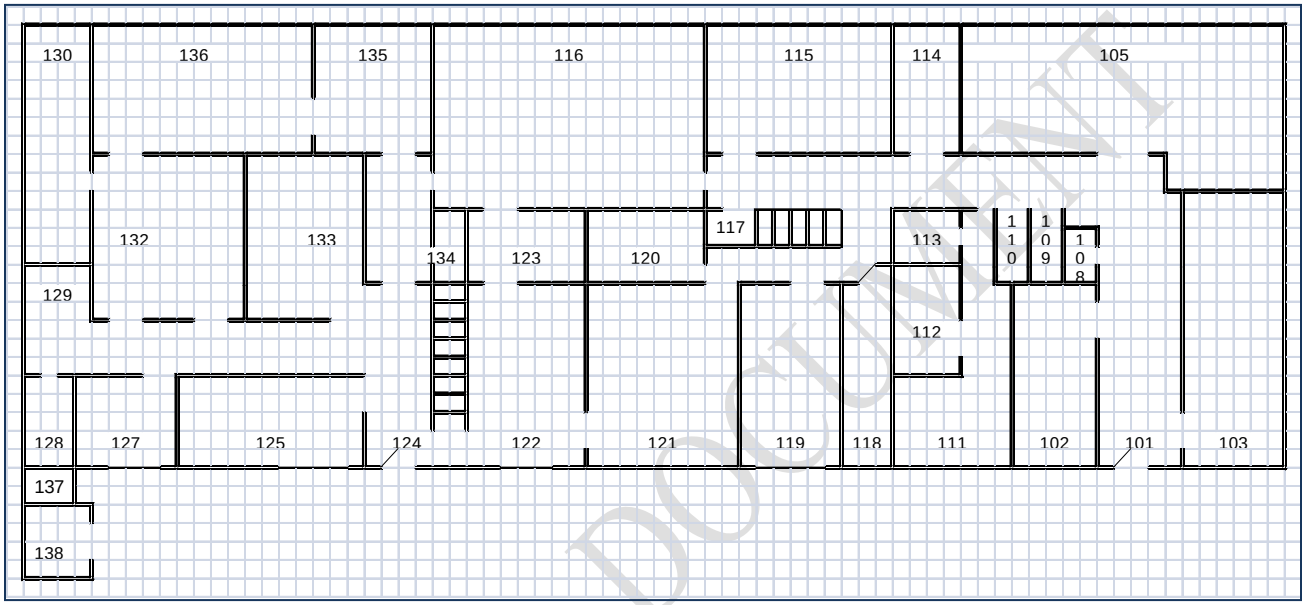
3.2. Summary Statement

SLGI facilities provide the space, equipment, instruments, ventilation, utility services, storage, safety equipment, and manuals required to safely, efficiently, and reliably perform analyses. The laboratory has security systems in place which restrict public access to testing areas. Internal design restricts access to hazardous areas and provides fire safety. Facilities are evaluated on an ongoing basis and renovated or remodeled as needed to accommodate all testing and safety needs.

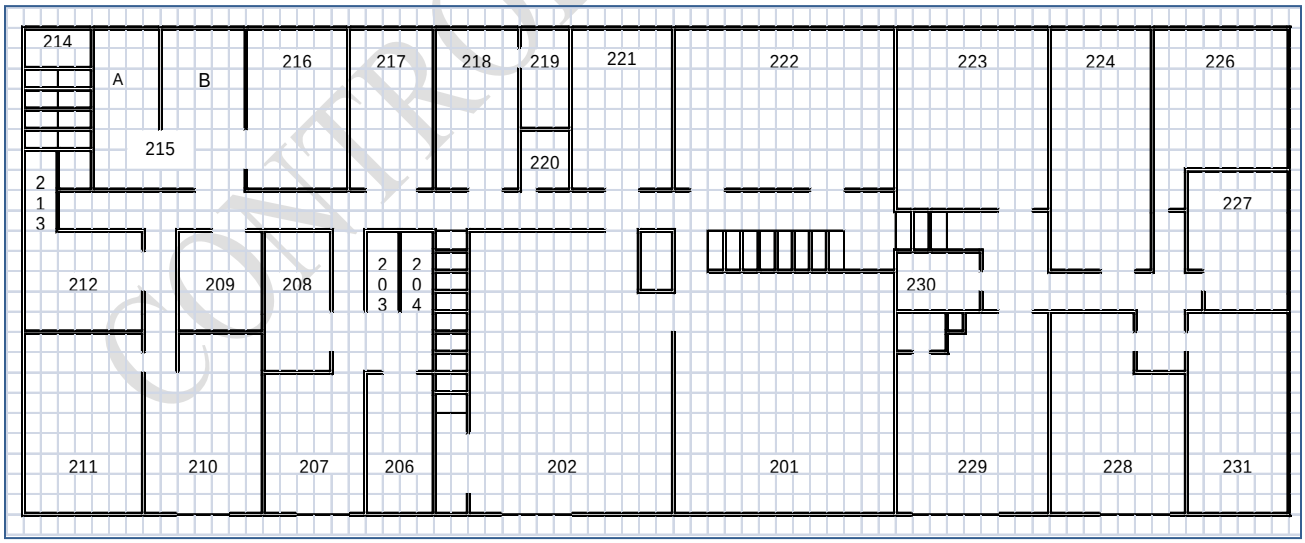
3.3. Floor Plan with Key

The following floor plan demonstrates the layout of the administrative, clerical and laboratory facilities.

Schneider Laboratories Global, Inc Facility



First Floor



Second Floor

Room #	Room Description	Room #	Room Description
101	Lobby / Main Phone and Fax	**201**	Semivolatiles Lab
102	Sample Receiving / Login	**202**	Volatiles Lab
103	Shipping / Media / Supply	**203**	Rest Room
105	Sample Receiving / Login	**204**	Rest Room
107	Sample Reporting	**206**	Gravimetric Lab
108	Storage Closet	**207**	FTIR Lab
109	Rest Room	**208**	HPLC Lab
110	Rest Room	**209**	PLM Lab
111	Kitchen and Vending Area	**210**	PLM Lab
112	Maintenance Closet / ADT / Phone Equipment	**211**	PLM Lab
113	Maintenance Closet	**212**	PCM Lab
114	Computer Room / File Server	**213**	Attic Access
115	Wet Chemistry Lab	**214**	PLM/PCM Storage / Stairway (not in use)
116	Organics Prep / Laboratory Hoods	**215A**	Microbiology Lab
117	Supply Closet	**215B**	Reduction Lab
118	Maintenance Closet/Electrical Service	**216**	Mold Lab
119	Customer Services Office	**217**	HPLC Prep Lab
120	Maintenance Closet	**218**	Kitchen
121	TCLP Prep Lab	**219**	Rest Room
122	Storage Area	**220**	Rest Room
123	Storage (with Tank Storage)	**221**	Lounge
124	Lobby	**222**	Industrial Hygiene Lab
125	ICP Lab	**223**	Accounting Office
127	Graphite Furnace Lab	**224**	IT Office
128	Glassware Storage	**226**	Conference Room
129	Glassware Cleaning	**227**	Accounting
130	Storage with DiH_2O Tanks	**228**	QA/QC Office
132	Flame AA Lab (100s, Tanks)	**229**	Lab Director Office
133	Metals - Sample Prep Lab	**230**	Copy / FAX
134	Rest Room	**231**	Contracts and Bids Office
135	Maintenance Closet		
136	Metal - Digestion Lab		
137	Compressor		
138	Storage Shed		

4. Quality Assurance Policies and Objectives

The top management and staff of Schneider Laboratories Global, Inc. are committed to the production of reliable analytical results through sound scientific practice, and to continual improvement of the effectiveness of the management system. It is the policy of Schneider Laboratories Global, Inc. to provide quality analytical laboratory services that meet or exceed the needs and expectations of its customers. Quality in analysis and customer-centered service together with cutting-edge technology make Schneider Laboratories Global, Inc. a leader in the laboratory industry. The QA Program is designed to monitor the implementation of this policy and maintain the standards established by SLGI accrediting agencies. SLGI management is committed to compliance with the 2003 NELAC Standard and the ISO/IEC 17025 standards. SLGI's top management encourages its employees to strive for ongoing improvement and enhancement of all services by providing training and listening to and acting upon their ideas and suggestions to continually improve the management system and the efficiency of quality analyses.

Top management at SLGI continually works to stay abreast of current developments in the industries it services to plan effectively for the company's future. This knowledge also aids in serving customers on a day-to-day basis. The management at SLGI is committed to maintaining the company's status as a leader in its industry.

Quality Control and Quality Assurance systems are in place to monitor performance throughout the laboratory system. The laboratory's Data Integrity Plan supports the objective for quality standards throughout all aspects of laboratory performance. All employees are responsible for working within the QA/QC structure monitored by Technical Mangers and the QA Director. Additionally, the laboratory has established an Annual Data Integrity Program, and all employees commit to uphold the data integrity policies established by the laboratory. Such a program ensures that laboratory staff members understand the technical and the ethical and legal responsibilities of their jobs, as well as the relevance of their actions in upholding the management system established by the laboratory management. The signatory sheet for the annual Data Integrity training is maintained with the original copy of the Quality Manual in the QA office. A Statement on Ethical Conduct is signed by all employees after initial training as evidence of this individual commitment. The Statement on Ethical Conduct and its signatory sheet are maintained with the original copy of the Quality Manual in the QA office. Employees are not subjected to undue pressures that may affect the quality of work. All employees have direct access to communicate any such concerns to the QA/QC Manager.

Each section described in this Quality Manual addresses a portion of the total QA program. Greater detail of these features of the QA program is documented in various SOPs. Together these documents provide complete details of the management systems in place in the laboratory.

5. Supplies, Reagents and Standards

All supplies, reagents and standards used in the laboratory meet or exceed the quality requirements of the methods in use for sample analysis. All reagents and chemical standards are inspected and labeled on receipt with dates of receipt and expiration. Chemical reagents are considered to have a minimum shelf life of 5 years unless otherwise specified by the vendor or unless degradation of the reagent is observed. It is the responsibility of the Department Managers, Supervisors, or Team Leaders to order supplies, consumables, and services of acceptable quality to meet the analytical needs of the test.

All purchased prepared standard and reference material providers must be accredited to ISO Guide 34 and ISO/IEC 17025. Neat materials will have a Certificate of Analysis showing purity. The vendor must supply the Certificate of Analysis indicating accreditation with ISO/IEC 17025 and ISO Guide 34 for all prepared standards and reference material. All certificates of analyses are stored in the analysis department and it is the responsibility of the Department Managers, Supervisors, or Team Leaders to maintain current records. Reference standards such as balance calibration weights must be NIST-traceable and must meet ISO/IEC 17025 specifications and documentation of compliance is required. Receipt of chemical standards is recorded and tracked by the lab. Each standard receives a unique identifier that is referenced when used by the lab so that traceability to the ISO/IEC 17025 certified source is maintained.

The laboratory accounting department maintains a list of suppliers. Contracts with suppliers are reviewed annually. Suppliers remain constant unless a contract is re-negotiated or past performance indicates a need for improved quality. This list can be consulted for information on supply procurement.

Standards used for instrument calibration and quality control in all analyses are certified and/or NIST traceable when available and must meet ISO/IEC 17025 requirements. Calibration service providers must have ISO/IEC 17025 accreditation. Documentation of compliance from the vendor is required.

Reference materials are substances that have concentrations that are sufficiently well established to use for calibration or as a frame of reference. Reference materials, where commercially available, are traceable to national standards of measurement, or to certified reference materials, usually by a Certificate of Analysis.

6. Equipment Calibration and Maintenance

Calibrations are made with ISO/IEC 17025 certified and/or NIST-traceable equipment, reagents, standards and second source standards. Laboratory documentation is maintained which facilitates traceability of all materials and results to appropriate ISO/IEC 17025 standards. Additionally, documentation allows tracking to the instrument, analyst, and reagents used in the analysis.

Equipment is calibrated and maintained as described in Standard Operating Procedures. Outside calibration services are provided by suppliers who are accredited ISO/IEC 17025 service providers only. All purchased equipment must be in compliance with ISO/IEC 17025 and display appropriate specifications on their certificate. The certificate must include the following:

ISO/IEC 17025 logo or reference
Estimation of uncertainty
Accreditation body for ISO/IEC 17025 certification

Calibration and maintenance is verified through evaluation of quality control samples. Any item of equipment that gives suspect results or has been shown by verification practices to otherwise be defective is taken out of service until such time that it is proven to be repaired or restored. Any such equipment is clearly identified as not-in-service. Any previous calibrations or tests that are suspected of being affected by faulty equipment are examined; corrective actions are taken at the discretion of the Laboratory Director.

A complete listing of current equipment is available with the original copy of the Quality Manual in the company library.

The laboratory procedure for safe handling, transport, storage, use and planned maintenance of measuring equipment to ensure proper functioning and in order to prevent contamination or deterioration is found in the instrument manual or maintenance log book. In some instances, this information may also be contained in the SOPs. Up-to-date instructions on the use and maintenance of equipment (including any relevant manuals provided by the manufacturer of the equipment) are readily available for use by laboratory personnel. All equipment is calibrated or checked before being placed into use to ensure that it meets laboratory specifications and any relevant standards.

Test equipment, including hardware and software, are safeguarded from adjustments which would invalidate the test results measured by limiting access to the equipment and using password protection and read-only where possible.

Support equipment includes, but is not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices, volumetric dispensing devices, and thermometers.

All support equipment is maintained in proper working order and records are kept of all repair and maintenance activities, including service calls. All raw data records are retained to document equipment performance.

All support equipment is calibrated or verified over the entire range of use with NIST traceable references where available. The results of the calibration of support equipment are within specifications or (1) the equipment is removed from service

until repaired, or (2) records are maintained of correction factors to correct all measurements. Microscopes, balances and weights are checked and calibrated by and outside ISO-17025 certified technician.

Support equipment such as balances, ovens, refrigerators, freezers, and water baths are checked with a NIST traceable reference each working day, prior to use.

Mechanical, volumetric dispensing equipment, including burettes (except Class A glassware), is checked for accuracy quarterly.

Glass micro-liter syringes have a certificate attesting to the established accuracy. If the certificate of accuracy for glass micro-liter syringes is not available, the accuracy of the syringe is demonstrated upon receipt and documented.

Records of maintenance to support equipment are documented in Instrument Maintenance Logs.

6.1. Asbestos

Each analyst is responsible for checking and calibrating his microscope daily and for ensuring that the microscope functions properly by keeping current all established maintenance procedures. Preparation equipment is maintained by the analyst or technician using the equipment; however, the ultimate responsibility for overseeing equipment maintenance in the asbestos area lies with the Laboratory Director.

6.2. Metals

Calibrations are done daily/as used in the metals analysis section on the Flame AA, Graphite Furnace AA, Mercury Analyzer, or ICP. All analysis results for a run are based on this calibration data, which is fully documented and kept in laboratory records. Individual SOPs for instrument use and for metals analysis, such as ME-033 for the FAA, ME-035 for GFAA and ME-036 for ICP analysis, outline specific calibration information. Support equipment used in sample preparation is maintained and/or calibrated on a routine basis with full documentation. The metals analysts are responsible for overseeing equipment maintenance in the metals area; however, the ultimate responsibility for overseeing equipment maintenance in the metals area lies with the Laboratory Director.

6.3. Organics

Calibrations and/or continuing calibration check standards are run in the organics analysis section with each batch of samples analyzed on the gas chromatograph or other instrumentation. All analysis results for a batch are based on this calibration data, which is fully documented. Individual SOPs for instrument use and for analysis of organic compounds outline specific calibration information. Support equipment used in sample preparation is maintained and/or calibrated on a routine

basis with full documentation. The organics analysts are responsible for overseeing equipment maintenance in the organics area; however, the ultimate responsibility for overseeing equipment maintenance in the organics area lies with the Laboratory Director.

6.4. Other Testing

All analyses which are calibration-dependent are carefully documented, related back to the batch or run number in which they were analyzed and quality-controlled appropriately. Testing which is not calibration-dependent is monitored with the introduction of samples of known content at established intervals. Additionally, all support equipment is carefully maintained to verify its operating condition at the time analysis was performed. For specific information for testing not described above, refer to the SOP for the test in question.

7. Sampling and Analysis

7.1. Sampling Methods and Materials

Information regarding appropriate sampling materials, sampling containers, preservatives, shipping instructions, and collection instructions is provided to all established and prospective customers upon request, and available on the lab's website. Collection instructions include the recommendation for field blanks when applicable. Sample collection media or materials appropriate for the analysis requested is supplied to customers upon request.

Schneider Laboratories Global, Inc. does not collect samples on behalf of its customers. Because sampling requirements may vary by state or region or by the administrator of a project, information provided by Schneider Laboratories Global, Inc. must be used at the discretion of the customer.

Complete information regarding analysis methods, sample type, sample media, and appropriate sample preservation is located on the laboratory's website at www.slabinc.com.

7.2. Basic Sample Acceptance

The laboratory collaborates with customers and/or their representatives in clarifying their requests and in monitoring of the laboratory performance related to their work.

The laboratory confidentiality policy is to not divulge or release any information to a third party without proper written authorization.

CONFIDENTIALITY NOTICE
This e-mail and any attachments may contain confidential or privileged information. If you are not the intended recipient, please advise by return e-mail

and delete this e-mail and any copies or links to this e-mail completely and immediately without forwarding to others.

It is the responsibility of the customer (or the sampler appointed by the customer) to provide the proper, full, and complete documentation appropriate to the sample collected, generally including: sample identification, the location, date, and time of collection, collector's name, preservation type, sample type, and special remarks.

Submitted samples shall be clearly labeled with a unique identification corresponding to written documentation. Sample labeling and documentation shall be done in indelible ink. If a sample contains more than one sample container then each sample's container will be identified with a unique alphabetic identifier. The unique alphanumeric identifier is documented in any logbooks, worksheets and/or internal documents. The specific test for each sample container will be documented in the Container Data entry tab in Sample Master. Containers, sample volumes, holding times, and shipping conditions shall be appropriate to the analysis requested. Further sample handling information can be found in SOP AD-017.

Sample integrity is checked using observable properties upon receipt at the laboratory, but acceptance of a sample by the laboratory does not assure that the sample has been properly collected. Because sampling is out of the control of the laboratory, Schneider Laboratories Global, Inc. has a "samples tested as received" policy. Laboratory staff evaluates samples for signs of damage, contamination, or improper collection, labeling, preservation, or shipping conditions. When required by method, temperature, pH, and/or free chlorine are tested and recorded on the chain-of-custody or laboratory worksheets. Any departures from standard conditions are noted on the job's paperwork. Where there is any doubt as to the sample's suitability for testing, where the sample does not conform to the description provided, or where the test required is not fully specified, the laboratory consults the customer for further instruction before processing. All correspondence is fully documented on laboratory records. Sample results may be reported with qualifying statements at the discretion of the Laboratory Director or his/her designee.

The minimum conditions an environmental sample must meet on receipt are:

temperature is checked with a calibrated IR gun;
actual temperature and corrected reading is provided;
pH and preservation is determined for aqueous samples as required.

If these conditions are not met, the customer is contacted prior to further processing.

The laboratory checks samples for the conditions above, where appropriate, to evaluate sample acceptance.

The following preservation checks are performed and documented upon receipt:

Thermal preservation;

a) For temperature preservation, the temperature must be </= 6°C and above freezing.
b) Samples that are delivered to the lab the same day that they are collected are likely to not have reached a fully chilled temperature. This is acceptable if there is evidence that the chilling process has begun, namely if ice is visible.
c) Record on the receipt form if ice is present and the temperature, both the observed temperature and the corrected temperature if the thermometer has a correction factor.

pH Checks

a) The pH of samples requiring acid/base preservation is checked upon sample receipt or upon initiation of analysis.

The review of all new work assures that oversight is provided so that requirements are clearly defined, the laboratory has adequate resources and capability, and the test method is applicable to the customer's needs. This process assures that all work must be given adequate attention without shortcuts that may compromise data quality. Contracts for new work may be formal bids, signed documents, verbal, or electronic.

The Quality Assurance Director in conjunction with the Laboratory Director determines if the laboratory has the necessary accreditations, resources, including schedule, equipment, deliverables, and personnel to meet the work request.

The Project Manager or Customer Service Manager informs the customer of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily.

The customer is informed, by the Project Manager in consultation with the Quality Assurance Director and/or the Laboratory Director, of any deviation from the contract including the test method or sample handling processes.

The Project Manager must forward the work contract to the appropriate personnel to evaluate such items as:

1.) Contractual obligations, bonding issues, and payment terms.
2.) Method capabilities, analyte lists, reporting limits, and quality control limits.
3.) Turnaround time feasibility.
4.) QA/QC issues, including certification and accreditation.
5.) Formal laboratory quote.
6.) Reporting format and electronic data deliverable requirements.
7.) Archiving time required for project samples.

The Project Manager, Sales Director, or Customer Service Manager submits the bid and formal quote to the customer. The Customer Service Manager maintains copies of all signed contracts.

7.3. Analytical Methods

The laboratory uses EPA, NIOSH, OSHA, and other published methods, or modifications thereof, for analytical testing. The Test List and Sampling Guide [Appendix F, or found on the laboratory's website] includes a detailed listing of analytical methods by analyte. Customers shall contact the laboratory before the initiation of testing to satisfy any questions regarding analytical methodology.

7.4. Method Selection

Method selection may be standard per analyte requested or based on a number of factors including, but not limited to: sample matrix, analyte(s) requested, required detection limit, and the customer's regulatory requirements. Methods are available in their original, published form in the SLGI Company Library, in software versions located on the lab's server, and/or on the internet. Additionally, exact SLGI protocol is described in the SLGI Standard Operating Procedure for each method. Detailed method information is available from the analysis department or the SOP Manual.

Each SOP indicates the revision date, the revision number, the effective date, and the signatures of the Author and the reviewers such as the Quality Assurance Director, General Manager, Laboratory Director, and the appropriate department(s) supervisor.

Controlled copies of all SOPs are accessible to all personnel.

7.5. Method Validation

Implementation of new methodologies or tests for new analytes is done with the recommendation and approval by the Laboratory Director and the Research and Development Director. Method development or new analyte testing is done under the close supervision of the Laboratory Director. No results are released for new tests until the Laboratory Director review and approve the testing and quality control measures. Standard Operating Procedures, including appropriate quality control and acceptance criteria, are developed by the Laboratory Director or his/her designee and reviewed by the QA Director. Demonstration of capability data is maintained for the method and for all analysts who perform the method.

MDLs are run for all solid and liquid matrices per analysis method and analyte initially and then on a yearly basis. These MDLs must be run the 2nd quarter of each year. Minimum reporting limits are established using MDL data. Seven spike samples taken through the entire preparation process are analyzed and using statistical calculations the MDL and minimum Reporting Limit is established.

During analysis the minimum reporting limit is verified using a continuing calibration standard prepared at or below the minimum reporting limit. All acceptance criteria are documented.

All air analyses will have their reporting limit verified at least annually using a reporting limit verification spike. The spike is prepared by spiking a blank media at or below the reporting limit. This spike is taken thru the entire preparation and analysis procedure. For lead in dust wipe, paint, air and soil analysis the reporting limit verification spike is prepared and analyzed daily. Besides the reporting limit verification spikes the minimum reporting limit is also verified using a continuing calibration standard prepared at or below the minimum reporting limit. All acceptance criteria are documented. All RLVs must have a percent recovery between 80-120% to be acceptable. Laboratory defined acceptance criteria is calculated based on RLV results.

The laboratory has SOPs for all test methods within its scope, located in the specific department and in the Quality Assurance office. A read-only version is available to the analysts. The SOP contains a consistent format of presentation of procedures that are part of the Management system which accurately reflects how the analytical process is performed. SOP AD-012 documents the format and content that must be located within each SOP.

Any deviation from a test method is reported to the customer.

Each Test Method SOP includes or references (as applicable) the following
1) Identification of the test method;
2) applicable matrix or matrices;
3) detection limit;
4) scope and application, including components to be analyzed;
5) summary of test method;
6) definitions;
7) interferences;
8) safety;
9) equipment and supplies;
10) reagents and standards;
11) sample collection, preservation, shipment and storage;
12) quality control, including acceptance criteria;
13) calibration and standardization;
14) procedure;
15) data analysis and calculations;
16) method performance;
17) pollution prevention; and/or internal documents.
18) data assessment and acceptance criteria for quality control measures;
19) corrective actions for out-of-control analyses;
20) contingencies for handling;
21) waste management;
22) references; and

23) any tables, diagrams, flowcharts and validation data.

The Mold Fungal Direct Exam SOP also includes a description of trace analysis and the calculations involved when only a percentage of the trace is read. The SOP also includes scope magnification and counting rules as well as a dichotomous key to aid in the identification of mold.

7.6 SOP and QA Manual Signatures and Effective Date

Each SOP indicates the signatures of the reviewers such as the Quality Assurance Director, General Manager, Lead Technical Director, and/or the appropriate department(s) supervisor. The QA Manual must be signed by the Lead Technical Director, General Manager and the QA Director. The effective date the QA/Manual or an SOP is placed into production is listed at the top of each under the revision date. The effective date is the date the QA Manual or SOP was signed by each signatory and placed into production.

8. Purchasing Services and Supplies

The laboratory ensures that purchased supplies and services that affect the quality of environmental tests are of the required or specified quality by using approved suppliers and products.

The laboratory's SOP AD-021 outlines the procedures for purchasing, receiving, and storage of supplies that affect the quality of environmental tests.

The Quality Assurance Director reviews and approves the supplier services and supplies and approves technical content of purchasing documents prior to ordering.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is the appropriate quality by signing packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered. Certificates of Analysis and MSDSs are supplied by the approved vendors.

Reference standards and materials are tracked from purchase, receipt, and the standard or material's integrity is verified.

Reagent quality is verified during routine blank analyses.

Records for all standards, reagent, reference materials, and media include:

1. the manufacturer/vendor name (or traceability to purchased stocks or neat compounds);
2. the manufacturer's Certificate of Analysis or purity (if supplied);

3. the date of receipt;
4. reference to the method of preparation;
5. date of preparation;
6. recommended storage conditions;
7. all containers of prepared standards and reference material have a preparation date and a unique identifier.
8. an expiration date after which the material shall not be used (unless its reliability is verified by the laboratory);
9. preparer's initials (if prepared).
10. Standard preparation records are kept in laboratory notebooks and indicate traceability to purchased stocks or neat compounds, reference to the method of preparation, date of preparation, expiration date, and preparer's initials.
11. Prepared reagents are verified to meet the requirement of the test method through method and calibration blank analyses.

The laboratory keeps a list of approved suppliers.

9. Laboratory QA/QC Specifications

All essential quality control elements are collected and assessed on a continuing basis. The qualities of test results are recorded in such a way that trends detectable, and where practicable, are statistically evaluated. Acceptance criteria are obtained for quality parameters as defined within the individual SOPs.

To monitor the validity of tests performed, the range of quality control parameters are produced, consisting of method blanks, duplicate analyses, laboratory control samples, and matrix spikes. Second source certified reference materials are analyzed with each analytical batch, where applicable. Samples are retested periodically at customer request. Also relationships between parameters, and historical trends, are evaluated when possible.

QC samples that fall outside QC limits indicate the test method is out of control. Control charts will be used in order to compare the results and to establish control limits. The charts will be used to monitor trends within the laboratory.

9.1 Airborne Asbestos Dust Evaluation

The internal quality control program for air sample analyses is designed to ensure that accurate and reproducible results are produced for all samples analyzed. Further information can be found in SOP AB-010, SOP for Air Asbestos (PCM) Quality Control. The program is divided into two areas as described below. Calibration of the microscope is performed with the adjustment and alignment of the microscope such as phase ring alignment is daily. The Walton Beckett graticule is verified using a calibrated stage micrometer.

9.1.1 Sample Quality Control

The Sample quality control program estimates the variability of air sample analytical results or precision for each analyst. Although it cannot estimate the accuracy at which an analyst counts fibers, it does give an estimate of the precision of the analyst's work. In this program, every 10th customer ("real-world") sample is mounted twice: once as a regular sample, once as a quality control sample. The same analyst counts both slides although he/she will not know which slide is duplicated as a QC sample. Both sets of results are analyzed in a computer program designed to flag those samples that statistically do not show precision of analysis. Monthly reports are generated to summarize laboratory and individual analyst performance.

9.1.2 Daily Reference Sample Quality Control

The Reference sample quality control program is designed to control the accuracy of the air filter analyses within the laboratory. In this program, a reference slide is selected for each day of that week. All analysts performing air sample analyses on a given day read the reference slide designated for that day. As data is collected it is recorded on control charts which monitor the reproducibility and statistical accuracy of results. The statistical data from these analyses is used to calculate the inter- and intra- analyst precision (Sr) for each fiber density range as well as the calculation of the intralaboratory (Sr) value, an estimate of the variability of analyses within the laboratory.

9.2 Bulk Building Material Samples QC Program

Bulk asbestos analysis quality control is less quantifiable than the QC in most other scientific analyses. Not only is the quantification of the material more inexact, there is the possibility that many different types of substances might be identified within a given sample. Given these complicating factors, the bulk asbestos QC program is based on an error classification scheme in which various differences between two analyses of the same bulk material are denoted by an error category and an error type. Daily calibration and alignment of the microscope is performed by each analyst station. The daily temperature is recorded at that time. Further information can be found in SOP AB-011, SOP for Quality Control for PLM Analysis.

An intra-laboratory QC plan estimates the variability of bulk asbestos identification and quantitation using blind replicate analyses of every 10th customer "real-world" sample. Replicate sample analysis evaluates and controls variability between analysts within the laboratory. Reference samples of known asbestos concentration are available for comparative analysis when an analysis replicate is not within acceptable range of the expected value. Reference samples are also available as comparators of known asbestos type and quantity for analysts to use at any time. On a daily basis, analysts examine reference samples prepared from NIST/NVLAP proficiency samples and other reference materials of known asbestos content. This reference program provides a test of the analyst

in addition to a visual calibration to a known value. Monthly reports are generated to summarize laboratory and individual analyst performance.

9.3 Organics and Metals QC Programs

The purpose of this QA/QC program is to ensure that data of the best quality is generated by the laboratory. Measuring the quality of the data is accomplished by analyzing a suite of QC samples with each sample prep batch and with each analytical run. A sample prep batch is defined as a set of samples with a similar matrix that are prepared according to a specified set of instructions during a defined time frame. Generally, a prep batch must consist of no more than 20 samples. An analytical run is the series of production and QC samples that are analyzed on an instrument that begins with an initial calibration or initial calibration verification and concludes when all samples are completed or the run is stopped. The following is brief discussion of the evaluation of QC samples and the types of QC samples included with the analysis run sequence and the sample prep batch sequence.

Evaluation of QC Samples

QC samples are analyzed at a frequency defined by the reference analytical method and the corresponding QC data is evaluated for accuracy and precision. Accuracy is an indicator of how close a measurement is to a known target value and is determined by analyzing samples of known concentration. Samples used for evaluation of accuracy include calibration verification samples (CCV), laboratory control samples (LCS), initial calibration verification samples (ICV) and matrix spike samples (MS). The known target value is often referred to as the "True Value" of the sample. Accuracy is evaluated by calculating the %recovery of the measurement where % recovery is defined as:

$$\% \text{ recovery} = \frac{\text{(Measured Result)}}{\text{(True Value)}} \times 100$$

Note that the measured result and the true value must be expressed in the same units. The % recovery must meet predefined acceptance criteria. The acceptance criteria is determined from the method or SOP or by calculating the acceptance criteria as +/- 3SD of the mean of at least 20 measurements.

Precision is an indicator of the reproducibility of a test and is evaluated by analyzing samples in duplicate. Samples used for evaluation of precision include laboratory control sample duplicates (LCSD), sample duplicates and matrix spike duplicates (MSD). The precision of an analytical system is evaluated by calculating the relative percent difference (RPD) between the duplicate measurements: The RPD is calculated as follows:

$$\text{RPD} = \frac{\text{(Measurement1 – Measurement2)}}{\text{(Average of Measurement1 and Measurement2)}} \times 100$$

Note that the units for measurement1 and 2 must be the same. The acceptance criteria is defined in the reference method or the SOP or by calculating the acceptance criteria from the historical data.

Analytical Run Level QC Data:

Analytical run level QC samples are standards and samples that used to define the instrument response and to verify performance of the instrument throughout the analytical sequence. The analytical sequence begins with an initial calibration or a calibration verification. Calibration verification samples are analyzed at a frequency determined by the analytical method. Generally calibration verification samples are analyzed with every 10 samples. All analysis runs must end with a calibration verification sample. The following are standards and samples associated with the analytical run sequence.

The following general controls are used:

Positive and Negative Controls such as:

a.) Blanks (negative)
b.) Laboratory Control Samples (positive)
c.) Reference Control Materials (positive)

Selectivity is assured through;

a.) Absolute and relative retention time in chromatographic analyses
b.) Dual-column confirmation when using non-specific detectors
c.) Use of acceptance criteria for mass-spectral tuning (found in test method SOPs)
d.) Use of the correct method according to its scope assessed during method validation

Consistency, Variability, Repeatability, and Accuracy are assured through:

a.) Proper installation and operation of instruments according to manufacturer's recommendations or according to the processes used during method validation
b.) Monitoring and controlling environmental conditions (temperature, access, proximity to potential contaminants)
c.) Selection and use of reagents and standards of appropriate quality
d.) Following SOPs and documenting any deviation, assessing for impact, and qualifying the data where appropriate
e.) Testing to define the variability and/or repeatability of the laboratory results, such as replicates

f.) Use of measures to assure the accuracy of the test method, including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples or other measures.

Initial Calibration (ICAL):

Unless otherwise specified in the analysis SOP the initial calibration consists of at least 5 standards prepared in a solvent identical to the sample extracts of known concentration. The lowest level standard corresponds to the lower reporting limit for analysis. The highest standard represents the highest level in the samples that can be reported without dilution. The initial calibration standards are generally evaluated using a least squares linear regression model. In some cases, the instrument response may be defined using a non-linear regression.

General Acceptance criteria for initial calibration curves:
r2 = 0.995 or better, where r2 is the correlation coefficient

The initial calibration shall be performed whenever there is a significant change in the instrument response. The instrument response will change depending on a number of factors including maintenance, repair, idle-time, highly contaminated samples, etc. In the event that an initial calibration fails to meet an r^2 criteria of 0.995 or better then it is acceptable to drop either the high or the low standard providing this yields an r^2 of 0.995 or better. Note that if the low standard is dropped then the corresponding lower reporting limit shall be elevated to the lowest calibration standard analyzed. Likewise, if the high point is dropped, then the linear range drops correspondingly and results above the new high standard require dilution.

Sufficient raw data records are collected to allow reconstruction of the initial instrument calibration. These include, at a minimum, calibration date, test method , instrument, analysis date, analyte names, analysts, signature or initials, concentration and response, calibration curve or response factor, or unique equation or coefficient used to reduce instrument responses to concentration.

Corrective actions are performed, and documented, when the initial calibration results are outside acceptance criteria.

IMPORTANT: If a calibration curve fails to meet the $r^2 > 0.995$ criteria it is NOT acceptable to drop a point in the middle of the curve. If a point in the middle of the curve is compromised for any reason then re-run or re-prep the calibration standards.

Initial Calibration Verification (ICV):

Initial calibration verification is a second source standard that is prepared exactly as the initial calibration standards are prepared, however, this sample is prepared

from a separate source then the initial calibration. It is preferable that the initial calibration standards and the initial calibration verification standards be obtained from separate vendors. In instances, where separate vendors are not available then the ICV shall be prepared by a separate analyst than the one that prepared the ICAL standards. The ICV shall be analyzed with each ICAL and shall be analyzed after all the ICAL standards are complete. The ICV must meet a ±10% recovery criteria unless otherwise specified in the reference method.

Any samples that are analyzed after an unacceptable initial calibration are reanalyzed or the data is reported with qualifiers, appropriate to the scope of the unacceptable condition.

Initial Calibration Blank:

The Initial Calibration Blank standard is a standard that consists of just the solvent used to prepare the calibration standards. There is no analyte added to the ICB. The ICB is used to evaluate the background levels of contaminant in the solvent. The ICB must be less than the reporting limit for the analyte or the lowest standard on the curve.

Continuing Calibration Verification:

A Continuing Calibration Verification sample is a standard taken from the ICAL that is re-run as sample in the analytical sequence. The concentration of the CCV shall be at a mid-level of the curve. The CCV is run at a frequency defined in the SOP or analytical method. Generally a CCV is run with every 10 to 20 samples and all analyses shall be concluded with a closing CCV. Unless otherwise noted, the CCV must meet a ± 10% recovery acceptance criteria. For analytical systems where the stability of the instrument allows the CCV can be used to verify an initial calibration from a previous run. It the CCV consistently fails a ±10% recovery criteria then re-calibration may be necessary. Only samples with passing bracketing CCVs shall be reported. If a CCV fails the samples analyzed between the last passing CCV and the failing CCV shall be re-analyzed.

If routine corrective action for continuing instrument calibration fails to produce a second consecutive (immediate) calibration verification within acceptance criteria, then a new calibration is performed or acceptable performance is demonstrated after corrective action with two consecutive calibration verifications.

For any samples analyzed on a system with an unacceptable calibration, some results may be useable if qualified and under the following conditions;

1.) If the acceptance criteria are exceeded high (high bias) and the associated samples are below detection, then those sample results that are non-detects may be reported as non-detects.

2.) If the acceptance criteria are exceeded low (low bias) and there are samples that exceed the maximum regulatory limit, then those exceeding the regulatory limit may be reported

Continuing Calibration Blank:

A continuing calibration blank sample is a standard that consists of the just the solvent used to prepare the continuing calibration and initial calibration standards. The CCB is used to evaluate the carry-over throughout the run. A CCB is run after every CCV sample. The CCB must be less than the reporting limit for the analyte or the lowest standard on the curve.

Sample Preparation Batch Level QC

Sample preparation batch level QC samples are samples that are prepared and analyzed along with production samples at a defined frequency. Batch level QC samples are prepared from a matrix that is as similar as possible to the production sample matrix.

Laboratory Control Sample (LCS):

A Laboratory Control Sample consists of a blank matrix identical (or at least similar) to the production sample matrix that is spiked with a known amount of analyte. In some cases, an LCS consists of a reference material with a known concentration of analyte that is taken through the sample preparation and analytical process. The LCS is prepared and handled exactly like a production sample and it is used as an indicator of the effectiveness of the sample preparation and analytical process. An LCS sample is prepared at a minimum frequency of 5% of production samples. The LCS sample is used to evaluate the systemic bias of the analytical process. The acceptance criteria for the LCS is defined by the method or from statistical evaluation of historical data. Acceptance criteria generated from historical data is calculated from at least 20 previous data points and is determined as ±3 standard deviations of the mean value.

Multiple matrix based quality control spikes shall be analyzed with each batch of multi matrix samples. The spike level shall be at a concentration level within the calibration curve of the applicable analysis. The Laboratory Control Samples (LCS-LCSD) are carried through the entire procedure, from preparation to analysis. Acceptance criteria shall be documented for LCS recovery and precision.

Laboratory Control Sample Duplicate (LCSD):

An LCSD is a duplicate preparation of the LCS and is use to evaluate the reproducibility of the analytical process. The LCSD is prepared at a minimum frequency of 5% of production samples. In addition to evaluation of analysis

accuracy the LCSD is used to estimate the precision. The relative percent difference between the LCS and the LCSD is a measure of the variability of the analytical system. The acceptance criteria for the difference between the LCS and LCSD is either defined in the analysis method or calculated from historical data.

Multiple matrix based quality control spikes shall be analyzed with each batch of multi matrix samples. The spike level shall be at a concentration level within the calibration curve of the applicable analysis. The Laboratory Control Samples (LCS-LCSD) are carried through the entire procedure, from preparation to analysis. Acceptance criteria shall be documented for LCSD recovery and precision.

Method Blank:

A method blank sample consists of a blank matrix identical (or at least similar) to the production sample matrix that is prepared and analyzed along with the production samples. A method blank sample is prepared at a frequency of at least 5% of samples. The method blank sample is used to evaluate background levels of analyte and as an indication of possible cross-contamination of samples. The method blank must be less than the reporting limit for the analyte or the lowest standard on the curve.

Matrix Spike Sample (MS):

A matrix spike sample is a production sample matrix that is spiked with a known amount of analyte and prepared and analyzed along with production samples. Whenever possible an MS shall be prepared with every 20 production samples. Note that with most typical IH samples preparation of a matrix spike is not practical. The matrix spike sample is used to evaluate system bias and matrix effects on analysis. The acceptance criteria for the matrix spike sample is based on the %recovery and is defined in the method or is calculated from historical data and is defined as ±3 standard deviations of the mean value for historical matrix spike samples on the same or similar matrix.

Matrix Spike Duplicate Sample (MSD):

A matrix spike duplicate sample is a duplicate preparation of matrix spike sample and is used to evaluate the reproducibility of the analytical process. When practical, a matrix spike duplicate sample is prepared at a minimum frequency of 5% of analytical samples. In addition to evaluation of analysis accuracy the MSD is used to estimate the precision. The relative percent difference between the MS and the MSD is a measure of the variability of the analytical system. The acceptance criteria for the difference between the MS and MSD is either defined in the analysis method or calculated from historical data.

Sample Duplicates:

A sample duplicate is a sample that is prepared and analyzed twice. Sample duplicates can only be performed when there is enough sample supplied by the customer to perform two preparations of the sample. Sample duplicates are evaluated by determining the relative percent difference between the two measurements. Acceptance criteria is defined in the method or by calculation of the RPD of historical similar duplicate pairs.

Surrogate Spike Samples:

Surrogate spike are uncommon in Industrial Samples. Surrogate spike consist of a spike solution with compounds that are highly unlikely to be present in the field samples and yet will behave analytically very similar to the target analytes. Surrogate spike samples are evaluated by %recovery and shall be based on ±3 standard deviations of the mean of at least 20 previous measurements.

Evaluation of QC Data

Data generated by this Quality Control Program is summarized statistically by month or quarter or batch, whichever is more appropriate for the volume of data collected. The arithmetic mean (commonly, "average") is used to summarize the data, and is always characterized by representation with the population's standard deviation ("sd"). The standard deviation gives expression of the averaged amount of scatter that the population of data demonstrates at or around the mean. For quality control evaluation, the mean and standard deviation for the previous month or batch summary may establish the guidelines for acceptance of the following month's/batch's data. The mean + 2 sd and the mean - 2 sd define the upper and lower warning limits; the mean + 3 sd and the mean - 3 sd define the upper and lower control limits. In a normal distribution (i.e., with random scatter), 95% of data points are expected to fall within the warning limits, and greater than 99% of data points are expected to fall within the control limits, as each are defined by the mean / standard deviation combinations cited above. These basic statistics principles are applied to the data collected during routine quality control testing to evaluate each data point. Outliers are treated with immediate corrective action, and analysis does not proceed until completion of the corrective action plan. Data is collected and maintained both on analyst's worksheets and in computer databases. Most commonly, data is maintained in the main computer database and downloaded into spreadsheets for control charting and statistical summary. For tests performed infrequently, the data is maintained on laboratory worksheets and manually entered into a computer spreadsheet for tabulation and statistical evaluation purposes.

9.4 Mold QC Evaluations

9.4.1 Mold Air Evaluation

The internal quality control program for air sample analyses is designed to ensure

that accurate and reproducible results are produced for all samples analyzed. Further information on Quality Control procedures for Mold analysis can be found in Section 11.0 in SOP MB009 – SOP for Non-Culturable Direct Exam of Mold.

The program is divided into two areas as described below.

9.4.1.1 Inter- and Intra- Laboratory Quality Control

Both inter-analyst and intra-analyst analyses will be performed on samples at a minimum of 5% each. Control charts will be used in order to compare the results from both the intra- and inter-analyst performance to establish control limits. The same acceptance criteria will be used as in the reference slide analyses. The charts will be used to monitor trends within the laboratory.

9.4.1.2 Reference Sample Quality Control

One reference slide will be read every day by each analyst at the beginning of the day. This data will be used to document the accuracy of each analyst. Reference slides will be chosen from the slide library of field samples with various count levels and groups of spores. The slides will be chosen in such a way that a difference slide is read each day until the entire collection has been examined. The results for the reference slide analysis will be documented with acceptance criteria. The acceptance criteria will be based on spore identification, spore abundance ranking and count acceptability. Upper and lower control limits will be generated based on three (3) standard deviations from the reference slide mean. The charts will be used to monitor trends within the laboratory.

10.0 Proficiency Testing

The laboratory must participate in various proficiency testing programs. NVLAP, New York ELAP and AIHA have their own proficiency testing programs. All other proficiency testing programs must be through approved NELAC providers. All PT samples must be treated as normal customer samples and follow the same sequence of preparation and analytical process as well as replicate and QC analysis. Once the PT has closed then the samples can be reanalyzed by other analyst for Documentation of Capabilities studies. The laboratory will also perform an Internal PT program for those areas that an external PT program is not performed.

The laboratory must also participate in Round Robin programs with other laboratories to document intra-laboratory analyses. These programs must be done either quarterly or semi-annually as required by the corresponding accrediting or certifying bodies. The results from the round robins are documented and statistical analyses are performed. Any outliers are discussed in the round robin report. All

analysts are made aware of the results and if the samples are still available, reanalysis of the samples may occur if necessary. Depending on the findings in-house training may occur. Significant differences between laboratories will be discussed.

10.1 Asbestos

SLGI participates in three external proficiency programs that together review both bulk and air sample testing:

AIHA Proficiency Analytical Testing Program (PAT): air filter samples for fiber counts, four times a year

NVLAP Proficiency Testing: bulk samples for PLM, twice a year

New York Environmental Laboratory Accreditation Program (ELAP) Asbestos: air filter samples for fiber counts by PCM and bulk samples by PLM, twice a year

Additionally, SLGI participates with other laboratories in a "Round Robin" program for both bulk and air samples. The program hosts an exchange of PCM samples twice a year and PLM samples 6 times a year

10.2 Metals

SLGI participates in several external proficiency programs that allow comparison of its results to other laboratories nationwide:

AIHA Proficiency Analytical Testing Program (IHPAT): air filters loaded with unknown concentrations of three specified metals, one of which is always lead, four times a year. This PT will be performed using ICP-AES Technology. The Atomic Absorption field of testing consisting of GFAA, CVAA and FAA technologies and the UV-VIS field of testing will be maintained by performing internal PTs consisting of at least four spikes at varying levels of concentration twice a year. Information on the program and acceptance criteria can be found in Section 10.5 below.

AIHA Environmental Lead Proficiency Testing Program (ELPAT): paint chips, wipes, and soil samples containing unknown quantities of lead, four times a year; also lead-in-air samples associated with the PAT rounds and evaluated by the ELPAT program. The laboratory will alternate the performance of this PT between ICP-AES technology and FAA technology.

New York Environmental Laboratory Accreditation Program (ELAP) Potable Water: samples for drinking water metals analysis, twice a year

New York Environmental Laboratory Accreditation Program (ELAP) Non-Potable Water: samples for wastewater metals analysis, twice a year

New York Environmental Laboratory Accreditation Program (ELAP) Solid & Hazardous Waste: samples for hazardous waste metals analysis, twice a year

TCLP Metals: supplied by independent vendor, soil sample for RCRA Metals profile with TCLP extraction, once a year

Phenova, ERA and Absolute Standards are commercial NELAC, TNI, and ISO17025 purveyors of Performance Evaluation samples. They provide Water Pollution, Water Supply, Soil, and Rapid Response Performance Evaluation samples as needed

10.3 Organics and Other Analytes

AIHA Proficiency Analytical Testing Program (PAT): air filters loaded with unknown concentrations of silica, four times a year. The Gravimetric, IC, HPLC UV and HPLC FL fields of testing will be maintained by performing an internal PT consisting of at least four spikes at varying levels of concentration twice a year. Information on the program and acceptance criteria can be found in Section 10.5 below.

AIHA Proficiency Analytical Testing Program (PAT): charcoal tubes loaded with unknown concentrations of three specified compounds, four times a year

AIHA Passive Monitor Proficiency Analytical Testing Program (PAT): passive monitor samples for solvents in air, two times a year

New York Environmental Laboratory Accreditation Program (ELAP) Non-Potable Water: samples for wastewater organics analysis, twice a year

New York Environmental Laboratory Accreditation Program (ELAP) Solid & Hazardous Waste: samples for hazardous waste organics analysis, twice a year

Phenova, ERA and Absolute Standards are commercial NELAC, TNI, and ISO17025 purveyors of Performance Evaluation samples. They provide Water Pollution, Water Supply, Soil, and Rapid Response Performance Evaluation samples as needed

10.4 Mold

SLGI participates in an external proficiency program for direct air exam and a round robin program:

AIHA Environmental Mold Proficiency Analytical Testing Program (EMPAT): online direct exam which is performed four times a year.

Additionally, SLGI participates with other laboratories in a "Round Robin" program for air samples twice a year. Analytical data will include raw counts and final concentration for each fungal spore observed. Acceptance criteria will be determined taking into account spore identification, ranking and quantification. Further information can be found in Section 13.0 of SOP MB-009, SOP for the Analysis of Fungi in the Indoor Environments using Direct Examination by Microscope for Non-Culture Based Analysis

10.5 **Internal PT Programs**

For methods in which no external proficiency test is available an Internal PT is performed. The Internal PT program is performed twice a year. Internal PTs are performed for the following fields of testing: Gravimetric, IC, HPLC-UV, HPLC-FL, UV-VIS, and Atomic Absorption consisting of CVAA, GFAA, and FAA technologies. For the IHLAP program under the Atomic Absorption field of testing, only one of the three technologies CVAA, GFAA or FAA must be performed biannually.

10.5.1 The Internal PT consists of at least 4 spikes that are treated as client samples.

10.5.2 The spiking is performed on the appropriate blank matrix and at various concentrations.

10.5.2.1 The Laboratory uses certified reference material that is traceable to an ISO standard as its spiking material.

10.5.2.2 The spikes are run through the entire preparation and analytical process.

10.5.3 Acceptance Criteria

10.5.3.1 All upper and lower control limits, standard deviation, and mean must be calculated for each internal PT.

10.5.3.2 The acceptance criteria of each sample is based on 3 standard deviations from the mean.

10.5.3.3 The standard deviation is statistically derived from the analysis of spike samples.

10.5.3.4 The Internal PT passing is at 75% or three out of four spikes must be within the acceptance criteria.

10.5.3.5 If the Internal PT passing result is less than 75%, then Internal PT will be repeated. If the Internal PT still fails then the PT will be repeated with four new spike samples. An

investigation will take place to determine the reason for the failure.

11. Performance and System Audits

11.1 System Audits

A comprehensive systems audit is performed annually and may be announced or unannounced. The audit is managed by the QA Department with input from each department manager. The audit results are reviewed with Department Managers, Supervisors and Team leaders, and the General Manager. Any deficiencies are explained and the laboratory corrective action plan is implemented. In the event that audit findings cast doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, SLGI must take corrective action. The QA Department follows up to assure that the corrective/preventative action plan has been followed. SLGI must notify customers promptly, within two weeks of the finding, by phone or in writing, of any event that casts doubt on the validity of test results given in any test report or amendment to a report. The audit report is maintained in laboratory files.

Site audits are performed by various accrediting agencies and customers. Because of the numerous programs in which SLGI participates, it is not unusual to have three or more such audits within a twelve month period. These audits are thorough outside evaluations of the total sample processing system and are documented in appropriate files maintained by the QA Department.

External quality control measures (see Section 9) are a form of performance audits since they are submitted and evaluated by outside agencies. Acceptable performance on these proficiency tests is an audit of sample handling and analysis methods. Additionally, some customers submit quality control samples in conjunction with unknowns for analysis. External quality control measures in addition to numerous internal quality control measures ensure reliability and reproducibility of analysis results.

Quarterly QC Internal audits are done throughout the laboratory to audit various areas of the laboratory, assuring that measures are being taken to maintain QC protocols. Checklists have been developed to aid in the audit of each department. Checklist are based on the NELAP, AIHA and NVLAP checklists. A full internal audit is performed yearly using the entire checklist during the audit in each department. All Quarterly audits are reviewed during the Annual Internal Audit. The audit is conducted by the QA Department using, but may not be limited to, AIHA and ISO/IEC 17025, NELAC Standard and NVLAP checklists. All checklists used during the audits must be kept as part of the audit process. Statistical evaluations are done whenever applicable in all audits. Monthly QC Summaries are also done within the laboratory and documented within the quarterly and annual audits. Deficiencies or irregularities are reviewed with Department Managers, Supervisors and Team leaders and follow-up is done as deemed

necessary by the QA Department. Communication between the QA Department and Department Managers, Supervisors and Team leaders occurs on an ongoing basis.

11.2 Senior Management Review

A Management review of the laboratory's management system and testing activities to ensure their continuing suitability and effectiveness must be conducted at least once each 12 months by the Senior Management Team. The annual review must be performed during the first quarter of the year and must include:

- The suitability of policies and procedures
- Reports from managerial and supervisory personnel
- Outcome of recent internal audits
- Corrective and preventative actions
- External audits findings
- Results of inter-laboratory comparisons or proficiency tests
- Review of the IT systems including but not limited to LIMS, external web site, intranet, etc.
- Changes in the volume and type of work
- Customer feedback
- Complaints
- Recommendations for improvement
- Other relevant factors including quality control activities, resources and staff training

The Senior Management Review must include the goals, objectives and action plan for the coming year. It must include consideration of related subjects at regular management meetings.

11.3 Control of Non-Conforming Work

Non-conforming work is work that does not meet acceptance criteria or requirements. Nonconformities can include unacceptable quality control quality control results or departures from standard operating procedures or test methods. Requests for departures from laboratory procedures are approved by the Quality Assurance Director, General Manager, or Laboratory Director and documented in the customer file either via hardcopy or electronically.

The policy for control of non-conforming work is to identify the nonconformity, determine if it will be permitted, and take appropriate action. All employees have the authority to stop work on samples when any aspect of the process does not conform to laboratory requirements.

The responsibility and authorities for the management of non-conforming work are detailed below. The laboratory evaluates the significance of the nonconforming work and generate a Work Order Management (WOM) form to track the action on

non-conforming work. Schneider Laboratories Global, Inc. takes non-conforming work seriously and takes corrective action immediately. The customers are notified if their data has been impacted.

If the degree of nonconformity warrants suspension of the method, the Quality Assurance Director, the General Manager, or the Laboratory Director must promptly notify all analytical staff of the suspension/restriction. The Quality Assurance Director, the General Manager, or the Laboratory Director must notify the analytical staff when the suspension has been removed and work may be resumed.

Corrective Action is the action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence.

Deficiencies cited in external assessments, internal quality audits, data reviews, complaints, or managerial reviews are documented and require corrective action. Corrective actions taken are appropriate for the magnitude of the problem.

The Corrective/Preventive Action Form (CAP) is started, maintained as a controlled document. The root cause is the condition or event that, if corrected or eliminated, would prevent the recurrence of a deficiency. Once an exceedance or nonconformity is noted, the first action is an investigation to determine the root cause. Records are maintained of nonconformities requiring corrective action to show that the root cause(s) was investigated and includes the results of the investigation. A root cause determination, appropriate to the infraction is commenced and there is a review conducted by the Quality Assurance department before the CAP is closed out so as to insure that the implemented correction is successfully addressing the issue and that it is continuing to be reinforced.

The Quality Assurance Director must monitor implementation and documentation of the corrective action to assure that the corrective actions were effective.

12. QA Meetings and Reports

The QA program is summarized and discussed in continual correspondences and meetings between the QA Department and Department Managers, Supervisors and Team leaders. Other staff members are invited to join the meetings if necessary to address topics of a QA nature. The QA Department schedules, plans, and facilitates the meetings and distributes information regarding meetings' contents as relevant to laboratory staff. The QA Department summarizes current QA issues in quarterly reports, in addition to notes on certifications, site visits, QA-related projects, proficiency results, or other related information. Relevant charts summarizing QC data are posted in the laboratory and/or filed in the appropriate file cabinet or binder and/or stored in electronic files to keep all employees abreast of QC status.

13. Sample Receipt and Handling

Samples received at SLGI routinely move through the processing system in an organized, predictable way. All samples begin the handling process immediately upon receipt, are prioritized to meet customer requests, and are maintained with appropriate storage, sample labels and paperwork throughout processing and analysis stages. The stages of sample processing are as follows: sample receipt; sample login and establishment of a work order; sample preparation; sample analysis; data review; report generation; report review; report release; sample storage, return, or disposal. All samples for all test types follow this pattern of handling. All samples are entered into Sample Master, the Laboratory Information Management System, which tracks the sample from sample receipt to reporting. Sample Master tracking allows instant identification of the processing status of samples at any stage of the handling process. Sample security and accountability for customer samples by SLGI staff can be assured for each sample during its processing stages. Detailed handling procedures are described in laboratory SOP AD-017. Handwritten documentation of sample handling and analysis is done in indelible ink. Any corrections made to data shall be documented with a single strikeout line and the analyst's initials and the date.

Clients must be contacted if problems arise with samples or if there is non-conforming work. Example of client sample problems are missing or extra samples, missing information on Chain of Custody, broken or damaged samples and samples outside holding times. Non-conforming work is work that does not meet acceptance criteria or requirements. Nonconformities can include unacceptable quality control quality control results or departures from standard operating procedures or test methods. All problems are documented on the Work Order Management (WOM) form and then given to the project managers. If, for any reason, samples are rejected by the laboratory, the client must be immediately contacted and the explanation must include instructions or resources on how to obtain and submit an acceptable sample. WOMs and any correspondences with clients regarding sample problems, acceptance or rejection are scanned in laboratory records and retained by the laboratory.

14. Data Reduction, Validation, and Reporting

Accurate and effective handling of data in a laboratory is of utmost importance. The SLGI system for data reduction, validation, and reporting has been designed to ensure that complete documentation is maintained, transcription and data reduction errors are minimized, and that data receives thorough review before reports are made final. This system assures quality, facilitates the needs of customers and laboratory staff, and makes it possible to locate a sample at any stage in the analysis process.

14.1. Data Reduction

Upon receipt into the laboratory, samples are logged into a computer database which assigns each sample an individual identification number and produces a label for the sample. Customer-supplied information about the project and samples is entered into the computer database. Paperwork is generated which identifies

samples as a group or job and provides the analyst with the information and worksheets necessary to perform and record analyses. Original submission paperwork from the customer and reduced data printouts from the computer database accompany the samples throughout the laboratory process.

Observed data is recorded on worksheets associated with the customer's samples. Data is recorded in indelible ink, no correction fluid is allowed on any lab documents. Any corrections made are done with a single strike-out line followed by the analyst's initials and the date. These stipulations for data recording and correction are standard for all handwritten documentation within the laboratory. Whenever the technology allows, instrument data is directly transmitted from the instrument to the LIMS system, so that manual handling of data is minimized or eliminated. When instrument readouts are not in units of concentration (for example, absorbance or other units needing conversion), they undergo linear regression or other appropriate calculations done through the computer by associating the sample results with the appropriate calibration curve. When instrument readouts are in units of concentration, they have undergone the linear regression calculations (or other appropriate conversion) within the instrument's software.

14.2. Data Validation

The system for data validation has three stages, all designed to identify an error in sample or data handling before it leaves the laboratory.

14.2.1 Technical Review

The analyst at the bench who performs the analysis reviews his/her own work before finalizing the documentation. This review includes careful inspection of all recorded results to assure that no observed information was omitted or incorrectly recorded on the worksheet. This review is focused on both freely recorded and transcribed data and on documentation of sample manipulations such as dilutions and/or special handling. An analyst's examination of his/her work also includes comparison of quality control results against the established acceptance limits. When the analyst has reviewed his/her analysis and QC, he/she signs or initials the analysis and records the date and time of completion.

14.2.2 Data Entry / Transcription Review

The personnel trained in data entry transfer the results into the computer database and generates a printed report of results, which reflects applied calculations for some types of analysis. Data entry personnel are trained to have an awareness of the critical nature of accurate transcription of data. Data entry tasks are modeled after laboratory worksheets, so that minimal or no technical manipulation of data is needed at this stage. Analysts are available to clarify information as needed and to supervise the use of reporting modules as needed. The data entry is reviewed by the person who enters the results before signing the chain-of-custody and printing the

final report. The generated report goes back to the original analyst for data entry review. Any edits made to electronic data after the release of a report are fully documented in the work order's paperwork.

14.2.3 Full Review & Release

Generated reports are delivered to the final reviewer with all associated paperwork, including but not limited to chain-of-custody and/or submission form, work order documentation, internal handling notes, analyst's worksheets, additional bench paperwork, and printed report. The final reviewer may be the Shift Department Managers, Supervisors and Team leaders or Designee, Laboratory Director, Qualified Analyst, or Quality Assurance Director. A list of approved signatories is maintained by each Department Managers, Supervisors or Team Leaders. The final review of printed reports includes review of quality control results, review of the original data and customer request, and comparison of original data with reported data. On reports in which data has undergone mathematical calculations, the reviewer examines all results and manually verifies calculations. Once reports have completed the final review stage, they are signed and released to the customer.

14.3. Data Reporting

Reviewed reports are released to the customer in a mode specified by the customer. Customer options include e-mail, mail, electronic facsimile followed by mail, telephone results followed by mail, customer pickup, and courier delivery. Customers may also arrange to have results formatted electronically to suit their database needs and delivered on diskette or by e-mail. Photocopies of final reports are retained in the laboratory files. All released reports meet AIHA and ISO/IEC 17025 standards.

15. Documentation and Record Keeping

15.1 Document Control

The laboratory has procedures for the identification, collection, indexing, access, filing storage, maintenance and disposal of all quality and technical records. The following is a list of controlled documents: QA Manual, SOPS, internal audits, management and quarterly reviews, corrective and preventive actions, reports, raw data, calibration records, instrument records, laboratory notebooks, instrument logbooks, and electronic data. A complete list of controlled documents can be found in the Master List of Controlled Documents. This spreadsheet denotes the identification, location, access, storage, maintenance and disposal of all controlled documents. The controlled document list is maintained by the Quality Assurance Director. The controlled document list is updated annually at the time the Quality Manual is reviewed. Further information can be found in SOP AD-10, the SOP for Document Control.

Controlled internal documents are uniquely identified with 1) date of issue, 2) revision identification, 3) page number, 4) the total number of pages, and 5) the signature of the issuing authority – in most instances, the Quality Assurance Director. Logbooks distributed to laboratory personnel are consecutively numbered from 1 to the total number of printed copies such as "1 of 50".

Paper document changes are approved by the Quality Assurance Director. The Quality Assurance Director or Laboratory Director must approve all document changes. Amendments to documents are incorporated into a new revision.
The modified document is then copied and distributed, while obsolete documents are removed from circulation.

Electronic document changes are approved by the Quality Assurance Director or the Laboratory Director and presented to the IT Director. Changes to electronic documents are approved either on an accompanying form or through electronic means (such as email, change tracking functions, or memoranda).

Obsolete or invalid documents are removed from general distribution so as to prevent unintended use. They are collected from employees according to the distribution log. Obsolete documents are retained for legal use or historical knowledge preservation.

15.2 Archival Copies

All controlled documents and quality records such as final reports, raw data, instrument logs, laboratory notebooks, calibration data, management reviews, internal audits, and Corrective and Preventive actions are retained for a minimum of 5 years. All paper documents are stored in files in the attic and can be disposed of by shredding after 5 years.

Copies of all paperwork associated with a sample, including submission form, work order, analyst worksheets, final report, and facsimile verification (if applicable) are scanned into a computer file and are filed on a separate drive in the LIMS (Laboratory Information Management System) by work order number. The scanned paper files are retained by the laboratory for a minimum of 3 months for all analyses and associated quality control records. Scanned documentation is maintained for minimum of 2 years on internal drives and then archived to CD. Archive files are also written onto CD annually for storage for a minimum of 5 years. In addition to local backup storage, critical files [database files for laboratory data and accounting] are backed up to an off-site location. In the event of a transfer of laboratory ownership, all such records would be transferred to the new ownership and all regulatory and state legal requirements concerning laboratory records would be honored. In the event of lab closure, all accrediting authorities and customers would be notified. Customer records would be made available to them.

15.3 Computer Files

The Schneider Laboratories Global, Inc. LIMS (Laboratory Information Management System) has been custom designed to track sample handling throughout the laboratory, and to maintain consistent analysis and reporting standards. The system was created using Visual Basic and Microsoft Access in the Windows environment. Microsoft Office Programs are also used throughout the lab for various purposes. Some analytical equipment has supportive software operating on local PCs. Electronic document exchange with customers is provided using a variety of options including data files stored as comma separated values (CSV) and Adobe PDF format. Hardware and software are expanded as needed to meet workload demands.

Schneider Laboratories Global, Inc. uses 3 servers and approximately 50 computers to carry out its day to day operations. These machines are connected by Ethernet Cat 5 cables and equipment including switches, hubs, and routers. Three Dell Power Edge servers handle the LIMS system, internet access, email, and accounting functions using Microsoft Server technologies. Additional network storage capacity is provided by external hard drives connected via the network. Some of the computers are used to access the servers through the network to perform data entry, reporting or other tasks. Other computers are primarily devoted to instrument operation and data collection. Calculations and data transfers are validated yearly.

Employees are given access to the computer system using login ID's and passwords. Shared and limited access to programs on the network is based on user ID and group level security associated with the functions the individual performs.

Servers are backed up on a daily basis. In addition to local backup storage, critical files [database files for laboratory data and accounting] are backed up to an off-site location.

16. Sample Retention and Disposal

16.1 Asbestos Samples

Samples not consumed in testing (air samples and bulk samples) are maintained on premises for a minimum of 60 days before disposal by a hazardous waste contractor. Customer requests for returned samples are honored; likewise, samples may be held longer upon request.

16.2 Metals Samples

Samples not consumed in testing are maintained on premises for a minimum of 15 days before appropriate disposal. Customer requests for returned samples are honored; likewise, samples may be held longer upon request.

16.3. Organics Samples

Samples not consumed in testing are maintained on premises for a minimum of 15 days in refrigerated storage before appropriate disposal. Customer requests for returned samples are honored; likewise, samples may be held longer upon request.

16.4. Microbiological and Mold Samples

Samples not consumed in testing are maintained on premises for a minimum of two weeks before disposal. Customer requests for returned samples are honored; likewise, samples may be held longer upon request.

17. Protocol Departures, Corrective/Preventative Action and Nonconformity

Departures from protocol must be approved, in advance, by the Laboratory Director and/or a Department Manager, Supervisor or Team leader, and the customer. If advance approval is not possible, analysis results and conditions are reviewed by the Analyst, Laboratory Director and/or Department Manager, Supervisor or Team leader before results are released. Special notes are made on the customer's report if any protocol departure is deemed to potentially affect the outcome of analysis by the Laboratory Director and/or Department Manager, Supervisor or Team leader.

Analysts are primarily responsible for the evaluation of quality control values as they are generated. If performance in any aspect of laboratory operation is determined to be out-of-control, or non-conformant, analysis must be immediately halted and the root cause determined. Standard Operating Procedures routinely address particular issues with suggestions on how to determine and eliminate the cause of QC results outside of the acceptance range. No values may be reported until quality control is within acceptance limits and/or the root cause has been identified or determined to be a random event no longer affecting data. Analysts understand the analyses they perform to an extent that allows them to make judgment calls regarding the validity of an analysis based on quality control data. Laboratory Director and/or Department Managers, Supervisors or Team leaders are made aware of any out-of-control situation occurring in the laboratory, and are responsible for ensuring the corrective action plan is followed before analysis continues. Laboratory Director and/or Department Managers, Supervisors or Team leaders may authorize the resumption of analysis after satisfactory completion of the corrective action plan. Samples are re-analyzed after the quality control issue is resolved. If this is not possible, data is appropriately qualified when reported. The laboratory shall notify customers, in writing, of any non-conforming event, such as the identification of defective equipment that casts doubt on the validity of results given in any previously-issued report. All failures to meet quality control standards, or any non-conforming event, must be fully documented and the corrective action plan followed.

The QA Department works with the Laboratory Director and/or Department Managers, Supervisors or Team leaders if any root cause identifies the need for systemic changes as a means of preventive action. A preventative action plan must be implemented to identify solutions to prevent future errors. Such changes receive

appropriate follow-up by the QA Department and other relevant staff. Preventive actions are pro-active processes to identify opportunities for improvement.

The corrective active program is initiated by a member of the laboratory staff that identifies a problem or issue that requires further investigation. The laboratory person who identifies the issue must discuss the problem with their appropriate supervisor or manager and if the supervisor or manager determines that further investigation is required they must discuss with the QA staff and a corrective action plan may be initiated. Once the corrective action plan is initiated a Corrective Action Plan (CAP) form is filled out. The CAP form is designed to guide and track the process of evaluating the root cause of the problem, identifying the source or cause of the failure and identification of a process that will prevent further failures. Employment the "5 Why's" technique in the root cause analysis is an essential in the investigation of this process. All corrective actions must be reviewed in the following quarter to insure that the corrective actions are still in process and working appropriately.

All Proficiency Testing failures must be documented with a corrective action form. Both the failure to report results within the acceptance range as well as the failure to report results within the 6 month PT time frame must cause the implementation of a corrective action process. As with all Corrective Actions the root cause must be determined and the corrective actions must be documented. Also as with all corrective actions a follow review must occur within the next quarter to insure that the corrections are still in place and working properly.

Additionally, the laboratory shall respond immediately to any customer quality complaints and maintain records of the investigation and the corrective action plan. Forms for such documentation are available from the QA Department.

18. Customer Communication and Satisfaction

SLGI customers communicate with laboratory staff through designated project managers, who are dedicated to assuring that customers' analysis needs are met. Project Managers are involved with the planning of customer projects and communicate information to laboratory staff on behalf of the customer. When further technical assistance is required, the customer communicates directly with the analyst, the Laboratory Director and/or Department Managers Supervisors or Team leaders. Project Managers maintain frequent contact with customers to seek feedback, both positive and negative, so that laboratory services can be continually improved. SLGI is committed to quick response to any form of customer dissatisfaction. Project Managers handle any customer complaint and the issue is given priority attention by all involved parties. Any errors in analysis, data handling, or accounting are promptly addressed. Quick resolution of any discrepancy is the aim of SLGI employees, and the continuing quality of analyses is always the minimal expectation of both the laboratory management and the customer.

Clients must be contacted if problems arise with samples or if there is non-conforming work. Example of client sample problems are missing or extra samples, missing information on Chain of Custody, broken or damaged samples and samples outside holding times. All sample problems are documented on the Work Order Management (WOM) form and then given to the project managers. If, for any reason, samples are rejected by the laboratory, the client must be immediately contacted. Non-conforming work is work that does not meet acceptance criteria or requirements. Nonconformities can include unacceptable quality control quality control results or departures from standard operating procedures or test methods. WOMs and any correspondences with clients regarding sample problems, acceptance or rejection are scanned in laboratory records and retained by the laboratory.

In the event that a final report requires correction, the newly generated report clearly states "Amended Report". The amended report must indicate why an amended report was issued. Both the original and the amended reports are retained in the customer's file. Documentation of the corrective action plan, and all related information, is maintained with the customer submission and summarized in a report given to the QA Department. The QA Department evaluates all corrective action plan documentation to assure that the action taken has solved the problem. Errors with a pattern determined to be systematic are addressed by the QA Department by implementation of the laboratory preventative action plan.

19. Contract Review, Design Control, and Quality Planning

Schneider Laboratories Global, Inc. reviews requests, contracts and bid proposals before the commencement of work when such information is provided by the customer. Contracts and bids are received and managed by the Vice President for Bids and Contracts, reviewed by the General Manager, and provided to the Laboratory Director and/or Department Managers, Supervisors or Team leaders as needed for additional technical review or for informational purposes. Any specifications for laboratory service or quality control differing from standard protocol are noted and laboratory management collectively determines if the specifications can be successfully met.

The sequence of events in the request, bid or contract review are as follows:

1. A request, contract or bid is received from the costumer.

2. The laboratory determines whether the request or bid is clear in that it identifies the test procedure required and turn-around times.

3. The laboratory identifies whether the requested work is routine, in the sense that it has a validated, documented and appropriate procedure and can meet the requested turn-around times.

4. If the work is identified as routine, then it is necessary for the laboratory to ensure that it can meet any state or national accreditations or certifications for the samples.

5. Laboratory must also ensure that it will only use approved environmental methods that are able to meet both customer and regulatory requirements

6. If the laboratory cannot meet the required accreditations or certifications, or is unable to meet the necessary regulatory requirements; the customer must be notified. The customer has the option of having the samples subcontracted to a laboratory that meets the necessary state or national accreditations or certifications as well as regulatory requirements.

7. If the laboratory cannot meet the required accreditations and certifications or meet the regulatory requirements and the customer still wants the laboratory to analyze the samples, then a request in writing or email is required from the client stating that the client is aware that the laboratory is not certified or accredited and/or is unable to meet regulatory requirements but still wants the samples to be analyzed by the laboratory.

8. If the work is not identified as routine, then it will be necessary for the laboratory to determine whether it can accept it or whether to subcontract the work. This will require an assessment of whether the necessary equipment and expertise is available. A method will also have to be identified and arrangements made to validate it and must meet regulatory requirements. All subcontracted work must meet any necessary state or national accreditations or certifications. Agreement from the customer is needed for all subcontracted work.

The QA/QC Manager may be consulted if special requests are made. Special data packages or reporting conventions or other customized details are designed to meet the customer's needs for testing and reporting. When quality assurance requirements are different from SLGI standard protocol, the standard protocol is first met and special requirements are done as additional measures. Contracts with suppliers are reviewed annually to ensure that all supplies and services used in the laboratory meet or exceed the quality requirements of the methods in use for sample analysis.

20. Customer Confidentiality, Proprietary Rights, and Laboratory Rights

Customers of the laboratory submit samples to the laboratory for testing, and the customer becomes the proprietor of those analytical results upon release by the laboratory. Results are released to the submitting customer. As a service to the customer, results may be also released to a third party if authorized by the customer. Results are not released to third party agencies without consent of the customer.

When sample submissions are for compliance testing and samples are identified as such, the laboratory may be obliged to report results directly to a regulating agency. An example of such compliance testing is drinking water testing for public water supplies. In such cases, the submitting customer is aware of the reporting agreements and regulations when the samples are submitted, and the submitting customer actually facilitates such reporting arrangements by disclosing the regulating authority and the appropriate identification information.

Results are given on a final report by mail, phone, facsimile, electronic mail, or hand-delivered to the customer. The final report meets all AIHA and ISO/IEC 17025 requirements. The customer specifies the method and details of the report delivery. Because the laboratory delivers reports per the customer's specifications, it is the responsibility of the customer to establish an arrangement that provides the desired or required level of security and confidentiality.

All testing performed by Schneider Laboratories Global, Inc. is done under a policy of customer confidentiality. Employees of Schneider Laboratories Global, Inc. are not at liberty to discuss laboratory tests with anyone outside of the laboratory except the customer or his designated representative. In the case of highly sensitive testing, a customer may arrange to increase the level of security on test information within the laboratory and appoint a sample custodian and point-of-contact. In this case, only laboratory employees with a need-to-know have access to analysis data. Laboratory policies regarding customer confidentiality apply to all samples tested, including any samples which may have national security concerns or other high-profile circumstances. Any breach in customer confidentiality must be investigated with the laboratory corrective action plan.

Customers have a proprietary right to the analysis data as presented by the laboratory. The customer does not have the right to demand changes or edits to the data or the presentation thereof after receipt of the analysis results. Requests for edits to reports are honored only when such edits are not believed to compromise the integrity of the analyses or to misrepresent the analytical results. Schneider Laboratories Global, Inc. reserves the right to deny requests for edited reports.

21. Sub-Contracted Analyses

When a customer request analyses which SLGI cannot provide due to lack of instrumentation or accreditation status then SLGI sub-contracts the samples to an appropriate laboratory to perform the requested testing. The sub-contracted laboratory shall meet all AIHA, NELAC, NVLAP or other required accreditations as appropriate. Tests are designated with "sendout" in the SLGI fee schedule if they are sub-contracted to another laboratory; additionally, any test not in the fee schedule may be sent to a sub-contracted laboratory at the discretion of SLGI. All customers are made aware and must approve the sub-contracting in writing prior to sending samples to another laboratory. Reports from sub-contracted laboratories are forwarded to customers in the format produced by the sub-contracted laboratory.

Information and credentials for associated laboratories is maintained by the QA Director.

22. Safety

Safety is of utmost importance in the operations at SLGI. All employees have access to the Hazard Communication Manual, Material Safety Data Sheets (MSDS) Manual, and Chemical Hygiene Plan Manual located in the SLI library. Initial training sessions and annual refresher sessions are scheduled with employees and attendance is documented. Additionally, the SOP manual contains SOP AD-039 addressing safety throughout the laboratory and individual department SOPs which contain highlights of safety precautions as reminders to employees of the most critical aspects of laboratory safety.

SLGI performs chemical/particulate hood monitoring and dust wipe monitoring as controls of contamination which would pose either a safety or sample contamination hazard. Good housekeeping procedures in place are designed to protect employees while maintaining the integrity of samples handled at SLGI.

SLGI has the following safety equipment in the laboratory work areas:

- One (1) safety shower
- Ten (10) emergency eyewash stations
- Four (4) first aid kits/stations
- Twelve (12) fire extinguishers
- ADT Smoke detectors with thermal heat detectors, throughout bldg.
- Sprinkler system, throughout bldg.
- Latex and industrial gloves
- Disposable and cloth laboratory coats
- Safety glasses
- Face shields
- Three (3) acid spill kits
- One (1) mercury spill kit
- Ten (10) fume hoods
- Eight (8) HEPA filter hoods

Emergency egress routes and exits are marked. The facility is equipped with emergency lighting.

SLGI strictly adheres to the OSHA regulations in protecting the health and safety of all employees.

23. Traceabililty

Traceability is defined as ability to relate a sample result to the appropriate standards through an unbroken chain of recorded identifications. It is the ability to perform "historical reconstruction" of the data from sample receipt through

preparation, analysis and to sample reporting. All records and documents on the computer drive are backed up nightly.

The laboratory must maintain documentation of personnel responsible for sample receipt, sample preparation, sample analysis and data verification and reporting. Initials of these personal must be indicated in records. All fields requiring initials of the personal involved in any aspects within the laboratory such as calibration records and review shall be completed.

All records of sample preparation including digestion, incubation times, sample volume, balance and weights used, instrument printouts, meter readings and calculations must be maintained. Unique identifiers must be assigned to equipment within the laboratory such as pipettes, balances, thermometers, meters, refrigerators and incubators. These identifiers must be listed in the worksheets and log books documenting sample preparation and analysis.

When standards are prepared in the laboratory, information about the source material is maintained. The reference material can be traced to a national standard of measurement. The following steps must be used for standard and reagent receipt and preparations.

23.1 Assign a unique identifier and expiration date to each of the purchased reagents and standards

23.2 This unique identifier is recorded in all preparation records as well as on the reagent and standard containers.

23.3 Document reagent, standard and media preparation in a log or bench sheet with the following information
- **23.3.1** Source reagent identifier
- **23.3.2** Source reagent volume
- **23.3.3** New reagent unique identifier
- **23.3.4** New reagent final volume and solvent identification
- **23.3.5** Preparation date
- **23.3.6** Expiration Date
- **23.3.7** Reagent Name
- **23.3.8** Preparer Initials

Maintenance log books must contain all routine and non-routine maintenance for analytical instruments. Any maintenance such as column changes in a gas chromatograph must be listed within the log book with the date and initials of the individual performing the change or maintenance. All equipment must be properly maintained, inspected and cleaned.

All calibration records of instruments must be maintained. All initial instrument calibrations must be verified by a second source standard traceable to a national standard, when available. Criteria for acceptance of initial and continuing

calibrations must be documented. Any deviation from accepted criteria must be documented. Samples affected by the deviations must be reanalyzed.

Quarterly monitoring to evaluate laboratory compliance with traceability must be performed. This monitoring must be conducted by pulling a report and tracing it back through the analysis process, preparation process and finally sample receipt to insure that the proper procedures were followed.

24. Uncertainty of Measurement

The laboratory has procedures for estimating uncertainty of measurement. The procedure identifies all the components of uncertainty and makes a reasonable estimation, and shall ensure that the form of reporting of the result does not give a wrong impression of the uncertainty. Reasonable estimation shall be based on knowledge of the performance of the method and on the measurement scope and shall make use of, for example, previous experience and validation data. The method for the estimation of uncertainty adopted for the laboratory is applicable to quantitative analyses and is based on Laboratory Control Standard (LCS) data collected in the course of the laboratory quality control program. For further information see SOP AD-034, the SOP for Uncertainty of Measurement.

25. References

25.1 "*General Requirements for the Competence of testing and Calibration Laboratories*", ISO/IEC 17025, (2005)

25.2 AIHA Laboratory Accreditation Programs, LLC, current policy modules. http://www.aihaaccreditedlabs.org/PolicyModules/Pages/2011%20Policy%20Modules.aspx

25.3 National Environmental Laboratory Accreditation Conference, "2003 NELAC Standard."

26. Appendices

Appendix A Organizational Chart

Revision History

08/06/2015 (15-003)

Revised:

Updated title page to include the signature of the Lead Technical Director.

Revised:

7.6 SOP and QA Manual Signatures and Effective Date

Each SOP indicates the signatures of the reviewers such as the Quality Assurance Director, General Manager, Laboratory Director, and/or the appropriate department(s) supervisor. The date the SOP is placed into production is listed at the top of each SOP under the revision date. The Effective date is the date the SOP is put into effect. The QA Manual Title page is signed and dated by the General Manager and the Quality Assurance Director. The date signed is the effective date for the QA Manual which is listed at the top of the title page. This date is entered once the QA Manual has been reviewed and approved and then the effective date is entered and the title page is printed for the signatures.

Revision:

7.6 SOP and QA Manual Signatures and Effective Date

Each SOP indicates the signatures of the reviewers such as the Quality Assurance Director, General Manager, Lead Technical Director, and/or the appropriate department(s) supervisor. The QA Manual must be signed by the Lead Technical Director, General Manager and the QA Director. The effective date the QA/Manual or an SOP is placed into production is listed at the top of each under the revision date. The effective date is the date the QA Manual or SOP was signed by each signatory and placed into production.

Revised the following Section:

7.2. Basic Sample Acceptance

The laboratory collaborates with customers and/or their representatives in clarifying their requests and in monitoring of the laboratory performance related to their work.

The laboratory confidentiality policy is to not divulge or release any information to a third party without proper written authorization.

CONFIDENTIALITY NOTICE
This e-mail and any attachments may contain confidential or privileged information. If you are not the intended recipient, please advise by return e-mail and delete this e-mail and any copies or links to this e-mail completely and immediately without forwarding to others.

It is the responsibility of the customer (or the sampler appointed by the customer) to provide the proper, full, and complete documentation appropriate to the sample collected, generally including: sample identification, the location, date, and time of collection, collector's name, preservation type, sample type, and special remarks.

Submitted samples shall be clearly labeled with a unique identification corresponding to written documentation. Sample labeling and documentation shall be done in indelible ink.

Containers, sample volumes, holding times, and shipping conditions shall be appropriate to the analysis requested.

Revision:

7.2. Basic Sample Acceptance

The laboratory collaborates with customers and/or their representatives in clarifying their requests and in monitoring of the laboratory performance related to their work.

The laboratory confidentiality policy is to not divulge or release any information to a third party without proper written authorization.

CONFIDENTIALITY NOTICE
This e-mail and any attachments may contain confidential or privileged information. If you are not the intended recipient, please advise by return e-mail and delete this e-mail and any copies or links to this e-mail completely and immediately without forwarding to others.

It is the responsibility of the customer (or the sampler appointed by the customer) to provide the proper, full, and complete documentation appropriate to the sample collected, generally including: sample identification, the location, date, and time of collection, collector's name, preservation type, sample type, and special remarks.

Submitted samples shall be clearly labeled with a unique identification corresponding to written documentation. Sample labeling and documentation shall be done in indelible ink. If a sample contains more than one sample container then each sample's container will be identified with a unique alphabetic identifier. The unique alphanumeric identifier is documented in any logbooks, worksheets and/or internal documents. The specific test for each sample container will be documented in the Container Data entry tab in Sample Master. Containers, sample volumes, holding times, and shipping conditions shall be appropriate to the analysis requested. Further sample handling information can be found in SOP AD-017.

Section 7

Schneider Laboratories Inc.
Standard Operating Procedures for Analysis of Lead

SCHNEIDER LABORATORIES GLOBAL, INCORPORATED

Document #: ME-011-15-004
Original Date: 08/25/95
Revision Date: 07/20/15
Effective Date: 07/23/15

Schneider Laboratories Global, Inc.
Standard Operating Procedure for Acid Digestion of Solid Samples for Metals Analysis (FLAA, GFAA, ICP) using EPA Method 3050B

Reviewed by: _____
Department Manager

Approved by: _____
QA/QC Department

Approved by: _____
Laboratory/Technical Director

Schneider Laboratories Global, Inc.
Standard Operating Procedure for Acid Digestion of Solid Samples for Metals Analysis (FLAA, GFAA, ICP) using EPA Method 3050B

1. Scope and Application

1.1. This method includes two different digestion procedures, one for the preparation of sediments, soils, sludge, wipes, paints and other solid waste (bulk) samples for analysis by flame atomic absorption (FLAA) spectroscopy or inductively coupled plasma optical emission spectroscopy (ICP-OES) and one for the preparation of sediments, soils, sludge, and other solid waste (bulk) samples for analysis by graphite furnace atomic absorption (GFAA).

NOTE: The digestates from these two procedures are NOT interchangeable and should only be used with the analytical determination outlined in this method.

1.2. This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become "environmentally available". By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

1.3. Samples prepared by the method may be analyzed for the following:

FLAA/ICP-OES		GFAA
Aluminum	Magnesium	Arsenic
Antimony	Manganese	Beryllium
Barium	Molybdenum	Cadmium
Beryllium	Nickel	Chromium
Cadmium	Potassium	Cobalt
Calcium	Silver	Iron
Chromium	Sodium	Lead
Cobalt	Thallium	Molybdenum
Copper	Vanadium	Selenium
Iron	Zinc	Thallium
Lead		Copper

2. Summary of Method

2.1. A representative 0.3 g (Paint sample) or 0.5 g (dry weight) solid (Soil & Bulk) sample is digested with repeated additions of nitric acid and hydrogen peroxide.

2.2. For GFAA analysis, the resultant digestate is reduced in volume while heating and then diluted with DI water to a final volume of 50 mL.

2.3. For ICP-OES or FLAA analyses, hydrochloric acid (HCl) is added to the initial digestate and the sample is refluxed. The sample is then brought to a final volume of 50 ml.

2.4 The entire wipe sample is digested with repeated additions of nitric acid and hydrogen peroxide.

3. Definitions

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of laboratory background and reagent contamination.

3.2. Matrix Blank (MB) - A matrix blank is performed with each batch of wipe samples. A matrix blank consists of a blank wipe which is carried through the entire preparation and analytical process. The matrix blank is used to define the level of contamination within the sample matrix.

3.3. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference.

3.4. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method.

3.5. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process. For wipe samples the LCS takes the place of the Matrix Spike and is prepared by adding a known quantity of CRM material to a blank wipe and then carried through the entire preparation and analytical procedure.

3.6. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. For wipe samples the LCSD takes the place of the Duplicate and is prepared by adding a known quantity of CRM material to a blank wipe and then carried through the entire preparation and analytical procedure.

3.7. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

3.8. *RLV spike* or Reporting Limit Verification spike – The RLV spike is a quality system matrix spiked sample prepared to have a concentration at or below the desired reporting limit and taken through the entire preparation and analytical process. The RLV is prepared daily for lead analysis for wipes, paints, soils and airs.

4. Interferences

4.1. Sludge samples can contain diverse matrix types, each of which may present its analytical challenge. Spiked samples and any relevant standard reference material should be processed in accordance with the quality control requirements listed in Section 9.4 to aid in determining whether this method is applicable to a given waste.

4.2. Reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing reagent or method blanks.

4.3. Analyses of reagent blanks provide information about the presence of contaminants.

4.4. Contamination by carryover can occur whenever high-level and low level samples are sequentially digested and analyzed. After the analysis of sample(s) containing high concentration(s) of analyte(s), sufficient rinse time should follow the analysis on the instrument.

5. Safety

This SOP does not address all safety issues associated with its use. The laboratory is responsible for maintain a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals included in this method. A reference file of material data safety sheets (MSDS) is available to all personnel involved in these analyses.

5.1. The preparation of all standards, reagents, and glassware procedures that involve acids will be conducted in a fume hood with the sash closed as far as the operations will permit.

5.2. Gloves, goggles, or face shield must be used when employees are using acids to rinse or clean glassware.

5.3. Work areas should be isolated and posted with signs. Glassware and tools should be segregated.

5.4. Exposure of chemicals will be maintained so it is as low as reasonable possible. All samples should be opened, transferred, and prepared in a fume hood, or under other means of ventilation.

5.5. The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. For this reason, the acidification and digestion of samples should be performed in a fume hood.

5.6. Waste containers must be kept closed unless transfers are being made.

5.7. In the event of a known or potential problem with the safety or health of an individual working in the laboratory, all work must be stopped. The situation must be reported to a laboratory supervisor or the laboratory manager immediately.

6. Apparatus and Materials

6.1. Analytical balance, capable of weighing to 0.001 g.

6.2. Drying oven – capable of drying at approximately 100°C.

6.3. Centrifuge tubes, plastic 50mL, with caps.

6.4. Erlenmeyer Flasks, glass, 125 mL

6.5. Hot blocks: adjustable and can maintain the samples at a temperature of 95° $\pm$ 5°C.

6.6. Syringes, plastic, disposable, 20mL

6.7. Filters for syringes, plastic, disposable, 25 mm, 1.5 µm glass fiber

7. Reagents and Standards

7.1. Deionized water: water should be monitored for impurities

7.2. Concentrated nitric acid: reagent grade HNO_3: acid should be analyzed to determine levels of impurities. If the method blank is <RL, the acid can be used.

7.3. Concentrated hydrochloric acid; reagent grade, HCL: acid should be analyzed to determine levels of impurities. If the method blank is <RL, the acid can be used.

7.4. Hydrogen peroxide (30%); H_2O_2, oxidant should be analyzed to determine levels of impurities. If the method blank is <RL, the peroxide can be used.

7.5. 50% (v/v) nitric acid solution: Mix 1 part concentrated nitric acid with 1 part deionized water.

7.6. Wipe samples should be stored at room temperature upon receipt and digested within 180 days of sample collection.

7.7. Examine the paperwork for necessary client information regarding processing and reporting of the samples and record the area of the wiped surface in square feet. If standard, write 1 ft^2 in column. If area is given in inches, calculate the square feet. Example: 12" x 3" sampled = 36 sq. inches; 36/144 = 0.25 $feet^2$. Always divide sample area in sq. inches by 144 to get square feet. [1 foot = 12 inches; 1 $foot^2$ = 144 $inches^2$]. This may be selectable as a standard unit of measurement in the data management program.

7.8. Dimensions given in cm or cm^2 must be converted to inches or $inches^2$ before they are converted to square feet. [1 inch = 2.54 cm; 1 $inch^2$ = 6.45 cm^2; 1 $foot^2$ = 929.03 cm^2]. This may be selectable as a standard unit of measurement in the data management program.

8. Sample Collection, Preservation, and Handling

8.1. SLGi does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2. All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3. It can be difficult to obtain a representative sample with wet or damp materials. Wet samples may be dried, crushed, and ground to reduce subsample variability as long as drying does not affect the extraction of the analytes of interest in the sample.

8.4. Non-aqueous samples also requesting organic analysis should be refrigerated at $4^oC \pm 2^oC$ upon receipt and analyzed as soon as possible.

8.5. Samples must be digested and analyzed within 180 days of sample collection.

9. Procedure

9.1. **Procedure for Soil, Bulk and paint:** Mix the sample thoroughly to achieve homogeneity. For each digestion procedure, weigh to the nearest 0.001 g into a 50mL centrifuge tube a 0.300 g to 0.350 g portion of the paint sample and 0.500 g to 0.550 g (dry weight) portion of the soil or bulk sample.

9.2. If solid samples contain excessive moisture, dry the sample in the drying oven for approximately 1 hour. A small amount of moisture is characteristic of soils, so soil samples are generally tested as received unless noted by the analyst as "Dried before analysis." The decision to dry a sample is made at the discretion of the analyst.

9.3. Label one sample with the SLGi sample ID. Label the matrix spike sample as the "SLGi sample ID-spike" (i.e. 12345-spike) and the duplicate sample as "SLGi sample ID-DUP" (i.e. 12345-DUP). Record the weight of each on the worksheet.

9.4. Spike the matrix spike sample by adding 100 µl of 1000 µg/ml standard into a 50ml tube. The spike increases the value of the un-spiked native sample by 2 µg/ml for FAAS. For GFAA analysis, prepare an MS by spiking with 500 µl of 1µg/ml multi-elemental standard into a lead free matrix blank in a 50ml tube to give a 10ug/l final concentration of lead in the MS. For ICP analysis, prepare an MS by spiking with 500 µl of 100µg/ml multi-elemental standard into a lead free matrix blank and dilute with water in a 50 ml tube to give a 1.0µg/ml final concentration of multi analytes in the MS.

9.5. Prepare a laboratory matrix blank (MB) for each batch of 18 samples using a known Lead-free matrix blank.

9.6. Prepare a laboratory control spike (LCS) sample and laboratory control spike duplicate (LCSD) for each batch:

9.6.1. For the analysis of lead by FAA Analysis, prepare an LCS/LCSD by weighing a known amount of a CRM material into a lead-free matrix blank.

9.6.1.1. Soils – 25 mg of Soil CRM
9.6.1.2. Paints – 50 mg of Paint CRM
9.6.1.3. Wipes – 50 mg of Soil CRM

9.6.2 For multi-metal GFAA analysis, prepare an LCS/LCSD by spiking with 500 µl of 1µg/ml multi-elemental standard into a matrix blank in a 50ml tube to give a 10ug/l final concentration of lead in the LCS/LCSD. All analyses for lead that fall under

the AIHA-LAP, Inc. ELLAP program analyzed by GFAA must use a solid CRM as shown in 9.6.1.

9.6.3 For multi-metal ICP analysis, prepare an LCS/LCSD by spiking with 500 µl of 100µg/ml multi-elemental standard into a matrix blank and dilute with water in a 50 mL tube to give a 1.0µg/ml final concentration of multi analytes in the LCS/LCSD. All analyses for lead that fall under the AIHA-LAP, Inc. ELLAP program analyzed by ICP must use a solid CRM as shown in 9.6.1.

9.7. Procedure for Wipes

9.7.1 Wipe samples received in plastic bags, are transferred to a centrifuge tube using forceps.

9.7.2 Wipe samples received in centrifuge tubes will be digested in the plastic centrifuge tubes they are received in. Do not transfer to another vessel unless the sample is a bulky, non-standard wipe. Bulky, non-standard wipes must be digested in a glass flask on a hotplate.

9.7.3 Lab Control Spike (LCS/LCSD) samples are prepared at a rate of 1 per 20 wipe samples and carried throughout the entire sample preparation and analytical process. For wipe samples the LCS takes the place of the Matrix Spike and the LCSD takes place of the duplicate. LCS acceptance is ± 20% Recovery. LCS/LCSD duplicate acceptance is ± 20% RPD.

9.7.3.1 Prepare an LCS/LCSD by weighing 50 mg of a soil CRM material into a wipe blank and take through the entire preparation and analysis process.

9.7.4 If the sample must be digested using the HOTPLATE method, make a clearly written notation on the paperwork. (e.g., "Hotplate – large wipes = 50 ml final volume). These wipes will be on a tray separate from block wipes and will need standard hotplate QC.

9.7.5 Composite wipe (comp-wipes) and baby wipe samples will generally not be digested using the BLOCK procedure. There is no change in procedure for comp-wipes.

Note: comp-wipe samples taken on a single wipe (standard media) may be digested on the block.

Note: Composite wipe testing does not fall under Schneider Laboratories Global AIHA program and the following disclaimer is put on the report for composite wipe analysis:

"Analyzed as a single wipe per client request. Analysis not recognized under our AIHA accreditation."

9.8 Digestion of Samples

9.8.1 For the digestion of all solid samples matrices (wipe, paint and soil and bulk) including GFAA samples: Add 5 ml of 1:1 nitric acid, mix the slurry, and cover the centrifuge tube with a refluxing cap. Place the sample in the hot block, heat the sample to 95°C ± 5°C, and reflux for 10-15 minutes WITHOUT boiling.

9.8.2 Add 3mL of concentrated nitric acid and reflux for 15 minutes.

9.8.3 Heat the sample to 95°C ± 5°C, and reflux for 10-15 minutes WITHOUT boiling. Maintain a covering solution over the bottom of the vessel at all times. Do not allow the sample to go to dryness.

9.8.4 Add 2mL of deionized water and 2mL of 30% H_2O_2. Cover the centrifuge tube with the refluxing cap and return to the hot block for warming and to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat at 95°C ± 5°C until effervescence subsides for about 15 minutes without boiling. Cool the sample.

9.8.5 If needed, add additional portions of 30% H_2O_2 until the general sample appearance is unchanged.

NOTE: Do not add more than a total of 5mL 30% H_2O_2.

9.8.6 The sample is now ready for GFAA analysis. After cooling, dilute the sample to 50mL with deionized water. For FLAA or ICP-OES analysis continue to 9.8.8.

9.8.7 Remove particulates in the digestate for GFAA analysis with filtration.

9.8.8 For the analysis of samples for FLAA or ICP-OES: Add 5mL of concentrated HCL to the sample digest from Section 9.8.4/9.8.5. Cover with a refluxing cap. Place the sample in the hot block and reflux at 95°C ± 5°C without boiling for 15 minutes.

9.8.9 After cooling dilute the sample to 50 mL with deionized water.

9.8.10 Remove particulates in the digestate with filtration. The sample is now ready for FLAA or ICP-OES analysis.

9.9 **Wipe Sample Digestion by Hot Plate** (for thick wipes, composite wipes, or dirty wipes):

9.9.1 Using forceps transfer the wipe into a pre-labeled 125 ml flask.

9.9.2 There is a separate prep tray logbook for the HOTPLATE. Keeping the hot plate process entirely separate will help provide reliable documentation of solution volume.

Note: For dirty wipes samples that cannot be prepared in centrifuge tubes, add at least 10 ml of deionized water to the flask. Add additional portions of deionized water as needed. Some wipes may require 20-30 ml of deionized water depending on how thick the wipe is. This will prevent foaming or bubbling of the sample. Follow the same digestion procedure as above in 9.8.1 - 9.8.10

Note: For very thick wipe samples that do not completely dissolve, the wipe must be filtered from the final volume of digestate. Decant the liquid into a second labeled beaker leaving the wipe behind in the first beaker. Rinse the wipe three times and transfer to the second flask. Adjust volume to 50 ml. Follow the same digestion procedure as above in 9.8.1 - 9.8.10

10. Quality Control

10.1 Blank Analyses

10.1.1 Matrix Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

10.1.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask in the sample tray. The Reagent Blank has the same reagents as a sample and is taken through the entire process.

10.1.3 If the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

10.2 Duplicate samples should be processed on a routine basis. A duplicate sample is a sample brought through the whole sample preparation and analytical process. A duplicate sample will be processed with each analytical batch or every 18 samples, whichever is greater. Duplicate acceptance is ± 20% RPD.

10.3 Matrix Spiked (MS) samples are employed to determine accuracy. A spiked sample is included with each batch of samples processed and whenever a new sample matrix is being analyzed. A spiked sample will be processed with each analytical batch or every 18 samples, whichever is greater. Matrix spiked sample acceptance is ± 25% Recovery.

10.4 Lab Control Spike (LCS/LCSD) samples are prepared at a rate of 1 per 20 (wipe) samples or 18 (paint, soil or bulk) and carried throughout the entire sample preparation and analytical process. For wipe samples the LCS takes the place of the Matrix Spike and the LCSD takes place of the duplicate. LCS acceptance is ± 20% Recovery. LCS/LCSD duplicate acceptance is ± 20% RPD.

10.5 LCS/LCSD Sample – This is a certified reference material standard containing a known concentration of lead or a multi-analyte reference standard.

10.5.1 For the analysis of lead by FAA Analysis, prepare an LCS/LCSD by weighing a known amount of a CRM material into a lead-free matrix blank.

10.5.1.1 Soils – 25 mg of Soil CRM is weighed in a 50ml tube.

10.5.1.2 Paints – 50 mg of Paint CRM is weighted in a 50ml tube.

10.5.1.3 Wipes – 50 mg of Soil CRM is weight in a blank wipe in a 50ml tube.

10.5.2 For multi-metal GFAA analysis, prepare an LCS/LCSD by spiking with 500 µl of 1µg/ml multi-elemental standard into a matrix blank in a 50ml tube to give a 10ug/l final concentration of lead in the LCS/LCSD. All analyses for lead that fall under the AIHA-LAP, Inc. ELLAP program analyzed by GFAA must use a solid CRM as shown in 10.5.1.

10.5.3 For multi-metal ICP analysis, prepare an LCS/LCSD by spiking with 500 µl of 100 µg/ml multi-elemental standard into a matrix blank and dilute with water in a 50 mL tube to give a 1.0µg/ml final concentration of multi analytes in the LCS/LCSD. All analyses for lead samples that fall under the AIHA-LAP, Inc. ELLAP program analyzed by ICP must use a solid CRM as shown in 10.5.1.

10.6 Reporting Limit Verification Spike (RLV) – Every day a lead RLV spike must be digested for each ELLAP matrix: Paint, Wipe, Soil and Air. The spike is prepared at the low level concentration and undergoes the entire preparation and analytical procedure. The acceptance range for the RLV is 80 – 120% Recovery.

10.6.1 Soil – Blank soil is spiked with 100 ul of 100 ppm stock lead standard, digested and brought to 50 ml final volume.

10.6.2 Paint – Blank paint is spiked with 100 ul of 100 ppm stock lead standard, digested and brought to 50 ml final volume.

10.6.3 Wipe - Blank wipe is spiked with 100 ul of 100 ppm stock lead standard, digested and brought to 50 ml final volume.

11 Method Performance

11.1. The above method is a modification of the EPA 3050B method on which it is based, although much of the text of this SOP is verbatim.

11.2. The method with its modifications has been used for all samples of the applicable matrix at SLGi and has been verified with quality control samples, both in-house and those which are part of nationally-recognized proficiency testing programs.

12 Data Analysis and Calculations

12.1. The quantitative values must be reported in the appropriate units of milligrams per kilogram (mg/kg) for solid, paint and soil and ug/ft^2 for wipes.

12.2. If dilutions were performed, the appropriate corrections must be applied to the sample values.

12.3. Results must be reported in units commensurate with their intended use and all dilutions must be taken into account when computing final results.

13 Calibration and Standardization

13.1. See specific analysis SOPs for the calibration and standardization information.

14 Pollution Prevention

14.1. Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities exist for pollution prevention in the laboratory.

14.2. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed of. The threat to the environment from solvents and/or reagents used in this method may be minimized when recycled or disposed of properly.

15. Waste Management

15.1 All waste will be disposed in accordance with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required. The storage and disposal of hazardous waste is further detailed in SLGi SOP AD-043.

15.2 For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel," and "Less is Better: Laboratory Chemical Management for Waste Reduction," both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036.

16 Handling Non-Conformance Data

16.1 Refer to Table 3: Corrective action flowchart for Non-Conformance handling information.

17 References

17.1. United States Environmental Protection Agency, “Method 3050B: Acid Digestion of Sediments, Sludges, and Soils”, SW846 Online, Revision 3B, November 2004.

Table 3: Corrective Action Flowchart

Sample Type	Test Result	Condition	Corrective Action	Note
Reagent/Matrix Blank (RB/MB)	Blank Reading> Reporting Limit (RL)	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet and notify QA dept.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Air and wipe samples are consumed during extraction. In this case, notify QA dept. Disclaimer is placed on report for any failing QC
Laboratory Control Sample / Laboratory Control Sample Duplicate (LCS/LCSD)	LCS > Upper Limit	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken. Note what the %R is on the internal tracking sheet.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed Air and wipe samples are consumed during extraction. In this case, notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do. Disclaimer is placed on report for any failing QC
	LCS < Lower Limit	Samples are non-detect for that analyte	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Since there is no more wipe or air sample, re-extraction cannot occur so notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do. Disclaimer is placed on report for any failing QC
		Samples are positive for that analyte.		
Matrix Spike (MS) and MS Duplicate (MSD)	MS/MSD > or < QC Limit	Samples are positive or non-detect for that analyte.	Note on internal tracking sheet. If the MS/MSD is unacceptable, notify QA dept or follow table as listed above for LCS/QC Samples.	Disclaimer is placed on report containing the failing MS/MSD.
Duplicate Sample (D) (If used)	%RSD > Upper Limit	Samples are positive or non-detect for that analyte.	Note on internal tracking sheet. Notify QA dept	Disclaimer is placed on report containing the failing duplicate.

Revision Page

07/20/2015 (15-004)

Revised the following:

9.6. Prepare a laboratory control spike (LCS) sample and laboratory control spike duplicate (LCSD) for each batch:

9.6.1. For FAA Analysis, prepare an LCS/LCSD by weighing a known amount of a CRM material into a lead-free matrix blank.
9.6.1.1. Soils – 25 mg of Soil CRM
9.6.1.2. Paints – 50 mg of Paint CRM
9.6.1.3. Wipes – 50 mg of Soil CRM

9.6.2 For GFAA analysis, prepare an LCS/LCSD by spiking with 500 µl of 1µg/ml multi-elemental standard into a lead free matrix blank in a 50ml tube to give a 10ug/l final concentration of lead in the LCS/LCSD. Lead wipe samples analyzed by GFAA must use a solid CRM as shown in 9.6.1.

9.6.3 For ICP analysis, prepare an LCS/LCSD by spiking with 500 µl of 100µg/ml multi-elemental standard into a lead free matrix blank and dilute with water in a 50 mL tube to give a 1.0µg/ml final concentration of multi analytes in the LCS/LCSD. Lead wipe samples analyzed by ICP must use a solid CRM as shown in 9.6.1.

Revision:

9.6. Prepare a laboratory control spike (LCS) sample and laboratory control spike duplicate (LCSD) for each batch:

9.6.1 For the analysis of lead by FAA Analysis, prepare an LCS/LCSD by weighing a known amount of a CRM material into a lead-free matrix blank.
9.6.1.1 Soils – 25 mg of Soil CRM
9.6.1.2 Paints – 50 mg of Paint CRM
9.6.1.3 Wipes – 50 mg of Soil CRM

9.6.2 For multi-metal GFAA analysis, prepare an LCS/LCSD by spiking with 500 µl of 1µg/ml multi-elemental standard into a matrix blank in a 50ml tube to give a 10ug/l final concentration of lead in the LCS/LCSD. All analyses for lead that fall under the AIHA-LAP, Inc. ELLAP program analyzed by GFAA must use a solid CRM as shown in 9.6.1.

9.6.3 For multi-metal ICP analysis, prepare an LCS/LCSD by spiking with 500 µl of 100µg/ml multi-elemental standard into a matrix blank and dilute with water in a 50 mL tube to give a 1.0µg/ml final concentration of multi analytes in the LCS/LCSD. All analyses for lead that fall under the AIHA-LAP, Inc. ELLAP program analyzed by ICP must use a solid CRM as shown in 9.6.1

Revised the following:

10.5 LCS/LCSD Sample – This is a certified reference material standard containing a known concentration of lead or a multi-analyte reference standard.

10.5.1 Soils – 25 mg of Soil CRM is weighed in centrifuge tube for FAA Analysis.
10.5.2 Paints – 50 mg of Paint CRM is weighted in centrifuge tube for FAA Analysis.
10.5.3 Wipes – 50 mg of Soil CRM is weight in a blank wipe in a centrifuge tube for FAA Analysis.

10.5.4 For GFAA analysis, prepare an LCS/LCSD by spiking with 500 µl of 1µg/ml multi-elemental standard into a lead free matrix blank in a 50ml tube to give a 10ug/l final concentration of lead in the LCS/LCSD. Lead wipe samples analyzed by ICP must use a solid CRM as shown in 10.5.3.

10.5.5 For ICP analysis, prepare an LCS/LCSD by spiking with 500 µl of 100µg/ml multi-elemental standard into a lead free matrix blank and dilute with water in a 50 mL tube to give a 1.0µg/ml final concentration of multi analytes in the LCS/LCSD. Lead wipe samples analyzed by ICP must use a solid CRM as shown in 10.5.3.

Revision:

10.5 LCS/LCSD Sample – This is a certified reference material standard containing a known concentration of lead or a multi-analyte reference standard.

10.5.1 For the analysis of lead by FAA Analysis, prepare an LCS/LCSD by weighing a known amount of a CRM material into a lead-free matrix blank.

10.5.1.1 Soils – 25 mg of Soil CRM is weighed in a 50ml tube.

10.5.1.2 Paints – 50 mg of Paint CRM is weighted in a 50ml tube.

10.5.1.3 Wipes – 50 mg of Soil CRM is weight in a blank wipe in a 50ml tube.

10.5.2 For multi-metal GFAA analysis, prepare an LCS/LCSD by spiking with 500 µl of 1µg/ml multi-elemental standard into a matrix blank in a 50ml tube to give a 10ug/l final concentration of lead in the LCS/LCSD. All analyses for lead that fall under the AIHA-LAP, Inc. ELLAP program analyzed by GFAA must use a solid CRM as shown in 10.5.1.

10.5.3 For multi-metal ICP analysis, prepare an LCS/LCSD by spiking with 500 µl of 100 µg/ml multi-elemental standard into a matrix blank and dilute with water in a 50 mL tube to give a 1.0µg/ml final concentration of multi analytes in the LCS/LCSD. All analyses for lead samples that fall under the AIHA-LAP, Inc. ELLAP program analyzed by ICP must use a solid CRM as shown in 10.5.1.

SCHNEIDER LABORATORIES GLOBAL, INCORPORATED

Document #: ME-012-15-002
Original Date: 07/08/13
Revision Date: 05/14/15
Effective Date: 05/18/15

Schneider Laboratories Global, Inc. Standard Operating Procedure for Acid Digestion of Aqueous Samples for Total Metals (GFAA) using EPA 3020A

Reviewed by: _____
Department Manager

Approved by: _____
QA/QC Department

Approved by: _____
Laboratory/Technical Director

Schneider Laboratories Global, Inc.
Standard Operating Procedure for
Acid Digestion of Aqueous Samples for
Dissolved and Total Metals (GFAA) using EPA 3020A

1. Scope and Application

1.1. This digestion procedure is used for the preparation of aqueous samples, including drinking waters and waste waters for analysis by graphite furnace atomic absorption (GFAA) spectroscopy. The procedure is used to determine dissolved and total metals.

1.2. Samples prepared by this method may be analyzed by for the following analytes:

Aluminum	Lead
Antimony	Manganese
Arsenic	Molybdenum
Beryllium	Nickel
Cadmium	Selenium
Chromium	Silver
Cobalt	Thallium
Copper	Zinc

2. Summary of Method

2.1 An aliquot of a well-mixed homogeneous aqueous sample is accurately measured. For total recoverable analysis of an aqueous sample containing undissolved material, samples first undergo a gentle refluxing with nitric and hydrochloric acids. After cooling, the sample is made up to volume, is mixed and centrifuged or allowed to settle overnight prior to analysis. For the determination of dissolved analytes in a filtered aqueous sample aliquot, or for the "direct analysis" total recoverable determination of analytes where sample turbidity is <1 NTU, the sample is made ready for analysis by the appropriate addition of nitric acid, and then diluted to a predetermined volume and mixed before analysis.

3. Definitions

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.2. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference. If not enough sample is submitted then an LCS/LCSD is prepared.

3.4. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.5. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.6. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. This is performed when not enough sample is submitted for a duplicate analysis to be performed.

3.7. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

4. Interferences

4.1. Reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing reagent or method blanks.

4.2. Analyses of reagent blanks provide information about the presence of contaminants.

4.3. Contamination by carryover can occur whenever high-level and low level samples are sequentially digested and analyzed. After the analysis of a sample containing high concentrations of analytes, sufficient rinse time should follow the analysis on the instrument.

4.4. With addition of HCl in sample prep the analyst should be cautioned that this digestion procedure may not be sufficiently vigorous to destroy some metal complexes. Precipitation will cause a lowering of the silver concentration and therefore an inaccurate analysis.

5. Safety

This SOP does not address all safety issues associated with its use. The laboratory is responsible for maintain a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals included in this method. A reference file of material data safety sheets (MSDS) is available to all personnel involved in these analyses.

5.1. The preparation of all standards, reagents, and glassware procedures that involve acids will be conducted in a fume hood with the sash closed as far as the operations will permit.

5.2. Gloves, goggles, or face shield must be used when employees are using acids to rinse or clean glassware.

5.3. Work areas should be isolated and posted with signs. Glassware and tools should be segregated.

5.4. Exposure of chemicals will be maintained so it is as low as reasonable possible. All samples should be opened, transferred, and prepared in a fume hood, or under other means of ventilation.

5.5. The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. For this reason, the acidification and digestion of samples should be performed in a fume hood.

5.6. Waste containers must be kept closed unless transfers are being made.

5.7. In the event of a known or potential problem with the safety or health of an individual working in the laboratory, all work must be stopped. The situation must be reported to a laboratory supervisor or the laboratory manager immediately.

6. Apparatus and Materials

6.1. Beakers, glass, 250-ml or equivalent

6.2. Watch glasses

6.3. Hot plate: adjustable and capable of maintaining samples at a temperature of 90 to 95°C.

6.4. Syringes, plastic, disposable, 20 mL

6.5. Filters for syringes, plastic, disposable, 25 mm, 1.5 µm glass fiber

6.6. Pipettes – 10 µL to 1000 µL

7. Reagents and Standards

7.1. Deionized water: water should be monitored for impurities

7.2. Concentrated nitric acid: trace metals grade, HNO_3: acid should be analyzed to determine levels of impurities.

7.3. Concentrated Hydrochloric acid: trace metals grade, HCl: acid should be analyzed to determine levels of impurities

8. Sample Collection, Preservation, and Handling

8.1. SLGi does not collect samples on behalf of its customers. It is the responsibility of the customer to provide a representative sample.

8.2. All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3. Aqueous samples must be acidified to a pH of <2 with HNO_3.

8.4. Samples must be digested and analyzed within 180 days of sample collection.

8.5. Drinking water is analyzed as is, turbidity must be less than 1, but if greater than 1, digest sample and digest one LCS along with the sample.

9. Procedure for EPA 200.9 Digestion

9.1. For Dissolved Analytes: Transfer 20 ml of the filtered, acid preserved sample into a 50 ml centrifuge tube. Add 0.4 ml (1+1) HNO3 to sample, cap and mix. The sample is now ready for analysis.

Note: If a precipitate is formed during acidification, transport, or storage,the sample aliquot must be treated using the procedure described in Sections 11.2.2 through 11.2.7 prior to analysis.

9.2. For Total Recoverable Analytes: For the "direct analysis" of drinking water samples containing turbidity <1 NTU, treat an unfiltered acid preserved sample aliquot to the preparation procedure outlined above in section 9.1. For the analysis of all other aqueous samples follow the procedure in sections 9.3 through 9.4 below.

9.3. For all aqueous samples, except drinking water with a turbidity <1 NTU, transfer a 100-ml representative aliquot of the well-mixed sample to a 250 ml beaker and add 2 ml of (1 + 1) HNO_3 and 1 ml (1+1) HCl and cover with a watch glass and place on preheated hot plate. Heat the sample to 90°C to 95°C.

9.2. Allow evaporation to occur until the sample volume reaches approximately 20 ml.

NOTE: Be careful not to let the sample boil or go to dryness, as either may result in poor recovery of some analytes. Should this occur, discard the sample and re-prepare.

9.3. Remove from heat and allow the beaker to cool.

9.4. Wash down the beaker walls and watch glass with water. Filter the sample if needed. Adjust the final volume to 50 mL. The sample is ready for analysis.

10. Procedure for EPA 3020A Digestion

10.1. Transfer a 50 ml or 100-ml representative aliquot of the well-mixed sample to a 250 ml beaker and add 1.5 ml or 3 ml of trace HNO_3. Cover with a watch glass and place on preheated hot plate. Heat the sample to 95°C ± 5°C.

NOTE: For drinking water samples only use trace metals nitric acid.

10.2. Allow evaporation to occur until the sample volume reaches approximately 7-10 ml.

NOTE: Be careful not to let the sample boil or go to dryness, as either may result in poor recovery of some analytes. Should this occur, discard the sample and re-prepare.

10.3. Remove the beaker from the hot plate, cool, and then add another 1.5 ml or 3 mL, portion of concentrated HNO_3. Cover the beaker with a watch glass and return to the hot plate. Heat the sample to $95^oC \pm 5^oC$.

10.4. The refluxing should continue until digestion is complete, usually indicated when the digestate is light in color or does not change in appearance with continued refluxing.

10.5. Evaporate to a low volume (usually about 5 ml) being careful to not let the sample go to dryness. Cool the beaker. Add about 2 mL of deionized water. Cover the beaker and heat for 10-15 minutes at $95^oC \pm 5^oC$ to dissolve any precipitate or residue resulting from evaporation.

10.6. Remove from heat and allow the beaker to cool.

10.7. Wash down the beaker walls and watch glass with water. Filter the sample if needed. Adjust the final volume to 50 m or 100 ml. The sample is ready for analysis.

11. Quality Control

10.1. For each analytical batch containing up to 10 samples, blanks (deionized water and reagents) are carried throughout the entire sample preparation and analytical process.

Note: When RB or MB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable RB or MB values have been obtained.

11.2. Matrix Spiked (MS) and Matrix Duplicates (D) samples should be employed to determine accuracy. A spiked sample should be included with each batch of samples processed and whenever a new sample matrix is being analyzed. A spiked sample will be processed with each analytical batch or every 10 samples, whichever is greater. Matrix spiked sample acceptance is $\pm$ 25% Recovery. Duplicate acceptance is $\pm$ 20% RPD.

11.3. Lab Control Sample (LCS) and Lab Control Sample Duplicates (LCSD) samples are prepared at a rate of 1 per 10 samples and carried throughout the entire sample preparation and analytical process. LCS acceptance is ± 20% Recovery. LCS/LCSD duplicate acceptance is ± 20% RPD.

12. Method Performance

12.1. The method has been used for all samples of the applicable matrix at SLGi and has been verified with quality control samples, both in-house and those which are part of nationally-recognized proficiency testing programs.

13. Data Analysis and Calculations

13.1 The quantitative values must be reported in the appropriate units of micrograms per liter (ug/l).

13.2 If dilutions were performed, the appropriate corrections must be applied to the sample values.

13.3. Results must be reported in units commensurate with their intended use and all dilutions must be taken into account when computing final results.

14. Calibration and Standardization

14.1. See specific analysis SOPs for the calibration and standardization information. Calibration standards should be prepared using the appropriate acid diluent. (See Note)

Note: The appropriate acid diluent for the determination of dissolved elements in water and for the "direct analysis" of drinking water with turbidity <1 NTU is 1% HNO . For total recoverable elements in waters, the appropriate acid diluent is 2% HNO and 1% HCl. The reason for these different diluents is to match the types of acids and the acid concentrations of the samples with the acid present in the standards and blanks.

15. Pollution Prevention

14.1. Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities

exist for pollution prevention in the laboratory.

14.2. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed of. The threat to the environment from solvents and/or reagents used in this method may be minimized when recycled or disposed of properly.

16. Waste Management

16.1. All waste will be disposed in accordance with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

16.2 The storage and disposal of hazardous waste is further detailed in SLGi SOP AD-043.

16.3. For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel," and "Less is Better: Laboratory Chemical Management for Waste Reduction," both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036.

17. Handling Non-Conformance Data

17.1 Refer to Table 3: Corrective action flowchart for Non-Conformance handling information.

18. References

18.1 United States Environmental Protection Agency, “Method 3020A: Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by GFAA Spectroscopy”, SW846 Online, Revision 1, July 1992.

18.2 T. D. Martin, C.A. Brockhoff, J.T. Creed, and EMMC Methods Work Group , “Method 200.9”, Revision 2.2, 1994.

Table 3: Corrective Action Flowchart

Sample Type	Test Result	Condition	Corrective Action	Note
Matrix Blank (B)	Blank Reading> Reporting Limit (RL)	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet and notify QA dept.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Air and wipe samples are consumed during extraction. In this case, notify QA dept.
Laboratory Control Sample / QC Sample (LCS)	LCS > Upper Limit	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken. Note what the %R is on the internal tracking sheet.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed Air and wipe samples are consumed during extraction. In this case, notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
	LCS < Lower Limit	Samples are non-detect for that analyte	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Since there is no more wipe or air sample, re-extraction cannot occur so notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
		Samples are positive for that analyte.		
Matrix Spike (MS) and MS Duplicate (MSD)	MS/MSD > or < QC Limit	Samples are positive or non-detect for that analyte.	No action is needed as long as the LCS/QC sample was acceptable. If the LCS and the MS/MSD is unacceptable, notify QA dept or follow table as listed above for LCS/QC Samples.	NA
Duplicate Sample (D) (If used)	%RSD > Upper Limit	Samples are positive or non-detect for that analyte.	No action is needed for duplicates.	NA

Revision Page

03/11/2015 (15-001)

Revised:

3. Definitions

3.1 Method Blank (MB)– An analytical control consisting of all reagents, and internal standards which are carried through the entire analytical procedure. The method blank is used to define the level of laboratory background and reagent contamination.

3.2 Laboratory Control Sample (LCS) - A solution of the method analyte of known concentration. It is used to check either laboratory or instrument performance.

3.3 Matrix Spike (MS) – A sample prepared at the sampling point (i.e., in the field) by adding a known mass of the target analyte to a specified amount of the sample. Field matrix spikes are used, for example, to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency (the analytical bias).

3.4 Matrix Spike Duplicate (MSD) – A second aliquot or sample that is treated the same as the original sample in order to determine the precision of the analytical method.

Revision:

3. Definitions

3.1 Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.2 Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3 Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference. If not enough sample is submitted then an LCS/LCSD is prepared.

3.4 Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.5 Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.6 Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. This is performed when not enough sample is submitted for a duplicate analysis to be performed.

3.7 Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

SCHNEIDER LABORATORIES GLOBAL, INCORPORATED

Document #: ME-033-15-001
Original Date: 11/26/09
Revision Date: 05/19/15
Effective Date: 05/18/15

Schneider Laboratories Global, Inc.
Standard Operating Procedure for
Analysis by Flame Atomic Absorption Spectrophotometry
[EPA SW-846, Update IV, 7000B, SM 3111B and Related Flame AA, Direct Aspiration Methods]

Reviewed by: _____
Department Manager

Approved by: _____
QA/QC Department

Approved by: _____
Laboratory/Technical Director

Schneider Laboratories Global, Inc. Standard Operating Procedure for Set-up, Calibration, and Maintenance for Analysis of Digested Metals in a Solution by Flame Atomic Absorption Spectrophotometry

1. Scope and Application

1.1. This method describes basic instructions for proper instrument set-up, maintenance, and calibration of Perkin-Elmer Flame Atomic Absorption Spectrophotometer (PE Flame AA) 100, 100M and 400.

1.2. Atomic absorption (AA) is the process that occurs when a ground state atom absorbs energy in the form of light of a specific wavelength and is elevated to an excited state. The amount of light energy absorbed at this wavelength will increase as the number of atoms of the selected element in the light path increases. The relationship between the amount of light absorbed and the concentration of analyte present in known standards can be used to determine unknown concentrations by measuring the amount of light the unknown concentrations absorb.

1.3. The Flame AA is an instrument for atomic absorption. The instrument contains a primary light source (a hollow cathode lamp (HCL)), an atom source, a monochromator to isolate the specific wavelength of light to be used, a detector to measure the light accurately, electronics to treat the signal, and a data display. A sample containing desired analyte is introduced as an aerosol into a flame via a burner and nebulizer. The flame burner head is aligned so that the light beam passes through the flame, where the light is absorbed by desired atom.

2. Summary of Method

2.1. Routine use of the PE Flame AA requires the following basic steps: powering up instrument, adjustments and checks, calibration, sample analysis, shut-down, calculations, and maintenance.

3. Definitions

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.2. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference. If not enough sample is submitted then an LCS/LCSD is prepared.

3.4. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.5. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.6. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. This is performed when not enough sample is submitted for a duplicate analysis to be performed.

3.7. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

3.8. RLV- The RLV or reporting limit verification spike is a spiked blank matrix run thru the entire preparation and analysis procedure on a daily basis.

3.9. LLCCV – The LLCCV are low level continuing calibration standards whose concentration is at or below the reporting limit. It is analyzed to verify the reporting limit of the instrument in question.

3.10. ICV or Initial Calibration Verification – The ICV is a second source standard measured to verify the calibration of the instrument in question.

3.11. CCV or Continuing Calibration Verification – The CCV is a quality measure to ensure the instrument remains in calibration before, after, and during analysis of sample(s).

4. Interferences

4.1. Reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing reagent.

4.2. Analyses of reagent blanks provide information about the presence of contaminants.

4.3. Contamination by carryover can occur whenever high-level and low-level samples are sequentially digested and analyzed. After the analysis of a sample containing high concentrations of lead, sufficient rinse time should follow the analysis on the instrument.

4.4. The most troublesome type of interference in atomic absorption spectrophotometry is usually termed "chemical" and is caused by lack of absorption of atoms bound in molecular combination in the flame. This phenomenon can occur when the flame is not sufficiently hot to dissociate the molecule, as in the case of phosphate interference with magnesium, or when the dissociated atom is immediately oxidized to a compound that will not dissociate further at the temperature of the flame. The addition of lanthanum will overcome phosphate interference in magnesium, calcium, and barium determinations. Similarly, silica interference in the determination of manganese can be eliminated by the addition of calcium.

4.5. The presence of high dissolved solids in the sample may result in an interference from nonatomic absorbance such as light scattering. A background correction lamp will help eliminate this problem. If background correction is not available, a nonabsorbing wavelength should be checked. Preferably, samples containing high solids should be extracted.

4.6. Ionization interferences occur when the flame temperature is sufficiently high to generate the removal of an electron from a neutral atom, giving a positively charged ion. This type of interference can generally be controlled by the addition, to both standard and sample solutions, of a large excess (1,000 mg/L) of an easily ionized element such as K, Na, Li or Cs.

4.7. Spectral interference can occur when an absorbing wavelength of an element present in the sample but not being determined falls within the width of the absorption line of the element of interest. The results of the determination will then be erroneously high, due to the contribution of the interfering element to the atomic absorption signal. Interference can also occur when resonant energy from another element in a multielement lamp, or from a metal impurity in the lamp cathode, falls within the

bandpass of the slit setting when that other metal is present in the sample. This type of interference may sometimes be reduced by narrowing the slit width.

4.8. Samples and standards should be monitored for viscosity differences that may alter the aspiration rate.

4.9. All metals are not equally stable in the digestate, especially if it contains only nitric acid, not nitric acid and hydrochloric acid. The digestate should be analyzed as soon as possible, with preference given to Sn, Sb, Mo, Ba, and Ag.

5. Safety

5.1 General

5.1.1. For safety reasons and to avoid contaminating samples, be sure that the instrument and work area are kept scrupulously clean. This is especially important when working with toxic elements or when measuring trace amounts of any element. Clean up spilled chemicals immediately and dispose of them properly.

5.1.2. Do not smoke in or around the work area. Smoking is a source of significant contamination as well as a potential route for ingesting harmful chemicals.

5.1.3. Food should not be stored, handled, or consumed in the work area.

5.1.4. Do not use the instrument in an area where explosion hazards may exist.

5.1.5. Make sure that the workbench for the instrument is capable of sustaining a weight of 300 kg (661 Ibs.).

5.1.6. Toxic combustion products, fumes, vapors, and ozone can be generated by the system, depending upon the type of analysis. Therefore, an efficient ventilation system must be provided for the instrument.

5.1.7. Hazardous ultraviolet radiation can be emitted by the flame when it is heated to incandescence, hollow cathode or electrodeless discharge lamps, and deuterium background corrector lamps. Prolonged exposure to ultraviolet radiation can cause serious damage to your eyes. To avoid this, always wear safety glasses that protect eyes from ultraviolet radiation.

5.2. Electrical

5.2.1. The instrument has been designed to protect the operator from potential electrical hazards. The instrument must be correctly connected to a suitable electrical supply. The supply must have a correctly installed protective conductor (earth/ground) and must be installed or checked by a qualified electrician before you connect the instrument. Any interruption of the protective conductor (earth/ground) inside or outside the instrument or disconnection of the protective conductor terminal is likely to make the instrument dangerous. Intentional interruption is prohibited.

5.2.2. Do not operate the instrument with any covers or internal parts removed.

5.2.3. Do not attempt to make internal adjustments or replacements except as directed in the manuals.

5.2.4. Whenever it is possible that the instrument is no longer electrically safe for use, make the instrument inoperative and secure it against any unauthorized or unintentional operation.

5.3. Gas

5.3.1. Store cylinders in accordance with the regulations and standards applicable to your locality, state, and country.

5.3.2. When gas cylinders are stored in confined areas, storage room, ventilation should be adequate to prevent toxic or explosive accumulations. The storage room should be will ventilated and dry.

5.3.3. Do not store cylinders near elevators, gangways, or in locations where heavy moving objects may strike or fall against them.

5.3.4. Use and store cylinders away from exits and exit routes.

5.3.5. Locate gas cylinders away from heat sources, including heat lamps. Compressed gas cylinders should not be subjected to temperatures above 52°C (125°F)

5.3.6. Store all gas cylinders only in a vertical position, with the valve cap in place, and fastened securely to an immovable bulkhead or a permanent wall.

5.3.7. If you are storing cylinders outdoors, store them above ground on a suitable floor where they are protected against temperature extremes (including the direct rays of the sun).

5.3.8. Use only approved regulators, tubing, and hose connectors. When connecting fittings, keep in mind that left-hand thread fittings are used for fuel gas tank connections for acetylene gas cylinders.

5.3.9. Arrange gas hoses where they will not be damaged or stepped on and where things will not be dropped on them.

5.3.10. Do not "crack the valve" or open the valve of an acetylene cylinder before attaching a regulator.

5.3.11. Do not attempt to refill gas cylinders.

5.3.12. Check the condition of pipes, hoses, and connectors regularly.

5.4. Reagent Use, Storage, and Disposal

5.4.1. Use, store, and dispose of chemicals in accordance with the manufacturer's recommendations and regulations applicable to the locality, state, and/or country.

5.4.2. When preparing chemical solutions, always work in a fume hood that is suitable for the chemicals you are using.

5.4.3. Conduct sample preparation away from the instrument to minimize corrosion and contamination.

5.4.4. Clean up spills immediately using the appropriate equipment and supplies such as spill cleanup kits.

5.4.5. Do not put open containers of solvent near the instrument.

5.4.6. Store solvents in an approved cabinet (with the appropriate ventilation, as required) away from the instrument.

5.5. Drain Vessel Contents

5.5.1. Carefully monitor the collection of effluent in the drain vessel and empty the drain vessel frequently.

5.5.2. When switching between organic and aqueous solutions, flush the drain tube thoroughly and empty and flush out the drain vessel.

5.5.3. Drain vessels may contain flammable, acidic, caustic, or organic solutions, and small amounts of the elements analyzed. The collected effluent may have to be disposed of as hazardous waste.

5.6. Primary Source Lamps

5.6.1. Hollow cathode lamps and electrodeless discharge lamps contain small quantities of the element listed on the label. When you dispose of lamps containing toxic elements, you must regard them as hazardous waste.

5.6.2. Hollow cathode lamps are maintained under reduced pressure. Handle and dispose of them correctly to minimize the implosion risk.

5.7. Flame

5.7.1. Never leave the flame unattended.

5.7.2. Do not adjust the nebulizer when using a nitrous oxide-acetylene flame. This can cause erratic flame conditions or a flashback.

5.7.3. Keep open containers of flammable liquids and solvents away from the flame.

5.7.4. It is essential to carefully follow proper procedures and regularly inspect and maintain the burner system to avoid flashbacks.

5.7.4.1. Should a flashback ever occur: Thoroughly check the burner and drain system and replace damaged parts. Do not reignite the flame until the problem has been corrected.

5.7.5. Keep the flame door closed while the flame is lit.

5.7.6. To avoid serious burns, let the burner head cool to room temperature before touching it.

5.7.7. Acetylene is dissolved in acetone. As the cylinder pressure falls, the concentration of acetone in the gas stream rises, increasing the possibility of acetone carryover which can damage valves or tubing within the gas control system. Such damage can lead to a serious explosion. Acetone carryover may also result if tanks are overfilled, improperly filled, or stored on their sides.

5.7.7.1. <u>Replace acetylene cylinders when the cylinder pressure falls below 600 kPa (90-100 psi).</u>

5.7.8. When high concentrations of mercury, copper, or silver are aspirated into the air-acetylene flame, unstable acetylides may form in the burner chamber. When permitted to dry, these compounds are likely to explode. Thoroughly flush the burner-mixing chamber and drain system with water immediately after analyzing these elements. Visually inspect the chamber to be sure that all traces of residue have been removed.

6. Apparatus and Materials

6.1. AAnalyst 100 Instrument

6.2. AAnalyst 400 Instrument

6.3. Burner Assembly

6.4. Drain Assembly

6.5. Drain Vessel

6.6. Burner Door

6.7. Nebulizer Assembly

6.8. Hollow Cathode Lamp, Lead

6.9. Air Compressor

6.10. Acetylene

6.11. Printer

6.12. Computer

6.13. Volumetric Flasks, 100-mL

6.14. Centrifuge Tubes, 50-mL

6.15. Beakers, 250-mL

6.16. Flask, 250-mL

7. Reagents

7.1. Reagent Water

7.2. Nitric Acid (HNO_3), reagent grade

7.3. Calibration Lead Standard Stock, 1000 ppm - Purchased as certified solution. Should be checked frequently for signs of degradation or evaporation. Protect from light. All purchased standards solutions have a manufacturer's expiration date on the label.

7.4. Second Source Lead Standard Stock, 10000ppm - Purchased as certified solutions from another lot as the stock solutions or from another vendor. Second source standards should be checked frequently for signs of degradation or evaporation. Protect from light. All purchased second source standards solutions have a manufacturer's expiration date on the label

7.5. Paint Lead Reference Material – Purchased as certified paint standard. Should be checked frequently for signs of degradation or contamination. Protect from light. All purchased standards have a manufacturer's expiration date on the label.

7.6. Soil Lead Reference Material - Purchased as certified soil standard. Should be checked frequently for signs of degradation or contamination. Protect from light. All purchased standards have a manufacturer's expiration date on the label.

7.7. Calibration Standards

7.7.1. Daily Calibration Standards – Prepare working solutions at 0.2, 0.5, 1.0, 2.0, 5.0, and 10.0 ppm in 100-mL volumetric flask for the calibration curve and spike according to the table below. Calibrate daily or when quality control samples are failing, with seven working standards.

Calibration Level	Final Conc. (ppm)	1000 ppm Calibration Lead Standard Stock (µL)	Nitric Acid (mL)
1	0.2	20	5
2	0.5	50	5
3	1.0	100	5
4	2.0	200	5
5	5.0	500	5
6	10.0	1000	5

7.8. Initial Calibration Verification (ICV) – Prepare a solution at 5.0ppm with 10% HNO_3 from a second source. Add 1ml of second source standard to 9ml of DiH2O in a 15ml centrifuge tube and mix. Prepare solution in 100-mL volumetric flask, according to the table below.

ICV Level	Final Concentration	10,000 ppm Second Source Lead Standard diluted to 1,000 ppm Stock (µL)	Nitric Acid (mL)
1	5.0	500	10

7.9. Reporting Limit Verification Standard (RLV Spk) - The RLV Spk also known as the low level calibration standard (LLCCV) is a standard prepared at the 0.2 ppm level in a 500 ml volumetric flask according to the chart below.

RLV Spk	Final Conc. (ppm)	1000 ppm Calibration Lead Standard Stock (µL)	Nitric Acid (mL)
1	0.2	100	5

7.10. Continuous Calibration Verification (CCV) – Prepare a solution at 5.0ppm in 500-mL volumetric flask according to the table below.

CCV Level	Final Conc. (ppm)	1000 ppm Calibration Lead Standard Stock (µL)	Nitric Acid (mL)
1	5.0	2,500	5

7.11. Reporting Limit Verification (RLV) – Prepare a matrix-matched sample at 0.2 for each matrix analyzed in 50-mL centrifuge tubes, according to the table below. RLVs are digested and handled in the same manner as samples.

Reporting Limit Verification

RLV Matrix	Spikes	Final Volume
RLV Wipe	100 µl / 100ppm	50 ml
RLV Paint	100 µl / 100ppm	50 ml
RLV Soil	100 µl / 100ppm	50 ml
RLV Air	20 µl / 100ppm	50 ml

7.12. Laboratory Control Sample (LCS) – Prepare a matrix-matched sample at a mid-range concentration, for each matrix analyzed, in 50-mL centrifuge tubes. Prepare them according to the table below. They are digested and handled in the same manner as samples.

LCS Matrix	Preparation
Air	Place a blank air filter in tube and spike with 50 µL of 1000 ppm Calibration Lead Standard Stock.
Paint	Weigh-out 50 mg of the Paint Lead Standard.
Soil	Weigh-out 25 mg of the Soil Lead Standard.
Wipe	Weigh-out 50 mg of the Soil Lead Standard and place a blank ghost wipe in tube.

7.13. Laboratory Control Spike Duplicate (LCSD) – Prepare the same as LCS.

7.14. Matrix Spike (MS) – Add 200 µL of 1000 ppm Calibration Lead Standard Stock solution to the sample chosen as the MS sample. Final volume of the MS sample is 100 mL. If the sample final volume differs, adjust the spike volume comparably.

7.15. Matrix Spike Duplicate (MSD) – Prepared the same as MS sample and needs to be from the same sample chosen for MS.

7.16. Blanks – Two types of blanks are required for the analysis of samples. The calibration blank is used in establishing the analytical curve and the method blank is used to identify possible contamination resulting from either the reagents or the equipment used during sample processing and filtration.

7.16.1. Continuing Calibration Blank (CCB) and Initial Calibration Blank (ICB) – Pour 40 mL of Reagent Water into a 50 mL centrifuged tube.

7.16.2. The method blank (MB) must contain all reagents in the same volumes as used during the processing of samples. The method blank must be carried through the complete procedure and contain the same acid concentration in the final solution as the sample solution used for analysis.

8. Sample Collection, Preservation, and Handling

8.1. SLGi does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2. When working with the sample, care must be taken so as to prevent any portion of the collected sample coming in contact with the analysts' gloves, thus causing contamination.

8.3. Wear appropriate eye protection at all times while handling chemicals. Use safety glasses with side shields, goggles, or full-face shields, depending on the types of chemicals handling.

8.4. Wear suitable protective clothing, including gloves specifically resistant to the chemicals being handled

9. Procedure

9.1. Powering Up 100M FAA Instrument

9.1.1. Make sure the vent above the instrument is on and working properly.

9.1.2. Switch the power ON (switch on lower right side of instrument)

9.1.3. The instrument will automatically run a self-test.

9.1.4. Wait while the instrument goes through its initializing process. The LEDs will all light as the instrument sequences through its test.

9.1.5. When the sequence test is complete the screen display will read "Recall Method (Y/N)"

9.1.5.1. No, and press [Enter] – A method will not be recalled and you can use default conditions.

9.1.6. Select desired lamp and press [Enter]

9.1.7. The screen display will read "Use Default Conditions (Y/N)"

9.1.7.1. Yes- The instrument automatically reads the defaults for the proper element in the coded lamp. The lamp current, slit width and slit height are set. Also, the instrument slews to the wavelength and then peaks on the wavelength.

9.1.7.2. No- the lamp current, slit, height and wavelength must be set for the desired lamp.

9.1.7.2.1. Current: 10 or12, Slit: 0.7, Full Height: Y, Wavelength: 283.3

9.1.8. Set Integration time as 1.0 and press [Enter]

9.1.9. Set Replicates as 1 and press [Enter]

9.1.10. Set Calibration as Non Linear and press [Enter]

9.1.11. Set Run as Continuous and press [Enter]

9.1.12. Press [Cont.] – This allows continuously reading of absorbance.

9.1.13. The instrument power up is complete. Allow lamp to warm-up for 30 minutes before calibration.

9.2. Powering up the 400 FAA Instrument

9.2.1 "Open" gas tank.

9**.2.2** Flip switch located at the bottom on instrument to "ON" position

9.2.3 Once powered up, go to lamp icon and place a finger carefully above the element box in the middle screen.

9.2.4 A screen will show up with element Pb. Press ok and the lamp will automatically come up.

9.2.5 Press the instrument setup icon on the right side of the screen to setup the lamp Wavelength.

9.2.6 Once lamp wavelength is adjusted, and then the flame is ready to be turn on.

9.2.7 Touch the flame icon; a screen with the absorbance value and flame control will come on.

9.2.8 If the box with the interlock has a check-marked and is green, then it is safe to turn on the flame by touching the on/off switch.

9.2.9 After 30mins optimize the absorbance with the highest standard (10PPM) before calibrating.

9.3. Adjustments and Checks

9.3.1. Align Lamp

9.3.1.1. Press [Energy]

9.3.1.2. If the bar chart is off scale, or does not extend about halfway across the screen, press [Energy] to bring the bar on scale.

9.3.1.3. To maximize the energy, adjust the two lamp alignment screws located on the mount, until you have obtained maximum energy. There is a vertical lamp alignment screw and a horizontal lamp alignment screw. (If a lamp turret is installed skip to this step)

9.3.1.4. If the bar chart goes off scale, press [Energy] to bring it on scale.

9.3.1.5. Lamp alignment is complete

9.3.2. Adjust the Burner Height

9.3.2.1. Place a piece of cardboard or a white business card above the burner head perpendicular to the slot. This will confirm the presence and general location of the light beam.

9.3.2.2. Make sure the burner head is not blocking the beam and that the beam is centered. Ideally, the beam needs to pass over the length of the burner head and to be centered over the burner slot. If it is not, or if the burner head is blocking the beam, turn the horizontal adjustment knob until the light beam is approximately centered directly over the burner slot

9.3.2.3. Lower the burner using the vertical adjustment knob so that the burner head is well below the light beam

9.3.2.4. Press [A/Z] – Autozero is preformed

9.3.2.5. Raise the burner with the vertical adjustment knob until the display indicates a slight positive absorbance (0.002 to 0.004 abs)

9.3.2.6. Now, slowly turn the vertical adjustment knob clockwise until the absorbance returns to zero (0.000).

9.3.2.7. Finally, rotate the vertical adjustment knob an additional quarter-turn clock-wise.

9.3.2.8. The burner height adjustment is now complete.

9.3.3. Adjusting the Gas Flow for Ignition

9.3.3.1. Set the pressure regulators on the gas cylinders that you'll be using as follows: Acetylene: 85-100 kPa (12-14 psig), Air: 345-450 kPa (50-65 psig)

Note: Always monitor the acetylene tank pressure. Change the tank before the tank pressure drops below 600 kPa (90 psi). If the pressure falls below this level, acetone may contaminate the burner regulator, valves and tubing.

Note: the [Gases On/Off] key will allow the fuel and oxidant to flow through the gas control system and out the burner head. Make sure that the vent above the instrument has been turned on.

9.3.3.2. Press [Gases On/Off] and observe the flowmeter tube labeled "Oxidant" on the instrument. Using the "Oxidant" control knob, adjust the oxidant flow until the ball in the flowmeter reads "4" units.

9.3.3.3. Press [Gases On/Off] and observe the flowmeter tube labeled "Fuel." Using the "Fuel" control knob, adjust the acetylene flow until the ball in the flowmeter reads about "2" units.

9.3.4. Safety Checks Before Ignition

Use the safety checks that follow to make sure that all components are properly installed and in good condition for safe operation. Inadequate inspection or maintenance of the burner system can cause the escape of fuel gas or the fuel gas mixture, which can cause a serious explosion or fire.

9.3.4.1. The vent is on and drawing properly.

9.3.4.2. The burner door is closed.

9.3.4.3. There is sufficient gas in the cylinders for your intended analyses.

9.3.4.4. A fire extinguisher is located near the instrument.

9.3.4.5. Burner Head Check

9.3.4.5.1. Be sure that:

- The burner head O-ring is in good condition. The O-ring is easily frayed when burner heads are interchanged and should be replaced when worn.
- The proper burner head has been selected based on your flame and sample conditions.
- The burner head slot is clean.
- The burner head is fully seated into the burner-mixing chamber.

9.3.4.6. Burner Mixing Chamber and End Cap

9.3.4.6.1. Be sure that:

- The standard end cap gasket (for aqueous solutions) or an organic-resistant gasket is properly seated and in good condition.
- The end cap is securely tightened.
- The fuel and auxiliary oxidant tubing connected to the burner is in good condition and the fittings have been properly tightened.

9.3.4.7. Nebulizer

9.3.4.7.1. Be sure that:

- The nebulizer O-rings that seal to the end cap are in good condition.
- The proper nebulizer has been selected based on the type of solutions that will be aspirated.
- The nebulizer is securely clamped in place.
- The nebulizer tubing is in good condition and the connection is tight.
- The nebulizer tubing is connected to the nebulizer side arm.

- The nebulizer interlock is intact.

9.3.4.8. Drain System

9.3.4.8.1. Be sure that:

- The drain system has been properly installed.
- The drain tubing is securely connected to the front of the burner and in good condition (i.e., it does not show signs of cracking or discoloration). The drain tubing should be checked regularly, especially if using organic solvents.
- Any waste collected in the drain vessel has been properly disposed of and the vessel and drain loop refilled as specified for your system.

9.3.5. Igniting the Flame

Never directly view the flame without protective eyewear. Potentially hazardous ultraviolet radiation may be emitted from the flame. In general, ordinary safety glasses will provide sufficient protection, but additional side shields will insure a further margin of safety. The safety glasses will also provide mechanical protection for the eyes.

9.3.5.1. Press the [Flame On/Off] key. The ignitor arm will swing over and light the burner. If the flame does not light on the first try, it may be necessary to press the [Flame On/Off] key a second time.
Note that sometimes when gases are first turned on, the flame may not ignite the first time due to air in the lines. As a safety feature, if the gases do not ignite within 9 seconds, the system will turn off the gas flow and will display an error message.
If the flame still does not light, an interlock might not be satisfied and an error message will be displayed.

9.3.5.2. With the flame on, aspirate the blank solution (reagent water) and let the flame stabilize for about 30 to 60 seconds.

9.3.5.3. If you see bubbles coming out of the capillary tube, the nebulizer needs an adjustment. Loosen the nebulizer locking ring and turn the nebulizer adjustment nut clockwise until the bubbles stop.

9.3.5.4. Press [A/Z] again. Always press the Autozero key when aspirating the blank.

9.3.6. Adjusting the Burner Position

9.3.6.1. Aspirate a standard that produces a signal of 0.2 or more absorbance units (use standard 10ppm)

9.3.6.2. Turn the horizontal adjustment knob on the burner assembly until you obtain maximum absorbance.

9.3.6.3. Turn the rotational adjustment knob until you obtain maximum absorbance.

9.3.7. Adjusting the Nebulizer

9.3.7.1. Aspirate the standard used in 9.3.6.1.

9.3.7.2. Loosen the nebulizer locking ring by turning it clockwise (CW) until it is free of the nebulizer adjustment nut

9.3.7.3. To establish a start point, slowly turn the nebulizer adjustment nut counterclockwise (CCW) until bubbles begin to appear at the end of the capillary tube in the standard solution.

9.3.7.4. Slowly turn the nebulizer adjustment nut CW until the absorbance goes to a maximum and then begins to decrease. The inversion point at which absorbance changes marks the optimum setting. Slowly turn the nebulizer adjustment nut CCW to obtain maximum absorbance.

9.3.7.5. Continue to adjust CW or CCW until the maximum absorbance is found.

9.3.7.6. Lock the nebulizer in this optimum position by firmly holding the nebulizer adjustment nut in place with one hand while turning the nebulizer locking ring CCW with the other. Turn it until it is snug against the nut. The ring will prevent the nut from moving.

9.4. Calibration

9.4.1. Obtain a “Run Number” from the Run Number Log Book.

9.4.2. On the computer, open [SLIAPPS] then [Metals] then [Run Data]

9.4.3. In the Run Data window enter in run number, date, instrument (100 or 100M), analyte (Pb), and analyst initials.

9.4.4. Select [Set-up Run]. Calibration table will appear.

9.4.5. On instrument autozero with blank

9.4.6. Aspirate standards (0.2, 0.5, 1.0, 2.0, 5.0, 10.0 ppm) one by one and enter in corresponding absorbance into table on computer. A 0.2 ppm standard should have an absorbance of about 0.007.

9.4.7. Once all standards have been read and absorbance entered into table click on [Check Cal] on computer.

9.4.8. A R2 value of 0.995 or greater is acceptable and analysis can continue.

9.4.9. Continue with analysis of ICV 5.0, ICB, LLCCV, CCV 5.0, CCB.

9.4.10. All ICVs must have a percent recovery between 90-110% to be acceptable and to continue with analysis of RLVs.

9.4.11. Continue with analysis of RLV Reagent, RLV Wipe, RLV Paint, RLV Soil, and RLV Air.

9.4.12. All RLVs must have a percent recovery between 80-120% to be acceptable and to continue with analysis of matrix matched LCSs.

9.4.13. Continue with analysis of matrix matched LCS spikes

9.4.14. All LCSs must have a percent recovery between 80-120% to be acceptable or within statistical calculation and then continue with sample analysis.

9.4.15. When all criteria has been met click on [Add to slim]

9.4.16. Instrument and Computer is now ready for sample analysis.

9.5. Sample analysis

9.5.1. Click on [Results Tray] in Metals Prep and Analysis window.

9.5.2. Enter in tray number, sample volume, analysis initials, and run number. Then click on [Select Tray].

9.5.3. Analyze samples on tray and then [Print and Save] when complete.

9.5.4. Below is a example analytical sequence of a tray

1. Reagent water - to flush system
2. First 10 samples on tray
3. CCV 5.0 ppm
4. CCB
5. CCV 5.0 ppm
6. CCB
7. MS/MD
8. LCS/LCSD
9. MB

9.6. Shut-Down for 100M FAA Instrument

9.6.1. When analysis is complete aspirate deionized water for one minute.

9.6.2. Extinguish the flame by pressing [Flame On/Off]

9.6.3. Close valves on acetylene tank by turning to the right

9.6.4. Bleed the gas lines by pressing [Bleed Gases]

9.6.5. Turn off Instrument.

9.7. Shut-down for 400 FAA Instrument

9.7.1. When analysis is complete, aspirate deionized water for one minute.

9.7.2. On the main screen, press the on/off icon to turn off the flame.

9.7.3. Close the regulator on acetylene tank

9.7.4. Press the “Bleed Gases” on the screen to bring the needles on the acetylene tanks to zero.

9.7.5. Press the button with “install lamps” by un-checking the box to zero the energy level and wavelength.

9.7.6. Turn the main switch off.

9.8. Calculations

9.8.1. Relative percent difference (RPD):

$$\frac{|R_1 - R_2|}{R_{ave}} x\ 100$$

$R_1 - R_2$ is the absolute difference between two values being compared

9.8.2. Spike Recovery:

$$\frac{(X_s - X_o)}{C_s}\ x\ 100$$

X_s = Concentration of spike sample
X_o = Concentration of unspiked sample
C_s = Concentration of spike added

9.9. Maintenance

9.9.1. Cleaning the Burner Head

9.9.1.1. The burner head should provide an even "blue" flame over the length of the burner slot. An uneven flame may indicate the slot needs cleaning.

9.9.1.2. Quick Cleaning Procedure

9.9.1.2.1. If the instrument is running, extinguish the flame, turn off the gases, and let the burner head cool. Open the burner door. Carefully work along and between the burner head slot using the burner head cleaning tool. Be sure not to nick the edges of the burner slot.

9.9.1.3. Complete Cleaning Procedure

9.9.1.3.1. If the instrument is running, extinguish the flame, turn off the gases, and power down the instrument. Let the burner head cool. Open the burner door.

9.9.1.3.2. Remove the burner head by pressing the safety latch on the igniter box while gently pulling and twisting the burner head until it comes off the chamber.

9.9.1.3.3. Once the head is removed, carefully work through the slot with the burner head cleaning tool. Do not nick the edges of the slot. Remove scrapings from inside and outside of the burner head.

9.9.1.3.4. If more cleaning is necessary, the burner head can also be soaked overnight in a detergent solution and then rinsed with deionized water and blown dry with a clean air supply. Make sure to take off the bronze coil.

9.9.1.3.5. Put the burner head back onto the burner chamber while pressing the safety latch tab. Position the magnetic strip on the burner head ring around the back of the assembly. Release the safety latch. Be sure the burner head is fully seated on the chamber. A gentle twisting and pushing may be necessary. The burner head is fully seated when the ignitor will swing over the burner.

9.9.1.3.6. Close the burner door.

9.9.2. Cleaning the Burner Chamber

9.9.2.1. When samples with high solids content are aspirated, clean the burner daily.

9.9.2.2. When switching from aqueous to organic solutions, the burner chamber should always be inspected for deposits and cleaned if necessary.

9.9.2.3. Be sure to clean the burner chamber after working with organic samples.

9.9.2.4. Cleaning the Burner Chamber After Use with Organic Solvents

9.9.2.4.1. If aqueous samples are aspirated right after aspirating organic samples the absorption signal produced can be noisy and erratic.

9.9.2.4.2. After aspirating organic samples, aspirate an organic solvent miscible with the samples that have just been aspirated for 5 minutes.

9.9.2.4.3. Aspirate methanol or another solvent miscible with both the organic solvent and water for 5 minutes.

9.9.2.4.4. Aspirate 1% HNO3 for 5 minutes.

9.9.2.4.5. Flush the drain tube thoroughly with water. Empty the collection vessel and refill with water. Dispose of hazardous or corrosive solutions properly and observe local codes concerning the effect of the waste on the environment.

9.9.2.5. Cleaning the Burner after Aspirating Cu, Ag, or Hg samples

9.9.2.5.1. Unstable acetylides (which are likely to explode when dry), may be formed when aspirating high concentrations of copper, silver, or mercury salts into an acetylene flame.

9.9.2.5.2. Aspirate dilute acid (1% HCl) for five minutes before turning off the flame.

9.9.2.5.3. Extinguish the flame and let the burner head cool.

9.9.2.5.4. Remove the burner head.

9.9.2.5.5. Continue to flush the system by slowly pouring about 500 mL of water into the burner chamber.

9.9.3. Cleaning the Burner Chamber Parts

9.9.3.1. Remove and disassemble the burner chamber

9.9.3.2. To remove the stubborn deposits from inside the burner chamber, from the end cap, from the flow spoiler and on the burner head, gently scrub them with a bottle brush, and a detergent solution. Be careful not to scratch the inner surfaces. Be sure to clean the drain outlet thoroughly. Do not soak the burner parts in acid or use kitchen-type cleaners.

9.9.3.3. Rinse the chamber, end cap, flow spoiler and head thoroughly with deionized water and allow to dry.
Note: An Ultrasonic cleaner can be used also. Let them soak in a detergent solution in the machine until they are completely clean. Remove, rinse with deionized water and allow to dry.

9.9.3.4. Reassemble the burner chamber.

9.9.4. Cleaning the Nebulizer

9.9.4.1. Disassemble the nebulizer

9.9.4.2. Push the copper cleaning wire all the way through the threaded side of the capillary holder and out the sapphire tip. Move the wire in and out to dislodge any solid particles. Take care not to scratch the insides.

9.9.4.3. Pull the Teflon tubing out of the gland nut.

9.9.4.4. Clean the capillary holder, Teflon tubing and gland nut in an ultrasonic cleaner with distilled water. If they still look dirty, discard the Teflon tubing and gland nut and replace them with new ones

9.9.4.5. All parts of the nebulizer can be clean in an ultrasonic cleaner

9.9.4.6. Inspect the 3 o-rings. They can be cleaned with detergent and water. If they look damaged, replace them.

9.9.4.7. Reassemble the nebulizer

9.9.5. Cleaning (or Flushing) the Drain System

9.9.5.1. It is recommended that the drain system be flushed thoroughly with water at the end of each working day to remove caustic, corrosive, or organic waste materials that could otherwise damage the burner chamber or drain tubing.

9.9.5.2. To flush the system, remove the burner head then slowly pour about 500 mL of water into the burner chamber. Allow the water to drain into the drain vessel.

9.9.6. Cleaning the Drain Float Assembly

9.9.6.1. Extinguish the flame, turn off the gases and power down the instrument.

9.9.6.2. Have a bucket or a container of water large enough in which to dip the drain trap assembly up to the water line. The drain trap is found in the drain vessel

9.9.6.3. Unscrew the retainer cap form the drain vessel. Slide out the drain trap assembly and the drain loop (leaving the hose and wire attached).

9.9.6.4. Clean the drain trap assembly with soap and water using a test tube brush.

9.9.6.5. Rinse with water.

9.9.6.6. Reassemble the system in reverse order

9.9.7. Gas Lines

9.9.7.1. Perform periodic gas leak tests at all joints and seals of the gas system regularly by applying an approved gas leak detection solution

10. Quality Control

10.1. All quality control data should be maintained and available for easy reference or inspection.

10.2. Dilute samples if they are more concentrated than the highest standard or if they fall on the plateau of a calibration curve.

10.3. Calibration

10.3.1. The calibration curve usually consists of at least three non-zero points (low-mid-high range) and a calibration blank. However, more calibration points may be analyzed as deemed necessary.

10.3.2. The calibration coefficient must be at least 0.995 or higher. The linearity of the curve must not be forced thru zero. If these evaluation criteria are not met,

analysis must be stopped and recalibration performed. If the recalibration fails, the standards must be re-made and/or the equipment must be evaluated.

10.4. Initial Calibration Verification (ICV)

10.4.1. After the daily calibration, the initial calibration verification (ICV) standard is analyzed.

10.4.2. The ICV standard is prepared from a second source and or made in a different way.

10.4.3. The percent recovery (%R) of the ICV standards must be between 90%-110%. If the second source fails calibration criteria, recalibration is necessary.

10.5. Continuing Calibration Verification (CCV)

10.5.1. A LLCCV is run at the beginning of the analysis

10.5.2. A CCV is analyzed twice in a batch, after every first 10 samples and next set of 10 samples.

10.5.3. The concentration of the CCV is at 5 ppm to verify the calibration curve.

10.5.4. The %R of the CCV must be within 90%-110%.

10.6. Reporting Limit Verification Spike (RLV)

10.6.1. This must be a matrix matched sample and analyzed after the ICVs.

10.6.2. The concentration of the RLV is at 0.2 ppm, which is the reporting limit of the calibration.

10.6.3. The RLV is run thru the entire preparation process as the samples.

10.6.4. The %R of the RLV must be within 80%-120%.

10.7. Laboratory Control Sample (LCS) and Laboratory Control Sample Duplicate (LCSD)

10.7.1. The LCS/LCSD are prepared from a second source stock solution to verify the efficiency of the digestion and analysis.

10.7.2. LCS/LCSD samples are prepared and run at a frequency of 1 per 10, 18 or 20 client samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.7.3. LCS/LCSD samples are digested and handled in the same manner as the samples.

10.7.4. The %R of the LCS/LCSD must be between 80-120% or within statistical calculation and then continue with sample analysis.

10.7.5. The results of the LCS/LCSD duplicate analyses should match within 20% Relative Percent Difference (RPD).

10.8. Duplicates

10.8.1. Duplicates are prepared and run at a frequency of 1 per 20 client samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.8.2. Duplicate samples are digested and handled in the same manner as sample(s) being analyzed.

10.8.3. Duplicates monitor analysis precision. The results of the duplicate analyses should match the original results within 20% Relative Percent Difference (RPD).

10.9. Matrix Spikes (MS) and Matrix Spike Duplicate (MSD)

10.9.1. Matrix Spikes are matrix matched and run at a frequency of 1 per 20 client samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.9.2. MS are digested and handled in the same manner as sample(s) being analyzed

10.9.3. The %R of the MS must be between 75-125%

10.9.4. The results of the MS/MSD duplicate analyses should match within 20% Relative Percent Difference (RPD).

10.10. Blank Analyses

10.10.1 Method Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

10.10.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask go through the entire preparation and analytical process.

10.10.3 If the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

11. Method Performance

11.1. The method detect ion limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations actually achieved will vary depending on instrument sensitivity and matrix effects.

11.2. The analytical group must generate a valid MDL for each individual analyte of interest. The MDL must be below the reporting limit or low level standard for each analyte. The procedure for determination of the MDL is given in 40 CFR Part 136, Appendix B.

11.3. MDLs are determined annually per matrix. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

12. Data Analysis and Calculations

12.1. The quantitative values must be reported in the appropriate units of milligrams per kilogram (mg/kg), milligrams per meters cubed (mg/m3) or milligram per liter (mg/l) as per the analysis method.

12.2. If dilutions were performed, the appropriate corrections must be applied to the sample values.

12.3. Results must be reported in units commensurate with their intended use and all dilutions must be taken into account when computing final results.

13. Pollution Prevention

13.1. Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities exist for pollution prevention in the laboratory.

13.2. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed of. The threat to the environment from acids and/or reagents used in this method may be minimized when recycled or disposed of properly.

14. Waste Management

14.1. All waste will be disposed in accordance with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

14.2. The storage and disposal of hazardous waste is further detailed in SLGi SOP AD-043.

14.3. For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel," and "Less is Better: Laboratory Chemical Management for Waste Reduction," both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036.

15. Handling Non-Conformance Data

15.1. Refer to Table 3: Corrective action flowchart for Non-Conformance handling information.

16. References

16.1 EPA SW-846 7000B; Flame Atomic Absorption Spectrophotometry; Revision 2, February 2007

16.2 Standard Methods 3111B; Metals by Flame Atomic Absorption Spectrometry; 18th Edition, 1992

16.3 Perkin-Elmer, *AAnalyst 100 Atomic Absorption Spectrometer: User's Guide*, 1997, United States of America, The Perkin-Elmer Corporation

16.4 Perkin-Elmer, *AAnalyst 100 Atomic Absorption Spectrometer: Installation Guide*, 1996, United States of America, The Perkin-Elmer Corporation

16.5 Perkin-Elmer, *AAnalyst 100 Atomic Absorption Spectrometer: Hardware Guide*, 1996, United States of America, The Perkin-Elmer Corporation

16.6 Perkin-Elmer, *AAnalyst 400 Atomic Absorption Spectrometer: User's Guide*, United States of America, The Perkin-Elmer Corporation

16.7 Perkin-Elmer, *AAnalyst 400 Atomic Absorption Spectrometer: Installation Guide*, United States of America, The Perkin-Elmer Corporation

16.8 Perkin-Elmer, *AAnalyst 400 Atomic Absorption Spectrometer: Hardware Guide*, United States of America, The Perkin-Elmer Corporation

Table 3: Corrective Action Flowchart

Sample Type	Test Result	Condition	Corrective Action	Note
Matrix/Reagent Blank (MB/RB)	Blank Reading> Reporting Limit (RL)	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet and notify QA dept.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Air and wipe samples are consumed during extraction. In this case, notify QA dept.
Laboratory Control Sample / QC Sample (LCS)	LCS > Upper Limit	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken. Note what the %R is on the internal tracking sheet.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed Air and wipe samples are consumed during extraction. In this case, notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
	LCS < Lower Limit	Samples are non-detect for that analyte	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Since there is no more wipe or air sample, re-extraction cannot occur so notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
		Samples are positive for that analyte.		
Matrix Spike (MS) and MS Duplicate (MSD)	MS/MSD > or < QC Limit	Samples are positive or non-detect for that analyte.	No action is needed as long as the LCS/QC sample was acceptable. If the LCS and the MS/MSD is unacceptable, notify QA dept or follow table as listed above for LCS/QC Samples.	NA
Duplicate Sample (D) (If used)	%RSD > Upper Limit	Samples are positive or non-detect for that analyte.	No action is needed for duplicates.	NA

Revision Page

05/18/2015 15-001

Revised:

3. Definitions

3.1. Method Blank (B)– An analytical control consisting of all reagents, internal standards and surrogate standards, which are carried through the entire analytical procedure. The method blank is used to define the level of laboratory background and reagent contamination.

3.2. Laboratory Control Sample (LCS) - A solution of the method analyte of known concentration. It is used to check either laboratory or instrument performance.

3.3. Matrix Spike (MS) – A sample prepared at the sampling point (i.e., in the field) by adding a known mass of the target analyte to a specified amount of the sample. Field matrix spikes are used, for example, to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency (the analytical bias).

3.4. Matrix Spike Duplicate (MSD) – A second aliquot or sample that is treated the same as the original sample in order to determine the precision of the analytical method.

Revision:

3. Definitions

3.11. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.12. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.13. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference. If not enough sample is submitted then an LCS/LCSD is prepared.

3.14. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.15. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.16. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. This is performed when not enough sample is submitted for a duplicate analysis to be performed.

3.17. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

3.18. RLV Spk - The RLV Spk or reporting limit verification spike is a spiked blank matrix run thru the entire preparation and analysis procedure on a daily basis.

3.19. RLV Std or LLCCV – The RLV Standard or LLCCV are low level continuing calibration standards whose concentration is at or below the reporting limit. It is analyzed to verify the reporting limit of the instrument in question.

3.20. ICV or Initial Calibration Verification – The ICV is a second source standard measured to verify the calibration of the instrument in question.

3.11. CCV or Continuing Calibration Verification – The CCV is a quality measure to ensure the instrument remains in calibration before, after, and during analysis of sample(s).

Added the following section:

10.10. Blank Analyses

10.10.1 Method Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

10.10.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask go through the entire preparation and analytical process.

10.10.3 If the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

Revised and renumbered:

7.9. Continuous Calibration Verification (CCV) – Prepare a solution at 5.0ppm in 500-mL volumetric flask according to the table below.

CCV Level	Final Conc. (ppm)	1000 ppm Calibration Lead Standard Stock (µL)	Nitric Acid (mL)
1	5.0	2,500	5

7.10. Reporting Limit Verification (RLV) – Prepare a matrix-matched sample at 0.2 for each matrix analyzed in 50-mL centrifuge tubes, according to the table below. RLVs are digested and handled in the same manner as samples.

Note: The TCLP is prepped in a 250-mL beaker, and the HI-VOL is prepped in a 250-mL flask.

Reporting Limit Verification

RLV Matrix	Spikes	Final Volume
RLV Reagent	100 µl / 100ppm	50 ml
RLV Wipe	100 µl / 100ppm	50 ml
RLV Paint	100 µl / 100ppm	50 ml
RLV Soil	100 µl / 100ppm	50 ml
RLV Air Block	20 µl / 100ppm	50 ml
Paint QC	50 mg Paint QC	50 ml
Soil QC	25 mg Soil QC	50 ml
Wipe QC	50 mg Soil QC / Wipe	50 ml
Air Spike	50 µl / 1000ppm	50 ml

Revision:

7.9. Reporting Limit Verification Standard (RLV S Std) - The RLV Std also known as the low level calibration standard (LLCCV) is a standard prepared at the 0.2 ppm level in a 500 ml volumetric flask according to the chart below.

RLV Standard	Final Conc. (ppm)	1000 ppm Calibration Lead Standard Stock (µL)	Nitric Acid (mL)
1	0.2	100	5

7.10. Continuous Calibration Verification (CCV) – Prepare a solution at 5.0ppm in 500-mL volumetric flask according to the table below.

CCV Level	Final Conc. (ppm)	1000 ppm Calibration Lead Standard Stock (µL)	Nitric Acid (mL)
1	5.0	2,500	5

7.11. Reporting Limit Verification Spike (RLV) – Prepare a matrix-matched sample at 0.2 for each matrix analyzed in 50-mL centrifuge tubes, according to the table below. RLVs are digested and handled in the same manner as samples.

Reporting Limit Verification

RLV Matrix	Spikes	Final Volume
RLV Wipe	100 µl / 100ppm	50 ml
RLV Paint	100 µl / 100ppm	50 ml
RLV Soil	100 µl / 100ppm	50 ml
RLV Air	20 µl / 100ppm	50 ml

Schneider Laboratories Global, Inc.
Standard Operating Procedure for ICP-OES

Reviewed by: _____
Department Manager

Approved by: _____
QA/QC Department

Approved by: _____
Laboratory/Technical Director

Schneider Laboratories Global, Inc.
Standard Operating Procedure for ICP-OES

1. Scope and Application

1.1. Inductively Coupled Plasma (ICP) - Optima Emission Spectrometer (OES) is used to determine trace metals in solution. With the exception of some drinking water samples, all aqueous and solid samples are acid digested prior to analysis.

1.2. This method describes the procedure for the setup, use, and adjustment of the Perkin Elmer ICP –OES/ iCAP 6300. Information in this method is taken from the Perkin Elmer Emission Spectrometer manuals. These manuals should be referenced when additional information is needed.

1.3. This method is based on SW-846 methods 6010C (Revision 3, February 2007), Standard Methods 3120B (20th Edition), EPA Method 200.7 (Revision 4.4), NIOSH 7300 (Issue 3, March 2003) 40CFR Part 50 Appendix G, with modifications for client specific analysis. This SOP covers the following matrices: drinking water, wastewater, soils, sediments, paint, bulk, wipe and air samples.

1.4. Use of this method is restricted to use by, or under the supervision of, spectroscopists appropriately experienced and trained in the correction of spectral, chemical, and physical interferences. Each analyst must demonstrate the ability to generate acceptable results with this method.

1.5. The LOQ for drinking and non-potable water samples are as follows: 0.20 mg/l for Calcium, Magnesium, Potassium and Sodium, 0.10 mg/l for Chromium, Boron, Copper, Iron and Zinc and 0.040 mg/l for all other metals. The LOQ for soils and sediments takes into effect a final extraction volume of 50 ml and the weight of the sample. The LOQ for air samples takes into effect a final extraction volume of 10 ml and the air volume in liters.

2. Summary of Method

2.1. Prior to analysis, samples must be solubilized or digested using the appropriate sample preparation methods. When analyzing groundwater or drinking water for dissolved constituents, acid digestion is not necessary if the samples are filtered and acid preserved prior to analysis.

2.2. Samples are aspirated by a peristaltic pump through a plasma torch. In the plasma, the sample is atomized and electrons are excited. When the electrons return from their excited state, a photon is emitted. This light then travels through a series of mirrors and filters, strikes a

grating, then an electronic diode. The signal is then translated to intensity ratios that are dependent on the concentration of the element in solution.

2.3. Background correction is required for trace metals determination. Background emission must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used should be as free as possible from spectral interference and should reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result.

3. Definitions:

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of laboratory background and reagent contamination.

3.2. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3. Initial Calibration Blank – A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to auto-zero the AA instrument. The ICB is the first calibration blank analyzed after the ICV analysis.

3.4. Continuing Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to auto-zero the AA instrument The CCBs are the analyzed after each CCV analysis.

3.5. LLCCV or Low Limit Continuing Calibration Verification – The LLCCV is a second standard measurement to verify the reporting limit of the instrument in question.

3.6. ICV or Initial Calibration Verification – The ICV is a second source standard measured to verify the calibration of the instrument in question.

3.7. CCV or Continuing Calibration Verification – The CCV is a quality measure to ensure the instrument remains in calibration before, after, and during analysis of sample(s).

3.8. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample and that is carried through the entire preparation and analytical process. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference.

3.9. Matrix Spike (MSD) – A duplicate sample is prepared by adding a known amount of target analyte to a specified amount of the sample and that is carried through the entire preparation and analytical process. Matrix spike duplicates are used to determine the precision of the analysis.

3.10. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method.

3.11. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.12. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. These take the place of MS and MSD for wipes and air samples.

3.13. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

3.14. MDL or Method detection limit. – The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero during analysis.

3.15. LOQ or Limit of Quantitation – The LOQ is the level above which quantitative results may be obtained with a specified degree of confidence. It is also refered to as the Reporting Limit (RL). Limits of quantitation are matrix, method, and analyte specific.

4. Interferences

4.1. Reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing reagent or method blanks.

4.2. Analyses of reagent blanks provide information about the presence of contaminants.

4.3. Spectral interferences are caused by background emission from continuous or recombination phenomena, stray light from the line emission of high concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra.

4.4. Contamination by carryover can occur whenever high-level and low level samples are sequentially digested and analyzed. After the analysis of a sample containing high concentrations of lead sufficient rinse time should follow the analysis on the ICP.

5. Safety

This SOP does not address all safety issues associated with its use. The laboratory is responsible for maintain a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals included in this method. A reference file of material data safety sheets (MSDS) is available to all personnel involved in these analyses.

5.1. General Laboratory Safety

5.1.1 The preparation of all standards, reagents, and glassware procedures that involve acids will be conducted in a fume hood with the sash closed as far as the operations will permit.

5.1.2 Equipment, goggles, or face shield must be used when employees are using acids to rinse or clean glassware.

5.1.3 Work areas should be isolated and posted with signs. Glassware and tools should be segregated.

5.1.4 Exposure of chemicals will be maintained so it is as low as reasonable possible. All samples should be opened, transferred, and prepared in a fume hood, or under other means of ventilation.

5.1.5 The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. For this reason, the acidification and digestion of samples should be performed in a fume hood.

5.1.6 Waste containers must be kept closed unless transfers are being made.

5.2. Gas Handling Safety

5.2.1. Gases commonly used with the ICP are argon and nitrogen. High pressure gas cylinders can be dangerous if mishandled.

5.2.2. Gas cylinders should be stored in a vertical position only. Fasten tanks securely to an immovable bulkhead or to a wall.

5.2.3. Move gas cylinders only with an approved handcart after insuring that the valve cap is closed and secured.

5.2.4. Locate gas cylinders away from heat or ignition sources. Cylinders have a pressure relief device that will release the contents of the cylinder if the temperature exceeds

52°C (125°F). With liquid argon it is not uncommon for the relief device to activate at lower temperatures.

5.2.5. Label gas cylinders to clearly identify the contents.

5.2.6. Use only approved regulators and hose connectors.

5.3. ICP Safety

5.3.1. Perkin Elmer / Thermo Scientific provide a number of interlocks on the instruments. Defeating the interlocks may compromise operator safety and SHOULD NOT be attempted.

5.3.2. ICP spectrometers use high power levels of radio frequency energy in the power supply and torch unit which is potentially hazardous if allowed to escape. Safety device and interlocks should not be bypassed or disconnected.

5.3.3. The power supply of the ICP is capable of generating lethal voltages. No maintenance should be performed by anyone other than a Perkin Elmer / Thermo Scientific Service Representative.

5.3.4. Never directly view the ICP torch without protective eyewear.

5.3.5. It is very important to provide venting for the ICP. Toxic combustion products, ozone, and metal fumes may concentrate in the laboratory if adequate ventilation is not provided.

5.4. In the event of a known or potential problem with the safety or health of an individual working in the laboratory, all work must be stopped. The situation must be reported to a laboratory supervisor or the laboratory manager immediately.

6. Apparatus and Materials

6.1. Gases, Argon and Nitrogen, high purity

6.2. ICP System: Perkin Elmer Optima 4300 DV Emission Spectrometer / Thermo Scientific iCAP 6300 – the systems are comprised of four parts, the spectrometer, the plasma source, the radio frequency (RF) power supply, and the application software.

6.3. Gases, Argon and Nitrogen, high purity

6.4. Syringes, plastic, disposable, 20 mL

6.5. Filters for syringes, plastic, disposable, 25 mm, 1.5 µm glass fiber

6.6. Centrifuge tubes, plastic, 15 ml and 50ml

6.7. Volumetric flasks, Class A, and/or plastic, various sizes

6.8. Beakers, 250ml or equivalent

7. Reagents and Standards

7.1. Nitric Acid, 69.0-70.0%, for trace metals analysis

7.2. Nitric acid, concentrated, HNO_3, reagent grade

7.3. Hydrochloric acid, HCl, reagent grade

7.4. Deionized water

7.5. Stock solutions: Stock solutions are purchased as certified solutions. Store, at room temperature and protected from light. Stock solutions may also be prepared from pure standard materials. All purchased certified stock standards solutions have a manufacturer's expiration date on the label.

7.6. Secondary dilution standards - Using stock standard solutions, prepare in 10% nitric acid, secondary dilution standards containing the compounds of interest. Secondary dilution standards are stored at room temperature, protected from light and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them. **Secondary dilution standards should be replaced after three months or sooner if indicated.**

7.7. Second Source Standards – Purchased as certified solutions from another lot as the stock solutions or from another vendor. Second source standards should be checked frequently for signs of degradation or evaporation. Protect from light. All purchased second source standards solutions have a manufacturer's expiration date on the label.

7.8. ICP Rinse Solution – 10% nitric acid rinse. In a 4L container, place approximately 2L-deionized water. Add 400 mL concentrated nitric acid and djust volume to 4L with deionized water.

7.9. Internal Standard Solution- For the Perkin Elmer: Yttrium (Y) or Scandium (Sc): prepare a working solution by adding 100 mL of concentrated nitric acid and 2 mL of the 10,000 ug/ml stock into some deionized water in a 2L container. Adjust final volume to two liter with deionized water. Mix well. For the Thermo: Yttrium (Y) / Indium (In): prepare a working solution by adding 50ml of conc HNO3, 25ul of 10,000 ug/ml Yttrium stock and 5ml of 10,000 ug/ml Indium stock into deionized water in a 1L container. Adjust final volume to one liter with deionized water. Mix well.

7.10. Calibration Standards

7.10.1. Daily Calibration Standards – Prepare working solutions from purchased 100ug/mL certified standard solutions for the calibration curve according to the table below.

Calibration Level	Amount trace HNO_3 Added (mL)	Amount conc. HCl Added (mL)	Amount 100 µg/mL Stock Standard Added (µL)	Final Volume (mL)	Final Concentration (µg/L)
1	10	10	80	200	40
2	10	10	200	200	100
3	10	10	2000	200	1000
4	10	10	10,000	200	5000

7.10.2. Initial Calibration Verification (ICV) Solution – Prepare a 1000 µg/L solution by adding 2 mL of the 100 ug/mL second source standard to a 200 mL volumetric. Add 10 mL trace HNO_3 and 10mL concentrated HCl. Adjust final volume to 200 mL using deionized water. Final Concentration is 1000 µg/L.

7.10.3. Continuing Calibration Verification (CCV) Solution – Prepare a 1000 µg/L solution by adding 2 mL of the 100ug/ml first source (calibration stock solution) stock standard to a 200 mL volumetric. Add 10 mL trace HNO_3 and 10 mL of concentrated HCl. Adjust final volume to 200 mL using deionized water. Final Concentration is 1000 µg/L.

7.10.4. Low–Level Continuing Calibration Verification (LLCCV) Solution – Prepare a 40µg/L and 100 µg/L working solution as indicated in Table above. The LLCCVs are prepared from the same stock solution as the daily calibration.

7.10.5. Reporting Limit Verification (RLV) – Prepare a 40µg/L matrix matched solution. See table below

Matrix	Preparation
Wipe	Place a blank ghost wipe in a 50-mL centrifuge tube and then spike it with 20 µL of 100 µg/mL Multi-Element Stock Standard
Bulk/Soil	Place a blank soil material in a 50-mL centrifuge tube and then spike it with 20 µL of 100 µg/mL Multi-Element Stock Standard
Paint	Place a blank bulk material in a 50-mL centrifuge tube and then spike it with 20 µL of 100 µg/mL Multi-Element Stock Standard
Air	Place a blank air filter in a 50-mL centrifuge tube and spike with 40 µL of 10 µg/mL Multi-Element Stock Standard

7.10.5.1. The RLVs are digested in the same manner as the samples using the appropriate SLI SOP.

7.10.6. Laboratory fortified Blank (LFB) – Prepare a 250µg/L solution using serial dilution by adding 25 µl of 100 ug/ml stock standard to a 10 ml tube. Add 1ml of trace HNO_3 and adjust final volume to 10ml with DI H_2O.

7.10.7. Interference Check Standard Solution – Prepare the interference standard according to the following table.

Amount conc. HCl Added (mL)	Amount trace HNO_3 Added (mL)	Amount Standard Added		Final Volume (mL)	Final Concentration (µg/L)	
		1000 µg/L Stock (multi Element) (mL)	Interference Check Standard (mL)		Analytes	Interferents
10	10	1	2	200	500	Al, Ca, Fe, Mg, and Na at various concentrations

7.11 Matrix Spike (MS) Solution – Purchase a 100 µg/ml certified stock standard solution. The certified solutions should contain all the target analytes. Multiple solutions may be used in order to spike all compounds being analyzed for. Add 500µl /1 ml of calibration solution to the sample chosen as the MS sample. Final volume of the MS sample is 50ml / 100 mL respectively resulting in a 1000 µg/L spike.

7.12 Post Spike (PS) Solution – The same calibration stock solutions used for the MS sample are used for the post spike sample. Add 100 µL of the 100 ug/ml MS solution to 10 mL of the sample chosen for the post spike analysis. This results in a 1000 µg/L spike.

7.13 Laboratory Control Spike (LCS/LCSD) – The same stock standard solution used as the MS spiking solution is used as the LCS spiking solution. For aqueous sample add 1 ml of this solution to the blank matrix and dilute with de-ionized water to 100 ml. Add 100 ul of this solution to a blank air matrix and dilute to a final volume of 10 ml. For wipe, soil, bulk, and paint LCS / LCSD, add 500 ul of this stock standard solution and dilute to a final volume of 50 mL. This results in a LCS/LCSD spike concentration of 1000 ug/L.

7.14 Blanks – Two types of blanks are required for the analysis of samples. The calibration blank is used in establishing the analytical curve and the method blank is used to identify possible contamination resulting from either the reagents or the equipment used during sample processing and filtration.

7.15 Continuing Calibration Blank (CCB) and Initial Calibration Blank (ICB) – The CCB and the ICB are prepared the same way as rinse solution. The rinse solution is prepped using 400ml of acid diluted to 4 L with de-ionized water.

7.16 The method blank must contain all reagents in the same volumes as used during the processing of the samples. The method blank must be carried through the complete procedure and contain the same acid concentration in the final solution as the as the sample solution used for analysis.

8 Sample Collection, Preservation, and Storage

8.1 SLI does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2 All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3 Aqueous samples must be acidified to a pH of <2 with HNO_3. The pH of all aqueous samples must be tested immediately prior to aliquoting for processing or "direct analysis" to ensure the sample has been properly preserved. If properly acid preserved, the sample can be held up to six months before analysis.

8.4 For the determination of the dissolved elements, the aqueous sample must be filtered through a 0.45 µm pore diameter membrane filter at the time of collection or as soon thereafter as practically possible. (Glass or plastic filtering apparatus are recommended to avoid possible contamination. Only plastic apparatus should be used when the determinations of boron and silica are critical.) Use a portion of the filtered sample to rinse the filter flask, discard this portion and collect the required volume of filtrate. Acidify the filtrate with (1+1) nitric acid immediately following filtration to pH

8.5 For the determination of total recoverable elements in aqueous samples, samples are not filtered, but acidified with (1+1) nitric acid to pH 2, more acid must be added and the sample held for 16 hours until verified to be pH(normally, 3 mL of (1+1) acid per liter of sample is sufficient for most ambient and drinking water samples). Preservation may be done at the time of collection, however, to avoid the hazards of strong acids in the field, transport restrictions, and possible contamination it is recommended that the samples be returned to the laboratory within two weeks of collection and acid preserved upon receipt in the laboratory. Following acidification, the sample should be mixed, held for 16 hours, and then verified to be pH 2, more acid must be added and the sample held for 16 hours until verified to be pH <2.

8.6 Non-aqueous samples should be refrigerated at $4^{o}C \pm 2^{o}C$ upon receipt. There is no established holding time limitation for solid samples.

8.7 Samples must be digested and analyzed within 180 days of sample collection.

9 Procedure

9.1 Preparation and Digestion of Samples

9.1.1 Aqueous, solid, paint, and air samples are prepared using the appropriate SLI SOP.

9.2 Calibration of ICP Instrument

The ICP source consists of a RF generator and a demountable source. Every function of the source is controlled by the system computer. Parameters such as RF power, argon flow rates, and plasma viewing are regulated through use of the computer. Plasma ignition is fully automatic and occurs following one keystroke. The RF generator is located in the main chassis of the system below the plasma torch compartment. Proper RF shielding and filters are provided to assure that the system complies with FCC and VDE regulations regarding radiation. In addition to RF shielding, the system has numerous safety interlocks for operator protection. The devices insure that the plasma is stable, cooling water is flowing, argon flows and pressures are correct, and covers are secure. The system shuts down automatically if any interlock is interrupted. In the event of an interrupted interlock, the analyst is alerted immediately to the faulty condition to minimize plasma down time.

The plasma source comprises a demountable torch and sample introduction system. All of the assembly components are housed in an enclosure that provides maximum shielding and protects the environment from RF radiation. The plasma can be viewed during operation through a UV blocking, low transmittance window situated in the sliding door. The sample introduction system is comprised of the spray chamber and nebulizer. The nebulizer is a well proven cross-flow design that incorporates wide bore sampling capillaries to minimize blockage due to particulate matter and high dissolved solids. A computer controlled peristaltic pump provides constant sample delivery to the nebulizer.

9.2.1 Set up the instrument with proper operating conditions established as detailed below. The instrument should be allowed to become thermally stable before beginning (usually 30 minutes for ICP-PE).

NOTE: The Emergency Cut-off switch for the ICP-PE is a Red Button located in the upper left hand corner of the front panel. Thermo on/off switch is at the back of the instrument.

9.2.2 Daily Instrument Checks: The following items are checked daily before calibration of the instrument.

9.2.2.1 Argon Gas Level – Verify that the argon tank has sufficient pressure and that a spare tank is ready, if needed.

9.2.2.2 Cooling Water – Check the water supply system and the water filter. Change water filter if needed.

9.2.2.3 Torch – Inspect the torch, glassware, and aerosol injector tube. The glassware should be clean with no traces of deposits or signs of melting.

9.2.2.4 Drain - Verify that the drain bottle is not full. Keep the drain tubing clear with as few bends as possible. Ensure that the drain tube fits tightly to the spray chamber drain. There must be some liquid in the tube.

9.2.2.5 Nebulizer - the nebulizer must not be clogged and the sample capillary tubing must be clean and in good condition.

9.2.2.6 Peristaltic Pump-Replace the pump tubing as needed. Inspect the tubing after a few hours of operation and replace if flat spots develop. Remove the tubing from the peristaltic pump when it is not in use to prevent flat spots from forming. Check each pump roller to ensure that it is not binding. Binding can cause poor precision.

9.2.3 Perkin Elmer

9.2.3.1 Instrument Start Up

9.2.3.1.1 Perform daily checks

9.2.3.1.2. Double click on the "ICP WinLabs32" software icon on the computer. The program will automatically establish connection with the plasma generator, the spectrometer, and the automated sampler. After communication is established, click on the "WRKSPC" icon. Choose the file labeled as "Sli.icp" and hit "OK". This will open the Plasma Control Automated Analysis Control, and Results Windows.

9.2.3.1.3 Go to the Plasma Control Window and click on the "PUMP" icon. Check the flow of the peristaltic pump to make sure liquid is flowing properly. Click on the "PUMP" icon again to stop the pump.

9.2.3.1.4 Click on "File" in top left corner. Click on "Open". Click on "Method". Click on the method called "MY". The MY method uses Yttrium as the internal standard. Click "OK".

9.2.3.1.5 Click on the "METHOD" icon. Choose the element to be analyzed for (e.g. lead) and chose "Yttrium". Delete all other analytes in the method that are not to be analyzed. Click on the "Calibration" button on the bottom of the Method Window. Click on "Define Standards" on right side of Method window. Review and edit, if needed.

9.2.3.1.6 Click on the "Calibration Units" and "Conc" on right side of method Window. Review and edit, if needed. Click on the "QC" tab on bottom of method window. Click on the "QC Sample Definition". Review and edit, if needed. Click on the "Check Conc and Limits". Review and edit, if

needed. Click on "Schedule QC" tab on right side of Method window. Review and edit, if needed. Close out of window when done.

9.2.3.1.7 On toolbar in the top left corner of screen, choose "File", "New", then "Sample Info File". Choose "autodatacollect.sid". Hit "OK".

9.2.3.1.8 In window, enter the batch ID which is the date followed by a letter. (e.g. 011810A – signifies the date of Jan 18, 2010 and A signifies the first analysis of the day. B would be the second analysis of the day, etc.) Type in Analysts initials.

9.2.3.1.9 An RLV run must be done before the daily run. Name the batch ID for the RLV run as the date followed by "RLV." (e.g. 011810-RLV)

9.2.3.1.10 Once both the sample info file and method have been chosen, click on the "Automated Analysis Control Window" at the top of the "ICP WinLabs" software tool bar. The sample info file should have automatically transferred to the window on the lower left side of the auto analysis window. If not then type in the sample info file name that you saved earlier. Directly to the right of the sample info window is the results window. Double click this window then type the name of the results file you want to save your results to. This should mirror the sample info file description of month date year letter designation.

After the files are loaded into the automated analysis portion of the winlab software click the bottom tab that reads "analyze". This takes you to the screen to run the calibration and the samples. Click "Calibrate" to start calibration. Refer to Calibration of Instrument.

9.2.3.1.11 Once calibration is complete, on the toolbar, go to "File", "Open", "Sample Info File". Now open the sample information file that was saved earlier (e.g. 011810A) and list samples to be analyzed and QC to be run. Save this file by clicking the file button in the top right of software then scroll down to "Save As" the scroll to "Sample Info File" then name this file in the format of the current month day year and a letter designation as to which order the file is. Example: 011810A.

9.2.3.1.12 In Columns on same page enter the following: In the Sample ID Column – type in the SLi sample numbers. The SLi samples begin in position #38.

9.2.3.1.13 In the Matrix Check Sample column, double click next to the sample that is the DUP sample. Click on Duplicate. Click on Reference Sample # and enter location of native sample, then click on Current Sample # and enter

location of duplicate sample. This lets the instrument know that the sample is a duplicate of the sample that has run before it.

9.2.3.1.14 In the Matrix Check Sample column, double click next to the sample that is the MS. Click on "Recovery Set #1", Click on "Reference Sample #" and enter position of the native unspiked sample, then click on "Current Sample #" and enter position of the spiked sample. This lets the instrument know that the sample is a matrix spike of the sample that has run before it.

9.2.3.1.15 Enter the initial volume (10 mL), enter any dilution factor, enter the sample prep volume (10 mL), enter volume units (mL).

9.2.3.1.16 About the 11th sample in the sequence, in the Analyze QCs before column, type in "6,7". This lets the instrument know to analyze a CCV and CCB before analyzing the next batch of 10 samples. The CCV and CCB are in positions 6 and 7, respectively, in the automated sample unit. Go to "File", Save As", and save as file used earlier in day (e.g. 011810A).

9.2.3.1.17 After the next 10 samples, analyze all QCs 6,7 when you have more than 20 samples.

9.2.3.2 Calibration of Instrument

9.2.3.2.1 Load the standards and RLVs in the automated sample. An example of the RLV Sequence is listed below.
Example RLV Sequence

1. Calibration Blank
2. 40 ppb Standard
3. 100 ppb Standard
4. 1000 ppb Standard
5. 5000 ppb Standard
6. 1000 ppb ICV QC– Second Source
7. ICB QC
8. 40 ppb LLCCV QC
9. 500 ppb ICS QC
10. CCV – 1000 ppb QC
11. CCB QC
12. RLV Paint QC
13. RLV Air QC
14. RLV Soil/Bulk QC
15. RLV Wipe QC
16. 500 ppb ICS QC
17. CCV – 1000 ppb QC
18. CCB QC

9.2.3.2.2 To be considered acceptable, the calibration curve should have a correlation coefficient of 0.998 or better. If the correlation coefficient is less than 0.998, then the instrument must be recalibrated.

9.2.3.3 Once the calibration criterion of 0.998 has been met, the analyst may proceed with the analysis of the ICV, the ICB, the LLCCV, the ICS, the CCV, CCB, and then the RLVs. Press the "Analyze Samples" button on the Automated Analysis Control window when ready to analyze samples. All criteria for these standards and blanks must be met before the analysis of samples. See the Quality Control Section for specific guidelines on acceptance criteria. When all criteria has been met continue with the daily calibration and sample analysis

9.2.3.4 Load the standards in the automated sample. An example of the Analytical Sequence of the standards and samples is listed below.

Example Analytical Sequence

1. Calibration Blank
2. 40 ppb Standard
3. 100 ppb Standard
4. 1000 ppb Standard
5. 5000 ppb Standard
6. 1000 ppb ICV QC– Second Source
7. ICB QC
8. 40 ppb LLCCV QC
9. 100 ppb LLCCV QC
10. 500 ppb ICS QC
11. CCV QC – 1000 ppb
12. CCB QC
13. 10 samples
14. DUP on one of 10 samples above
15. MS on one of 10 samples above
16. CCV QC – 1000 ppb
17. CCB QC
18. 10 samples
19. DUP on one of 10 samples above
20. MS on one of 10 samples above
21. 500ppb ICS QC
22. CCV QC – 1000 ppb
23. CCB QC

9.2.3.5 Several analytes have more than one wavelength that can be used to quantify a sample.

9.2.3.5.1 The following table lists the Analytes, the primary wavelength and the secondary wavelength.

Analyte	Primary Wavelength	Secondary Wavelength
Calcium	315.887	317.933
Cadmium	214.438	228.802
Copper	324.754	327.396
Iron	239.562	261.187
Magnesium	279.079	285.213
Zinc	206.200	213.856

9.2.3.5.2 The primary wavelength is used for the majority of analyses. The only time the secondary wavelength is chosen is if the QC for the primary wavelength fails and the QC for the secondary wavelength passes.

9.2.3.6 Data reporting

9.2.3.6.1 When analysis is finished, export data by going to the Toolbar and clicking on “File”, “Utilities”, “Data Manager”.

9.2.3.6.2 Highlight the desired file (e.g. 011810A)

9.2.3.6.3 Click on “Export”. Click on “Use Existing Design”. Click on “Browse”. Click on “Export.xpt” file then hit “Open” then “Next”.

9.2.3.6.4 To export data to SLI Applications, open SLI Applications. Click on “Metals” then “Imports”.

9.2.3.6.5 Select instrument from dropdown menu, which is the “Optima 4300”. Type in run ID and choose initial from dropdown menu. The run ID is the run established earlier as the date and letter (e.g. 011810A).

9.2.3.6.6 Click “Copy and Check results”. Close window when done.

9.2.3.6.7 To unclick the desired dilutions click on “Check Results/Current Batch”. Close window when done.

9.2.3.6.8 Click on “View and Import QC” to uncheck QCs unwanted QCs for the run.

9.2.3.6.9 Click on "Data/Analysis Report", if you want to preview the report, click on "Preview Only" button underneath. Click "Import SLI Data", "Yes", "Yes".

9.2.4 **Thermo iCAP**

9.2.4.1 Perform Daily checks

9.2.4.2 Turn on the chiller on and automated sampler.

9.2.4.3 Double click on iTEVA center software icon on the computer and choose a user name –admin. The program will automatically establish connection with plasma generator, the spectrometer, and the automated sampler and initialize the instrument. After initialization is established, click on the "Flame" icon (next to admin at the bottom corner). Click on instrument status (all icons must be green). Then click on plasma on or fix the icon that is not activated and then click on plasma on and hit "OK".

9.2.4.4 Double click on the Analyst application on the left on control center and this will open the method window. Choose the method needed and this will open the Analysis (results page), method and sequence windows.

9.2.4.5 Go to the Sequence Window to setup sample information file. Click on auto session at the top left corner on screen and choose new auto sampler.

9.2.4.6 Under list of sequence to run: choose new and add the number of samples and sample name, then click OK. Then ok on new auto sampler.

9.2.4.7 The auto sampler can be viewed in two different formats either as a list (where samples information are typed) or as auto sampler location. When auto sampler page opens, locate standards and samples.

9.2.4.8 Additional samples can be added on the list view. In Columns on same page enter the following: In the Sample ID Column – type in the SLi sample numbers, to locate duplicates and spikes click on a sample and and auto locate the samples.

9.2.4.9 Click on auto session and save sample information file with batch ID, which is the date, followed by a letter (e.g. 030111A – signifies the date of March 1st, 2011 and A signifies the first analysis of the day. B would be the second analysis of the day, etc.).

9.2.4.10 An RLV run must be done before the daily run. Name the batch ID for the RLV run as the date followed by "RLV QC." (e.g. 030111-RLV QC).

9.2.4.11 Once both the sample info file and method have been chosen, The sample info file should have automatically transferred to the window on the lower left side of the auto analysis window. If not then type in the sample info file name that you saved earlier.

9.2.4.12 Click on the "Run auto session icon" at the top of the "ICP iTEVA" software tool bar to run the calibration standards and samples and click on the Analysis icon at the bottom right of the auto session window to view the results. Refer to calibration of Instrument in section 9.2.5.

9.2.4.13 Once calibration is complete, go to method icon next to the analysis icon to view the calibration correlation coefficient. Click on method icon, method reports, element calibration reports and print the report.

9.2.4.14 Go back to sequence icon to add more samples and matrix DUP, SPK and LCS to sample information list. Place the cursor on the sample to add DUP and click the fourth icon to insert duplicate (sample_DUP), Place cursor on another sample and click the third icon on top left to insert recovery (sample_RQ) and drag the SPK to the right location and do the same for LCS. Then, rename the DUP, SPK and LCS according (e.g. 31114444 DUP QC, 31114444 SPK QC and LCS SOIL QC). Insert blank as unknown sample just like the sample and then rename as BLK MATRIX QC (e.g. BLK SOIL QC).

9.2.4.15 Enter the initial volume (10 mL), enter any dilution factor, enter the sample prep volume (10 mL) enter volume units (mL).

9.2.4.16 QCs (CCV and CCB) are analyzed after every ten samples in the sequence, the method is already set up to generate CCV and CCB after every ten samples, remember to drag the QCs into the right locations.

9.2.5 Calibration of Instrument

9.2.5.1 Load the standards and RLVs in the automated sample. An example of the RLV Sequence is listed below in section 9.2.3.2.1.

9.2.5.2 To be considered acceptable, the calibration curve should have a correlation coefficient of 0.998 or better. If the correlation coefficient is less than 0.998, then the instrument must be recalibrated.

9.2.5.3 Once the calibration criterion of 0.998 has been met, the analyst may proceed with the analysis of the ICV, the ICB, the LLCCV, the ICS, the CCV, CCB, and then the RLVs. Press the "Analyze Samples" button on the Automated Analysis Control

window when ready to analyze samples. All criteria for these standards and blanks must be met before the analysis of samples. See the Quality Control Section for specific guidelines on acceptance criteria. When all criteria has been met continue with the daily calibration and sample analysis .

9.2.5.4 Load the standards in the automated sample. An example of the Analytical Sequence of the standards and samples is listed in section 9.2.3.4.

9.2.5.5

9.2.5.6 Data reporting

9.2.5.6.1 The network is setup to transfer the analyzed data automatically into LIMS

9.2.5.6.2 To import data to SLI Applications, open SLI Applications. Click on "Metals" then "Imports".

9.2.5.6.3 Select instrument from dropdown menu, which is the "Thermo". Type in run ID and choose initial from dropdown menu. The run ID is the run established earlier as the date and letter. Importing data is specific to the analyzed date, if a run was done on the 15th and needs to be imported on the 16th (e.g. 03/15/2011) in order for the correct data to show up.

9.2.5.6.4 Click "Copy and Check results".

9.2.5.6.5 To unclick the desired dilutions click on "Check Results/Current Batch". Close window when done.

9.2.5.6.6 Click on "View and Import QC" to uncheck QCs unwanted QCs for the run.

9.2.5.6.7 Click on "Data/Analysis Report", if you want to preview the report, click on "Preview Only" button underneath. Click "Import SLI Data", "Yes", "Yes".

10 Quality Control

10.1 Matrices of Standards

10.1.1 Standards have relatively the same acid concentration as the samples being analyzed. All digested samples have a final nitric acid content of approximately 10% and a final hydrochloric acid content of 10%. Likewise, calibration standards have a final concentration of 10% and blanks have a final concentration of 5% of each acid.

10.1.2 Because variation from the 5% acid concentration tends to give the physical interference of viscosity effects, this interference is eliminated by an internal standard that is run in each and every sample, automatically correcting for physical interferences.

10.2 Calibration Protocol

10.2.1 A calibration is run at the beginning of each set of analyses or at least once daily.

10.2.2 The calibration curve usually consists of at least three non-zero points (40, 100, 1000 and 5000 µg/L) and a calibration blank. However, more calibration points may be analyzed as deemed necessary.

10.2.3 The calibration coefficient must be at least 0.998 or higher. The linearity of the curve must not be forced thru zero. If this evaluation criterion is not met, analysis must be stopped and recalibration performed. If the recalibration fails, the standards must be re-made and/or the equipment must be evaluated.

10.3 Initial Calibration Verification

10.3.1 After the daily calibration, the initial calibration verification (ICV) standard is analyzed.

10.3.2 The ICV standard is prepared from a second source at 1000 µg/L, which is almost at the mid-range of the calibration curve.

10.3.3 The percent recovery (%R) of the ICV standard must be between 95%-105% for Aqueous and 90%-110% for Solids. If the second source fails calibration criteria, recalibration is necessary.

10.3.4 After the ICV is analyzed, an initial calibration blank (ICB) is analyzed. Target analytes should not be detected in the ICB at a concentration greater than the reporting limit.

10.4 Low-Level Continuing Calibration Verification (LLCCV)

10.4.1 The LLCCV of 40µg/L for most analytes is analyzed after the ICB. However, other concentrations of LLCCVs may be analyzed as deemed necessary for other analytes with higher reporting limits.

10.4.2 The percent recovery of the LLCCV is between 70-130%.

10.5 Interference Check Sample (ICSAB)

10.5.1 The Interference Check Sample (ICSAB) is run at the beginning and end of every run and should be must be within 20% of the true value.

10.5.2 The concentration of target analytes in the ICSAB is 500 µg/L. The interferents (aluminum, calcium, iron, magnesium, and sodium) are also contained in this solution at varying concentrations.

10.6 Continuing Calibration Verification (CCV)

10.6.1 A CCV is run once every 10 samples.

10.6.2 The concentration of the CCV is at 1000 µg/L, which is the mid-range of the calibration curve for most analytes. However, higher concentrations may be analyzed for target analytes which have a higher reporting limit.

10.6.3 The %R of the CCV must be within 90%-110%.

10.6.4 After the CCV is analyzed, a continuing calibration blank (CCB) is analyzed. Target analytes should not be detected in the CCB at a concentration greater than the reporting limit.

10.7 LCS Samples

10.7.1 The LCS is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

10.7.2 LCS samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCS takes the place of the MS for wipes and airs.

10.7.3 LCS samples are digested and handled in the same manner as the samples.

10.7.4 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%.

10.8LCSD Samples

10.8.1 The LCSD is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

10.8.2 LCSD samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A

batch can be no greater than 20 samples. The LCSD takes the place of the MSD for wipes and airs.

10.8.3 LCS samples are digested and handled in the same manner as the samples.

10.8.4 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%. The RPD of the LCS/LCSD should be between +/- 20%.

10.9 Matrix Spike

10.9.1 Matrix Spike are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for soil and solids or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.9.2 Matrix Spikes are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MS sample, the laboratory will add a disclaimer to the final report.

10.9.3 The %R for the matrix spike should be between 75%-125%. If the recovery of the MS is outside of these limits, a post-digestion spike is performed on the sample. The recovery of the post-spike should be between 80%-120%.

10.10 Matrix Spike Duplicates

10.10.1 Matrix spike duplicates are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.10.2 Matrix spike duplicates are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MSD sample, the laboratory will add a disclaimer to the final report.

10.10.3 The %R for the matrix spike should be between 75%-125%. The RPD of the MS/MSD should be +/- 20%.

10.11 Post Spikes

10.11.1 Post spikes are analyzed whenever MS recoveries are unacceptable.

10.11.2 Post spikes are analyzed in the same manner as the original sample.

10.11.3 Post spike samples are spiked with 100 µL of a 100 µg/mL spiking solution in a 10ml tube.

10.11.4 The recovery of the post-spike should be between 80-120%.

10.12 Reporting Limit Verification (RLV)

10.12.1 This must be a matrix matched sample and analyzed after the daily calibration/run for lead in paint, soil, airs and wipes under the AIHA ELLAP program. The RLV is analyzed after the CCB.

10.12.2 The RLV is a solid certified reference material spiked onto a blank matrix and is put through the entire preparation and analytical process.

10.12.3 The %R of the RLV must be within 80%-120%.

10.13 Blank Analyses

10.13.1 Method Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

10.13.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask go through the entire preparation and analytical process.

10.13.3 If for Solid Samples the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

10.13.4 For Aqueous samples, when the blank values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable blank values have been obtained.

11 Method Performance

11.1 The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations actually achieved will vary depending on instrument sensitivity and matrix effects.

11.2 The analytical group must generate a valid MDL for each individual analyte of interest. The MDL must be below the reporting limit or low level standard for each analyte. The procedure for determination of the MDL is given in 40 CFR Part 136, Appendix B.

11.3 MDLs are determined annually per matrix per each analyst. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

12 Data Analysis and Calculations

12.1 The quantitative values must be reported in the appropriate units of milligram per kilogram (mg/kg), microgram per feet squared (ug/ft2), microgram per meter cubed (ug/m^3) or milligram per liter (mg/l).

12.2 If dilutions were performed, the appropriate corrections must be applied to the sample values.

13.3. Results must be reported in units commensurate with their intended use and all dilutions must be taken into account when computing final results.

13 Corrective Actions and Handling of Non-Conformance Data

13.1 Refer to *Table 4*: Correction action flowchart for Non-Conformance handling information

14 Pollution Prevention

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities exist for pollution prevention in the laboratory.

14.2 Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed of. The threat to the environment from acids and/or reagents used in this method may be minimized when recycled or disposed of properly.

15 Waste Management

15.1 All waste will be disposed in accordance with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

15.2 The storage and disposal of hazardous waste is further detailed in SLGi AD-043.

15.3 For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel," and "Less is Better: Laboratory Chemical Management for Waste Reduction," both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036.

16 References

16.1 United States Environmental Protection Agency, “Method 6010C: Inductively Coupled Plasma-Atomic Emission Spectrometry, SW846 Online, Revision 3, February 2007.

16.2 T.D. Martin, C.A. Brockhoff, J.T. Creed, and EMMC Methods Work Group , “Method 200.7: Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry”, Revision 4.4, 1994

16.3 National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods, “Method 7300: Elements by ICP”, Issue 3, March 2003.

16.4 Code of Federal Register (CFR), Title 40 (40 CFR), Subchapter C (Air Programs), Ch. 2, Part 50—National Primary and Secondary Ambient Air Quality Standards for Lead, February 2010.

Table 4: Corrective Action Flowchart

Sample Type	Test Result	Condition	Corrective Action	Note
Matrix Blank (B)	Blank Reading> Reporting Limit (RL)	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet and notify QA dept.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Air and wipe samples are consumed during extraction. In this case, notify QA dept.
Laboratory Control Sample / QC Sample (LCS)	LCS > Upper Limit	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken. Note what the %R is on the internal tracking sheet.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on internal tracking sheet and disclaimer on the final report. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed Air and wipe samples are consumed during extraction. In this case, notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
	LCS < Lower Limit	Samples are non-detect for that analyte	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Since there is no more wipe or air sample, re-extraction cannot occur so notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Disclaimer on the final report.	
Matrix Spike (MS) and MS Duplicate (MSD)	MS/MSD > or < QC Limit	Samples are positive or non-detect for that analyte.	If the MS/MSD is unacceptable, notify QA dept or follow table as listed above for LCS/QC Samples. A disclaimer is put on the final report.	NA
Duplicate Sample (D) (If used)	%RSD > Upper Limit	Samples are positive or non-detect for that analyte.	Duplicate fails then a disclaimer is placed on the final report. QC is notified of failure.	NA

Revision Page

08/06/2015 (15-002)

Revised the following section:

1.3 This method is based on SW-846 methods 6010C (Revision 3, February 2007), Standard Methods 3120B (20th Edition), EPA Method 200.7 (Revision 4.4), NIOSH 7300 (Issue 3, March 2003) 40CFR Part 50 Appendix G, with modifications for client specific analysis.

Revision:

1.3 This method is based on SW-846 methods 6010C (Revision 3, February 2007), Standard Methods 3120B (20th Edition), EPA Method 200.7 (Revision 4.4), NIOSH 7300 (Issue 3, March 2003) 40CFR Part 50 Appendix G, with modifications for client specific analysis. This SOP covers the following matrices: drinking water, wastewater, soils, sediments, paint, bulk, wipe and air samples.

Added the following sections:

1.5 The LOQ for drinking and non-potable water samples are as follows: 0.20 mg/l for Calcium, Magnesium, Potassium and Sodium, 0.10 mg/l for Chromium, Boron, Copper, Iron and Zinc and 0.040 mg/l for all other metals. The LOQ for soils and sediments takes into effect a final extraction volume of 50 ml and the weight of the sample. The LOQ for air samples takes into effect a final extraction volume of 10 ml and the air volume in liters.

3.12 LOQ or Limit of Quantitation – The LOQ is the level above which quantitative results may be obtained with a specified degree of confidence. It is also refered to as the Reporting Limit (RL). Limits of quantitation are matrix, method, and analyte specific.

Added the following section and renumbered:

9.2.3.5 Several analytes have more than one wavelength that can be used to quantify a sample.

9.2.3.5.1 The following table lists the Analytes, the primary wavelength and the secondary wavelength.

Analyte	Primary Wavelength	Secondary Wavelength
Calcium	315.887	317.933
Cadmium	214.438	228.802
Copper	324.754	327.396
Iron	239.562	261.187
Magnesium	279.079	285.213
Zinc	206.200	213.856

9.2.3.5.2 The primary wavelength is used for the majority of analyses. The only time the secondary wavelength is chosen is if the QC for the primary wavelength fails and the QC for the secondary wavelength passes.

Revised the following section:

8 **Sample Collection, Preservation, and Storage**

8.1 SLI does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2 All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3 Aqueous samples must be acidified to a pH of <2 with HNO_3.

8.4 Non-aqueous samples should be refrigerated at $4^oC \pm 2^oC$ upon receipt and analyzed as soon as possible if it contains organic testing.

8.5 Samples must be digested and analyzed within 180 days of sample collection.

Revision:

8 **Sample Collection, Preservation, and Storage**

8.1 SLI does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2 All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3 Aqueous samples must be acidified to a pH of <2 with HNO_3. The pH of all aqueous samples must be tested immediately prior to aliquoting for processing or "direct analysis" to ensure the sample has been properly preserved. If properly acid preserved, the sample can be held up to six months before analysis.

8.4 For the determination of the dissolved elements, the aqueous sample must be filtered through a 0.45 µm pore diameter membrane filter at the time of collection or as soon thereafter as practically possible. (Glass or plastic filtering apparatus are recommended to avoid possible contamination. Only plastic apparatus should be used when the determinations of boron and silica are critical.) Use a portion of the filtered sample to rinse the filter flask, discard this portion and collect the required volume of filtrate. Acidify the filtrate with (1+1) nitric acid immediately following filtration to pH

8.5 For the determination of total recoverable elements in aqueous samples, samples are not filtered, but acidified with (1+1) nitric acid to pH 2, more acid must be added and the sample held for 16 hours until verified to be pH(normally, 3 mL of (1+1) acid per liter of sample is sufficient for most ambient and drinking water samples). Preservation may be done at the time of collection, however, to avoid the hazards of strong acids in the field, transport restrictions, and possible contamination it is recommended that the samples be returned to the laboratory within two weeks of collection and acid preserved upon receipt in the laboratory. Following acidification, the sample should be mixed, held for 16 hours, and then verified to be pH 2, more acid must be added and the sample held for 16 hours until verified to be pH <2.

8.6 Non-aqueous samples should be refrigerated at $4^oC \pm 2^oC$ upon receipt. There is no established holding time limitation for solid samples.

8.7 Samples must be digested and analyzed within 180 days of sample collection.

Removed the following section and renumbered:

9 RLV Pb Procedures

Revised the following section:

11.12.3 If the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

Revison:

11.12.3 If for Solid Samples the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

11.12.4 For Aqueous samples, when the blank values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable blank values have been obtained.

Revised the following section:

11.1 Reporting Limit Verification (RLV)

11.1.1 This must be a matrix matched sample and analyzed before the daily calibration/run. The RLV is analyzed after the CCB.

11.1.2 The concentration of the RLV is at 40 ppb, which is the reporting limit of the calibration.

11.1.3 The %R of the RLV must be within 80%-120%.

Revision:

10.12 Reporting Limit Verification (RLV)

10.12.1 This must be a matrix matched sample and analyzed after the daily calibration/run for lead in paint, soil, airs and wipes under the AIHA ELLAP program. The RLV is analyzed after the CCB.

10.12.2 The RLV is a solid certified reference material spiked onto a blank matrix and is put through the entire preparation and analytical process.

10.12.3 The %R of the RLV must be within 80%-120%.

Revised the following sections and renumbered:

11.7 LCS Samples

11.7.1 The LCS is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

11.7.2 LCS samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

11.7.3 LCS samples are digested and handled in the same manner as the samples.

11.7.4 The %R of the LCS must be between 80-120% except for drinking water samples analyzed by method 200.7, where the %R must be between 90%-110%.

11.8 Duplicates

11.8.1 Duplicates are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

11.8.2 Duplicate samples are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a duplicate sample, the laboratory will prepare a LCS/LCSD pair instead.

11.8.3 Duplicates monitor analysis precision. The results of the duplicate analyses should match the original results within 25% Relative Percent Difference (RPD).

11.9 Matrix Spikes

11.9.1 Matrix spikes are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

11.9.2 Matrix spikes are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MS sample, the laboratory will prepare a LCS/LCSD pair instead.

11.9.3 The %R for the matrix spike should be between 75%-125%. If the recovery of the MS is outside of these limits, a post-digestion spike is performed on the sample. The recovery of the post-spike should be between 80%-120%.

Revision:

10.7 LCS Samples

10.7.1 The LCS is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

10.7.2 LCS samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCS takes the place of the MS for wipes and airs.

10.7.3 LCS samples are digested and handled in the same manner as the samples.

10.7.4 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%.

10.8 LCSD Samples

10.8.1 The LCSD is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

10.8.2 LCSD samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCSD takes the place of the MSD for wipes and airs.

10.8.3 LCS samples are digested and handled in the same manner as the samples.

10.8.4 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%. The RPD of the LCS/LCSD should be between +/- 20%.

10.9 Matrix Spike

10.9.1 Matrix Spike are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for soil and solids or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.9.2 Matrix Spikes are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MS sample, the laboratory will add a disclaimer to the final report.

10.9.3 The %R for the matrix spike should be between 75%-125%. If the recovery of the MS is outside of these limits, a post-digestion spike is performed on the sample. The recovery of the post-spike should be between 80%-120%.

10.10 Matrix Spike Duplicates

10.10.1 Matrix spike duplicates are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.10.2 Matrix spike duplicates are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MSD sample, the laboratory will add a disclaimer to the final report.

10.10.3 The %R for the matrix spike should be between 75%-125%. The RPD of the MS/MSD should be +/- 20%.

Revised the following section:

11.12 Blank Analyses

11.12.1 Method Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

11.12.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask go through the entire preparation and analytical process.

11.12.3 If the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

Revision:

10.13 Blank Analyses

10.13.1 Method Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

10.13.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask go through the entire preparation and analytical process.

10.13.3 If for Solid Samples the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

10.13.4 For Aqueous samples, when the blank values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable blank values have been obtained.

SCHNEIDER LABORATORIES GLOBAL, INCORPORATED

Document #: ME-013-15-002
Original Date: 07/20/95
Revision Date: 05/14/15
Effective Date: 05/18/15

Schneider Laboratories Global, Inc. Standard Operating Procedure for Acid Digestion of Aqueous Samples for Total and Dissolved Metals (Flame AA, ICP) Using EPA 3010A

Reviewed by: _____
Department Manager

Approved by: _____
QA/QC Department

Approved by: _____
Laboratory/Technical Director

Schneider Laboratories Global, Inc.
Standard Operating Procedure for
Acid Digestion of Aqueous Samples for
Total and Dissolved Metals (Flame AA, ICP)
using 3010A

1. Scope and Application

1.1. This digestion procedure is used for the preparation of aqueous samples, including drinking waters, waste waters, and TCLP extracts for analysis by inductively coupled plasma (ICP) spectroscopy or flame atomic absorption (FLAA) spectroscopy. The procedure is used to determine total metals.

1.2. Samples prepared by this method may be analyzed by for the following analytes:

Aluminum	Lead
*Arsenic	Magnesium
Barium	Manganese
Beryllium	Molybdenum
Cadmium	Nickel
Calcium	Potassium
Chromium	*Selenium
Cobalt	Sodium
Copper	Thallium
Iron	Vanadium
	Zinc

* Analysis by ICP only

1.3. This digestion procedure is not suitable for samples which will be analyzed by graphite furnace atomic absorption (GFAA) spectroscopy.

2. Summary of Method

2.1. Method 3010A

2.1.1 A mixture of nitric acid and the material to be analyzed is refluxed in a beaker. This step is repeated with additional portions of nitric acid until the digestate is light in color or until its color has stabilized. After the digestate has been brought to a low volume, it is refluxed with hydrochloric acid and brought up

to volume. If the sample should go to dryness, it must be discarded and the sample re-prepared.

2.2. Method 3005 B

2.2.1 Total recoverable metals - The entire sample is acidified at the time of collection with nitric acid. At the time of analysis the sample is heated with acid and substantially reduced in volume. The digestate is filtered and diluted to volume, and is then ready for analysis.

2.2.2 Dissolved metals - The sample is filtered through a 0.45-µm filter at the time of collection and the liquid phase is then acidified at the time of collection with nitric acid. Samples for dissolved metals do not need to be digested as long as the acid concentrations have been adjusted to the same concentration as in the standards.

3. Definitions

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.2. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference. If not enough sample is submitted then an LCS/LCSD is prepared.

3.4. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.5. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.6. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. This is performed when not enough sample is submitted for a duplicate analysis to be performed.

3.7. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

4. Interferences

4.1 Reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing reagent or method blanks.

4.2 Analyses of reagent blanks provide information about the presence of contaminants.

4.3 Contamination by carryover can occur whenever high-level and low level samples are sequentially digested and analyzed. After the analysis of a sample containing high concentrations of analytes, sufficient rinse time should follow the analysis on the instrument.

4.4 With addition of HCl in EPA Method 3005 the analyst should be cautioned that this digestion procedure may not be sufficiently vigorous to destroy some metal complexes. Precipitation will cause a lowering of the silver concentration and therefore an inaccurate analysis.

5. Safety

This SOP does not address all safety issues associated with its use. The laboratory is responsible for maintain a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals included in this method. A reference file of material data safety sheets (MSDS) is available to all personnel involved in these analyses.

5.1. The preparation of all standards, reagents, and glassware procedures that involve acids will be conducted in a fume hood with the sash closed as far as the operations will permit.

5.2. Equipment, gloves and goggles or face shield, must be used when employees are using acids to rinse or clean glassware.

5.3. Work areas should be isolated and posted with signs. Glassware and tools should be segregated.

5.4. Exposure of chemicals will be maintained so it is as low as reasonable possible. All samples should be opened, transferred, and prepared in a fume hood, or under other means of ventilation.

5.5. The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. For this reason, the acidification and digestion of samples should be performed in a fume hood.

5.6. Waste containers must be kept closed unless transfers are being made.

5.7. In the event of a known or potential problem with the safety or health of an individual working in the laboratory, all work must be stopped. The situation must be reported to a laboratory supervisor or the laboratory manager immediately.

6. Apparatus and Materials

6.1. Beakers, glass, 250-ml or equivalent.

6.2. Hot plate: adjustable and capable of maintaining samples at a temperature of 95° $\pm$ 5° C.

6.3. Syringes, plastic, disposable, 20 mL.

6.4. Filters for syringes, plastic, disposable, 25 mm, 1.5 µm glass fiber.

6.5. Disposable gloves.

7. Reagents and Standards

7.1. Deionized water: water should be monitored for impurities.

7.2. Concentrated nitric acid: reagent grade, HNO_3: acid should be analyzed to determine levels of impurities. If the method blank is <RL, the acid can be used.

7.3. Hydrochloric acid; HCl: Acid should be analyzed to determine levels of impurities. If the method blank is <RL, the acid can be used.

8. Sample Collection, Preservation, and Handling

8.1. SLGi does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2. All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3. Aqueous samples must be acidified to a pH of <2 with HNO_3.

8.4. Samples must be digested and analyzed within 180 days of sample collection.

9. Procedure

9.1. EPA Method 3010: Transfer a 50ml or 100-ml representative aliquot of the well-mixed sample to a 250-ml beaker and add 1.5 or 3 ml of concentrated HNO_3. Place on a preheated hot plate or hot block. Heat the sample to $95^oC \pm 5^oC$.

9.2. Allow evaporation to occur until the sample volume reaches approximately 20 ml

NOTE: Be careful not to let the sample boil or go to dryness, as either may result in poor recovery of some analytes. Should this occur, discard the sample and re-prepare.

9.3. Remove the beaker from the hot plate, cool, and then add another 1.5 or 3 ml portion of concentrated HNO_3. Return to the hot plate. Heat to $95^oC \pm 5^oC$ for about 10 minutes.

9.4. The refluxing should continue until digestion is complete, usually indicated when the digestate is light in color or does not change in appearance with continued refluxing.

9.5. Evaporate to a low volume (usually about 20 ml) being careful to not let the sample go to dryness. Cool the beaker. Add 5 ml or 10 mL of 1:1 HCl. Heat for 10 minutes at 95°C ± 5°C to dissolve any precipitate or residue resulting from evaporation.

9.6. Remove from heat and allow the beaker to cool.

9.7. Wash down the beaker walls with water. Filter the sample if needed. Adjust the final volume to 50 ml or 100 mL. The sample is now ready for analysis.

9.8. **EPA Method 3005:** Transfer a 50 or 100-ml representative aliquot of the well-mixed sample to a 200-ml beaker and add 1 ml or 2 ml of concentrated HNO_3 and 2.5 ml or 5 ml of HCl. Cover with a watch glass and allow sample to evaporate approximately to 15 to 20ml on a preheated hot plate from 90 to 95°C.

9.9. Remove from heat and allow the beaker to cool.

9.10. Wash down the beaker walls and watch glass with water. Filter the sample if needed. Adjust the final volume to 50 ml or 100 mL. The sample is now ready for analysis.

10. Quality Control

10.1. For each analytical batch containing up to 10 samples, blanks (deionized water and reagents) are carried throughout the entire sample preparation and analytical process.

Note: When RB or MB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable RB or MB values have been obtained.

10.2. Matrix Spiked (MS) and Matrix Duplicates (MD) samples should be employed to determine accuracy. A spiked sample should be included with each batch of samples processed and whenever a new sample matrix is being analyzed. A spiked sample will be processed with each analytical batch or every 10 samples, whichever is greater. Matrix spiked sample acceptance is ± 25% Recovery. Duplicate acceptance is ± 20% RPD.

10.3. Lab Control Sample (LCS) and Lab Control Sample Duplicates (LCSD) samples are prepared at a rate of 1 per 10 samples and carried throughout the entire sample preparation and analytical process. LCS acceptance is ± 20% Recovery. LCS/LCSD duplicate acceptance is ± 20% RPD.

11. Method Performance

11.1. The above method is a modification of the EPA 3010A method on which it is based, although much of the text of this SOP is verbatim.

11.2. The method with its modifications has been used for all samples of the applicable matrix at SLGi and has been verified with quality control samples, both in-house and those which are part of nationally-recognized proficiency testing programs.

12. Data Analysis and Calculations

12.1 The quantitative values must be reported in the appropriate units of micrograms per liter (ug/l).

12.2 If dilutions were performed, the appropriate corrections must be applied to the sample values.

12.3. Results must be reported in units commensurate with their intended use and all dilutions must be taken into account when computing final results.

13. Calibration and Standardization

13.1. See specific analysis SOPs for the calibration and standardization information.

14. Pollution Prevention

14.1. Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities exist for pollution prevention in the laboratory.

14.2. Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed of. The threat to the environment from solvents and/or reagents used in this method may be minimized when recycled or disposed of properly.

15. Waste Management

15.1. All waste will be disposed in accordance with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

15.2. The storage and disposal of hazardous waste is further detailed in SLGi SOP AD-043.

15.3. For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel," and "Less is Better: Laboratory Chemical Management for Waste Reduction," both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036.

16. Handling Non-Conformance Data

16.1 Refer to Table 3: Corrective action flowchart for Non-Conformance handling information.

17. References

17.1 United States Environmental Protection Agency, “Method 3010A: Acid Digestion of Aqueous Samples for Total Metals for Analysis by FLAA or ICP Spectroscopy”, SW846 Online, Revision 1, July 1992.

17.2 United States Environmental Protection Agency, “Method 3005A: Acid Digestion of Aqueous Samples for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy”, SW846 Online, Revision 1, July 1992.

17.3 T.D. Martin, C.A. Brockhoff, J.T. Creed, and EMMC Methods Work Group , “Method 200.7”, Revision 4.4, 1994.

Table 3: Corrective Action Flowchart

Sample Type	Test Result	Condition	Corrective Action	Note
Matrix Blank (B)	Blank Reading> Reporting Limit (RL)	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet and notify QA dept.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Air and wipe samples are consumed during extraction. In this case, notify QA dept.
Laboratory Control Sample / QC Sample (LCS)	LCS > Upper Limit	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken. Note what the %R is on the internal tracking sheet.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed Air and wipe samples are consumed during extraction. In this case, notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
	LCS < Lower Limit	Samples are non-detect for that analyte	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Since there is no more wipe or air sample, re-extraction cannot occur so notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
		Samples are positive for that analyte.		
Matrix Spike (MS) and MS Duplicate (MSD)	MS/MSD > or < QC Limit	Samples are positive or non-detect for that analyte.	No action is needed as long as the LCS/QC sample was acceptable. If the LCS and the MS/MSD is unacceptable, notify QA dept or follow table as listed above for LCS/QC Samples.	NA
Duplicate Sample (D) (If used)	%RSD > Upper Limit	Samples are positive or non-detect for that analyte.	No action is needed for duplicates.	NA

Revision Page

05/14/15 (15-002)

Revised Section 3 Definitions:

3.1 Method Blank (B)– An analytical control consisting of all reagents, internal standards and surrogate standards, which are carried through the entire analytical procedure. The method blank is used to define the level of laboratory background and reagent contamination.

3.2 Laboratory Control Sample (LCS) - A solution of the method analyte of known concentration. It is used to check either laboratory or instrument performance.

3.3 Matrix Spike (MS) – A sample prepared at the sampling point (i.e., in the field) by adding a known mass of the target analyte to a specified amount of the sample. Field matrix spikes are used, for example, to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency (the analytical bias).

3.4 Matrix Spike Duplicate (MSD) – A second aliquot or sample that is treated the same as the original sample in order to determine the precision of the analytical method.

Revision:

3.8. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.9. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.10. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference. If not enough sample is submitted then an LCS/LCSD is prepared.

3.11. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.12. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.13. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. This is performed when not enough sample is submitted for a duplicate analysis to be performed.

3.14. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

Revised:

10. Quality Control

10.1. For each analytical batch containing up to 10 samples, blanks (deionized water and reagents) are carried throughout the entire sample preparation and analytical process.

Duplicate samples should be processed on a routine basis. A duplicate sample is a sample brought through the whole sample preparation and analytical process. A duplicate sample will be processed with each analytical batch or every 10 samples, whichever is greater. Duplicate acceptance is ± 20% RPD.

10.2. Matrix Spiked (MS) samples should be employed to determine accuracy. A spiked sample should be included with each batch of samples processed and whenever a new sample matrix is being analyzed. A spiked sample will be processed with each analytical batch or every 10 samples, whichever is greater. Matrix spiked sample acceptance is ± 25% Recovery.

11.3. Lab Control Spike (LCS) samples are prepared at a rate of 1 per 10 samples and carried throughout the entire sample preparation and analytical process. LCS acceptance is ± 10 - 20% Recovery.

NOTE: If insufficient sample volume is received to prepare a matrix spike sample, then an LCS/LCSD pair is prepared. Duplicate acceptance is ± 20% RPD.

Revision:

10. Quality Control

10.2. For each analytical batch containing up to 10 samples, blanks (deionized water and reagents) are carried throughout the entire sample preparation and analytical process.

Note: When RB or MB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable RB or MB values have been obtained.

11.2. Matrix Spiked (MS) and Matrix Duplicates (MD) samples should be employed to determine accuracy. A spiked sample should be included with each batch of samples processed and whenever a new sample matrix is being analyzed. A spiked sample will be processed with each analytical batch or every 10 samples, whichever is greater. Matrix spiked sample acceptance is ± 25% Recovery. Duplicate acceptance is ± 20% RPD.

11.3. Lab Control Sample (LCS) and Lab Control Sample Duplicates (LCSD) samples are prepared at a rate of 1 per 10 samples and carried throughout the entire sample preparation and analytical process. LCS acceptance is ± 20% Recovery. LCS/LCSD duplicate acceptance is ± 20% RPD.

SCHNEIDER LABORATORIES GLOBAL, INCORPORATED

analyzing the world

Document #: ME-035-15-002
Original Date: 08/18/10
Revision Date: 08/09/15
Effective Date: 08/14/15

Schneider Laboratories Global, Inc.
Standard Operating Procedure for
Analysis by Atomic Absorption, Furnace Technique

Reviewed by: _____
Department Manager

Approved by: _____
QA/QC Department

Approved by: _____
Laboratory/Technical Director

Schneider Laboratories Global, Inc.
Standard Operating Procedure for the
Analysis by Atomic Absorption, Furnace Technique

METHODS SUMMARIZED IN THIS SOP:
EPA SW-846, Update IV, 7010
Standard Methods, 18th to 20th Editions, SM 3113B
EPA Method 200.9
EPA, other 200-series methods
Related Atomic Absorption, Furnace Technique Methods

1. Purpose

This Standard Operating Procedure (SOP) summarizes the details of analyses performed by Schneider Laboratories Global, Inc. using above-referenced methods for metal analysis by platform furnace atomic absorption. The content of this SOP is taken directly from the published methods, as referenced. Common portions of the individual methods are described in the initial sections of the SOP, followed by sections devoted to information about individual metals.

For greater detail, see the published method. This SOP serves to summarize and simplify all of the methods listed above. This SOP is not intended to replace the need for analysts to refer to the published methods, but rather to summarize the similarities and differences between the referenced methods for atomic absorption, furnace technique.

2. Scope and Application

2.1. This procedure describes the analysis by Atomic Absorption, Furnace Technique.

2.2. Estimated quantitation limits (EQLs) of this method for an individual compound are somewhat instrument dependant. Quantitation limits will be proportionately higher for samples requiring dilutions or when a reduced sample size is used.

2.3. Metals in solution may be readily determined by atomic absorption spectroscopy.

2.4. The method is simple, rapid, and applicable to a large number of metals in drinking, surface, and saline waters and domestic and industrial solid and aqueous wastes.

2.5. While drinking water free of particulate matter may be analyzed directly, ground water, other aqueous samples, EP extracts, industrial wastes, soils, sludges,

sediments, and other solid (solids) wastes require digestion prior to analysis for both total and acid leachable metals.

2.6. Analysis for dissolved elements does not require digestion if the sample has been filtered and acidified.

2.7. This method is restricted to use by, or under the supervision of, analysts experienced in the use of Atomic Absorption, Furnace Technique. Each analyst must demonstrate the ability to generate acceptable results with this method.

2.8. Detection limits, sensitivity, and optimum ranges of the metals will vary with the matrices and models of atomic absorption spectrophotometers.

2.9. The furnace technique is used for greater sensitivity than is generally seen in direct aspiration techniques, but is subject to interference effects not seen in the less-sensitive methodology.

2.10. The Limit of Quantitation (LOQ) for drinking and non-potable water samples are as follows: 1.0 ug/l for Beryllium, Cadmium and Thallium, and 5.0 ug/l for all other metals. The LOQ for soils and sediments takes into effect a final extraction volume of 50 ml and the weight of the sample. The LOQ for air samples takes into effect a final extraction volume of 10 ml and the air volume in liters.

3. Definitions

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.2. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3. Initial Calibration Blank – A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to auto-zero the AA instrument. The ICB is the first calibration blank analyzed after the Initial Calibration Verification analysis.

3.4. Continuing Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard

and is used to auto-zero the AA instrument The CCBs are the analyzed after each Continuing Calibration Verification analysis.

3.5. LLCCV or Low Limit Continuing Calibration Verification – The LLCCV is a second standard measurement to verify the reporting limit of the instrument in question.

3.6. ICV or Initial Calibration Verification – The ICV is a second source standard measured to verify the calibration of the instrument in question.

3.7. CCV or Continuing Calibration Verification – The CCV is a quality measure to ensure the instrument remains in calibration before, after, and during analysis of sample(s).

3.8. Matrix Spike (MS) or Laboratory Fortified Matrix (LFM) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample and that is carried through the entire preparation and analytical process. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference.

3.9. Matrix Spike (MSD) or Laboratory Fortified Matrix Duplicate (LFMD) – A duplicate sample is prepared by adding a known amount of target analyte to a specified amount of the sample and that is carried through the entire preparation and analytical process. Matrix spike duplicates are used to determine the precision of the analysis.

3.10. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.11. Laboratory Control Sample (LCS) or Laboratory Fortified Blank (LFB)- These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.12. Laboratory Control Sample Duplicate (LCSD) or Laboratory Fortified Blank Duplicate (LFBD) : This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. These take the place of MS and MSD for wipes and air samples.

3.13. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

3.14. MDL or Method detection limit. – The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero during analysis.

3.15. LOQ or Limit of Quantitation – The LOQ is the level above which quantitative results may be obtained with a specified degree of confidence. It is also refered to as the Reporting Limit (RL). Limits of quantitation are matrix, method, and analyte specific.

4. Summary of Method

4.1. Although methods have been reported for the analysis of solids by atomic absorption spectroscopy, the technique generally is limited to metals in solution or solubilized through some form of sample processing.

4.2. Preliminary treatment of waste water, ground water, EP extracts, and industrial waste is always necessary because of the complexity and variability of sample matrix. Solids, slurries, and suspended material must be subjected to a solubilization process before analysis. This process may vary because of the metals to be determined and the nature of the sample being analyzed. Solubilization and digestion procedures are presented in Method SW-846, Chapter 3. See SLGi SOPs on acid digestion.

4.3. When using the furnace technique in conjunction with an atomic absorption spectrophotometer, a representative aliquot of a sample is placed in the graphite tube in the furnace, evaporated to dryness, charred, and atomized.

4.4. As a greater percentage of available analyte atoms is vaporized and dissociated for absorption in the tube rather than the flame, the use of smaller sample volumes or detection of lower concentrations of elements is possible.

4.4.1. The principle is essentially the same as with direct aspiration atomic absorption, except that a furnace, rather than a flame, is used to atomize the sample.

4.5. Radiation from a given excited element is passed through the vapor containing ground-state atoms of that element.

4.5.1. The intensity of the transmitted radiation decreases in proportion to the amount of the ground-state element in the vapor.

4.6. The metal atoms to be measured are placed in the beam of radiation by increasing the temperature of the furnace, thereby causing the injected specimen to be volatilized.

4.7. A monochromator isolates the characteristic radiation from the hollow cathode lamp or electrodeless discharge lamp, and a photosensitive device measures the attenuated transmitted radiation.

5. Interferences

5.1 Although the problem of oxide formation is greatly reduced with furnace procedures because atomization occurs in an inert atmosphere, the technique is still subject to chemical interferences.

5.2 The composition of the sample matrix can have a major effect on the analysis. It is those effects which must be determined and taken into consideration in the analysis of each different matrix encountered.

5.3 To help verify the absence of matrix or chemical interference, the serial dilution technique (MSA SOP) may be used.

5.4. Those samples which indicate the presence of interference should be treated in one or more of the following ways.

5.5. When the sample is beyond the highest point of the curve the sample is diluted to fall within the curve.

5.6. Sample is diluted based upon the concentration of the sample being tested.

5.7. Modify the sample matrix either to remove interferences or to stabilize the analyte. Examples are the addition of ammonium nitrate to remove alkali chlorides and the addition of ammonium phosphate to retain cadmium. The mixing of hydrogen with the inert purge gas has also been used to suppress chemical interference. The hydrogen acts as a reducing agent and aids in molecular dissociation. Since mixing hydrogen with the inert purge gas is commonly used to reduce chloride interferences, it is not needed in most cases. Samples received with a turbidity of < 1 are not digested (per EPA Method 200.9) so no chloride interferences exist

5.7.1. Drinking water samples are tested for sample turbidity using a turbidimeter. Results are recorded on the analysis worksheet as <1 or >1. Samples with a turbidity of >1 must be acid digested before analysis. Samples with a turbidity of <1 may be analyzed as received.

5.8. Analyze the sample by method of standard additions while noticing the precautions and limitations of its use.

5.9. Gases generated in the furnace during atomization may have molecular absorption bands encompassing the analytical wavelength. When this occurs, use either background correction or choose an alternate wavelength. Background correction may also compensate for nonspecific broad-band absorption interference.

5.10. Continuum background correction cannot correct for all types of background interference. When the background interference cannot be compensated for, chemically remove the analyte or use an alternate form of background correction, e.g., Zeeman background correction.

5.11. Cross-contamination and contamination of the sample can be major sources of error because of the extreme sensitivities achieved with the furnace.

5.12. The sample preparation work area should be kept clean.

5.13. Special attention should be given to reagent blanks in both analysis and in the correction of analytical results.

6. Safety

6.1. This SOP does not address all safety issues associated with its use. The laboratory is responsible for maintain a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals included in this method. A reference file of material data safety sheets (MSDS) is available to all personnel involved in these analyses.

6.2. Equipment, goggles, or face shield must be used when employees are using solvents to rinse or clean glassware.

6.3. Work areas should be isolated and posted with signs. Glassware and tools should be segregated.

6.4. All digestion procedures are conducted under a lighted fume hood.

6.5. Refer to all safety guidelines outlined in "SOP for Safety in Metals Analysis" and the SLGi manuals for Hazard Communication and Chemical Hygiene.

6.6. Solvent and waste containers must be kept closed unless transfers are being made.

6.7. In the event of a known or potential problem with the safety or health of an individual working in the laboratory, all work must be stopped. The situation must be reported to a laboratory supervisor or the laboratory manager immediately.

7. Beryllium by EPA-846 7010/SM 3113B/EPA 200.9/EPA 210.2

The long residence time and high concentrations of the atomized sample in the optical path of the graphite furnace can result in severe physical and chemical interferences. Furnace parameters must be optimized to minimize these effects.

In addition to the normal interferences experienced during graphite furnace analysis, beryllium analysis can suffer from severe nonspecific absorption and light scattering caused by matrix components during atomization. Simultaneous background correction is required to avoid erroneously high results.

NOTE: The recommended concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above-recommended settings.

8. Cadmium by EPA-846 7010/SM 3113B/EPA 200.9/EPA 213.2.

In addition to the normal interferences experienced during graphite furnace analysis, cadmium analysis can suffer from severe nonspecific absorption and light scattering caused by matrix components during atomization. Simultaneous background correction is required to avoid erroneously high results.

Excess chloride may cause premature volatilization of cadmium. Ammonium phosphate used as a matrix modifier minimizes this loss. Other modifiers may be used as long as it is documented with the type of suppressant and concentration.

Many plastic pipet tips (yellow) contain cadmium. Use "cadmium- free" tips.

NOTE: The recommended concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time

periods than the above-recommended settings.

9. Chromium by EPA SW-846 7010/SM 3113B/EPA200.9/EPA 218.2

Low concentrations of calcium and/or phosphate may cause interferences; at concentrations above 200 mg/L, calcium's effect is constant and eliminates the effect of phosphate. Calcium nitrate is therefore added to ensure a known constant effect.

Nitrogen should not be used as the purge gas because of a possible CN band interference.

Background correction may be required because nonspecific absorption and scattering can be significant at the analytical wavelength. Background correction with certain instruments may be difficult at this wavelength due to low-intensity output from hydrogen or deuterium lamps. Consult the specific instrument manufacturer's literature for details.

NOTE: The recommended concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above-recommended settings.

10. Lead by EPA SW-846 7010/SM 3113B/EPA 200.9/EPA 239.2

Background correction is required.

If poor recoveries are obtained, a matrix modifier may be necessary. Add 10 uL of phosphoric acid (Paragraph 5.3) to 1 mL of prepared sample in the furnace sampler cup and mix well.

NOTE: The recommended concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above-recommended settings.

11. Manganese by EPA SW-846 7010/SM 3113B/EPA 200.9/EPA 243.2

Background correction must be used.

NOTE: The recommended concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time

periods than the above-recommended settings.

12. Nickel by EPA SW-846 7010/SM 3113B/EPA 200.9/EPA 249.2

In addition to the normal interferences experienced during graphite furnace analysis, nickel analysis can suffer from severe nonspecific absorption and light scattering caused by matrix components during atomization. Background correction is strongly recommended.

Severe memory effects for nickel may occur in graphite furnace tubes used for arsenic or selenium analysis by Methods 7060 and 7740, resulting from the use of a nickel nitrate matrix modifier in those methods. Use of graphite furnace tubes and contact rings for nickel analysis that are separate from those used for arsenic and selenium analyses is strongly recommended.

For basic apparatus, see Section 4.0 of Method 7000. Due to the widespread use of a nickel-nitrate modifier for atomic absorption analyses, a dedicated instrument is recommended when conducting analyses by this method. If a dedicated instrument is not available, the furnace tubes and contact rings should be changed prior to using this methodology.

NOTE: The recommended concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above-recommended settings.

13. Selenium by EPA 200.9

For the analysis of Selenium by EPA 200.9, pure argon gas must be used, not the mixture of 95% Argon + 5 % Hydrogen.

14. Silver by EPA SW-846 7010/SM 3113B/EPA 200.9/EPA 272.2

Method 7761 is an atomic absorption procedure approved for determining the concentration of silver in wastes, mobility procedure extracts, soils, and ground water. All samples must be subjected to an appropriate dissolution procedure.

In addition to the normal interferences experienced during graphite furnace analysis, silver analysis can suffer from severe nonspecific absorption and light scattering caused by matrix components during atomization. Simultaneous background correction must be employed to avoid erroneously high results.

If the analyte is not completely volatilized and removed from the furnace during atomization, memory effects will occur. If this situation is detected, operating the furnace at higher atomization temperatures should clean the tube.

Silver nitrate solutions are light sensitive and have the tendency to plate out on container walls. Thus, silver standards should be stored in brown bottles.

Silver chloride is insoluble; therefore, hydrochloric acid should be avoided unless the silver is already in solution as a chloride complex.

NOTE: The recommended concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above-recommended settings.

Sample preparation - Aqueous samples should be prepared according to the following steps. The applicability of a sample preparation technique to a new matrix type must be demonstrated by analyzing spiked samples and/or relevant standard reference materials.

Preparation of aqueous samples

1. Transfer a representative aliquot of the well-mixed sample to a beaker and add 3 mL of concentrated trace HNO_3. Cover the beaker with a watch glass. Place the beaker on the hot plate and cautiously evaporate to near dryness, making certain that the sample does not boil. DO NOT BAKE. Cool the beaker and add another 3-mL portion of concentrated HNO_3. Cover the beaker with a watch glass and return to the hot plate. Increase the temperature of the hot plate (95ºC ± 5ºC) so that a gentle reflux action occurs.

<u>NOTE</u>: If the sample contains thiosulfates, this step may result in splatter of sample out of the beaker as the sample approaches dryness. This has been reported to occur with certain types of photographic wastes.

2. Continue heating, adding additional acid, in increments of 1.5 mL, until the digestion is complete (generally indicated when the digestate is light in color or does not change in appearance with continued refluxing). Again, evaporate to near dryness and cool the beaker. Add a small quantity of HNO_3 so that the final dilution contains 0.5% (v/v)

HNO_3 and warm the beaker to dissolve any precipitate or residue resulting from evaporation.

3. Wash down the beaker walls and watch glass with water and, when necessary, filter the sample to remove silicates and other insoluble material that could clog the

nebulizer. Adjust the volume to some predetermined value based on the expected metal concentrations. The sample is now ready for analysis.

4. If plating out of AgCl is suspected, the precipitate can be redissolved by adding cyanogen iodide to the sample. This can be done only after digestion and after neutralization of the sample to a pH > 7 to prevent formation of toxic cyanide under acid conditions. In this case, do not adjust the sample volume to the predetermined value until the sample has been neutralized to pH > 7 and cyanogen iodide has been added. If cyanogen iodide addition to the sample is necessary, then the standards must be treated in the same manner. Cyanogen iodide must not be added to the acidified silver standards. New standards must be made, as directed in Step 5.2, except that the acid addition step must be omitted. For example, to obtain a 100 mg/L working standard, transfer 10 mL of stock solution to a small beaker. Add water to make about 70 mL. Make the solution basic (pH above 7) with NH_4OH. Rinse the pH meter electrodes into the solution with water. Add 1 mL cyanogen iodide and allow to stand 1 hour. Transfer quantitatively to a 100-mL volumetric flask and bring to volume with water.

CAUTION: CNI reagent can be added only after digestion to prevent formation of toxic cyanide under acidic conditions. CNI reagent must not be added to the acidified silver standards.

NOTE: Once the sample or sample aliquot has been treated with the CNI reagent and diluted per instruction, the solution has a cyanide concentration of approximately 260 mg/L. A solution of that cyanide concentration must be considered a potential hazardous waste and must be disposed of using an approved safety plan in accordance with local authority requirements. Until such time that a detailed disposal plan can be fully documented and approved, the use of the CNI reagent should be avoided.

5. The 328.1-nm wavelength line and background correction shall be used.

6. Following the manufacturer's operating instructions for all other spectrophotometer parameters.

7. Furnace parameters suggested by the manufacturer should be employed as guidelines. Since temperature-sensing mechanisms and temperature controllers can vary between instruments or with time, the validity of the furnace parameters must be periodically confirmed by systematically altering the furnace parameters while analyzing a standard. In this manner, losses of analyte due to higher than necessary temperature settings or losses in sensitivity due to less than optimum settings can be minimized. Similar verification of furnace parameters may be required for complex sample matrices.

8. Inject a measured uL aliquot of sample into the furnace and atomize. If the concentration found is greater than the highest standard, the sample should be diluted in the same acid matrix and reanalyzed. The use of multiple injections can improve accuracy and help detect furnace pipetting errors.

9. Either (1) run a series of silver standards and construct a calibration curve by plotting the concentrations of the standards against the absorbances or (2) for the method of standard additions, plot added concentration versus abosrbance. For instruments that read directly in concentration, set the curve corrector to read out the proper concentration.

10. Analyze, by the method of standard additions, all EP extracts, all samples analyzed as part of a delisting petition, and all samples that suffer from matrix interferences.

11. Calculate metal concentrations by (1) the method of standard additions, or (2) from a calibration curve, or (3) directly from the instrument's concentration readout. All dilution or concentration factors must be taken into account. Concentrations reported for multiphased samples must be appropriately qualified.

15. Thallium by EPA SW-846 7010/SM 3113B/EPA 200.9/EPA 279.2

Background correction is required.

Hydrochloric acid or excessive chloride will cause volatilization of thallium at low temperatures. Verification that losses are not occurring, by spiked samples or standard additions, must be made for each sample matrix.

Palladium is a suitable matrix modifier for thallium analysis.

NOTE: The recommended concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above-recommended settings.

16. Apparatus and Materials

16.1. 600 A Analyst Perkin Elmer Atomic Absorption Spectrometer

16.2. AS800 Perkin Elmer Auto Sampler

16.3. AA Accessory Cooling System Perkin Elmer

16.4. THGA Graphite Tubes Perkin Elmer

16.5. Eppendorf Research Pipet 10-100 µL
Eppendorf Research Pipet 100-1000 µL
Disposable Pipet tips

16.6. pH indicator strips pH (0-14)

16.7. 2100P Turbidmeter

17. Reagents and Standards

17.1. Concentrated trace Nitric Acid

17.2. De-Ionized water

17.3 GFAA Rinse Solution – 0.5% 10ml HNO_3 + 0.25% Trixon-X-100 (5 ml)

17.3.1 Prepare 10 ml of trace HNO_3 and 5 ml of Trixon–X–100 and dilute to a final volume of 2 liters using DI H_2O.

17.4 Stock Solution – 1.0 ppm (µg/ml)

17.4.1 Prepare 1 ml of 100 ppm standard solution + 1 ml of trace HNO_3 and dilute to final volume of 100 ml in a volumetric bottle or flask.

17.5 Table below shows possible range of calibration standards: A minimum of three calibration standards must be used. The low level standard used varies from analyte to analyte.

Calibration Level	Amount trace HNO_3 Added (mL)	Amount of 10 µg/mL Stock Standard Added (µL)	Final Volume (mL)	Final Conc. (µg/L)
1	1	100	100	1
2	1	200	100	2
3	1	300	100	3
4	1	500	100	5
5	1	1000	100	10
6	1	2000	100	20
7	1	4000	100	40

17.6 Second Source Pb – A second source is used to prepared the ICV for concentrations of 2, 5, 10 and 20 using the same process as above.

17.7 Matrix Modifiers for Pb $Mg(NO_3)_2$ is commercially purchased.

17.8 Matrix Modifier for $Mg(NO_3)_2$ is prepared by adding 300 mg of Magnesium Nitrate and adjust with DI H_2O to 100 ml volume. $Mg(NO_3)_2 \times 6H_2O$

17.9 Matrix Spike – 10 µl of 1.0ppm to 990 µl of sample chosen as MS to a final volume of 1 ml.

17.9.1 For Silver – AG = 5 spike. Add 1 ml of 1.0ppm stock is added to 10 ml DI H_2O. Take 50 µl from the spike + 950 ml of sample.

17.9.2 For Beryllium and Cadmium – Be, Cd = 2 spike. Add 1 ml of 1.0ppm stock is added to 10 ml DI H_2O. Take 20 µl from the spike + 980 ml of sample.

17.10 LCS – Same solution used as the MS spiking solution is used as LCS spiking solution.

18. Sample Collection, Preservation, and Handling

18.1 SLI does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

18.2 All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

18.3 Aqueous samples must be acidified to a pH of <2 with HNO_3. The pH of all aqueous samples must be tested immediately prior to aliquoting for processing or "direct analysis" to ensure the sample has been properly preserved. If properly acid preserved, the sample can be held up to six months before analysis.

18.4 Non-aqueous samples should be refrigerated at $4^oC \pm 2^oC$ upon receipt. There is no established holding time limitation for solid samples.

18.5 Samples must be digested and analyzed within 180 days of sample collection.

19. Procedure

19.1 Samples are received via login and stored at room temperature in the Graphite furnace room.

19.2 The sample arrives collected in a 1L plastic bottle.

19.3 When ready to analyze, the pH of the sample is checked.

19.3.1 If preserved with Nitric Acid the pH must be less than 2.

19.4. If the pH is greater than 2 or the sample is not preserved with Nitric Acid, the sample must first be preserved with Nitric Acid. Samples not preserved before laboratory receipt are preserved by addition of 100 µl to 1 ml of Trace Metal Nitric Acid. The volume of acid added is dependent on the sample volume. As a guideline: 100 µl of acid is added to 100 ml of sample, 500 µl is added to 500 ml of sample, 1000 µl or 1ml is added to 1000 ml or 1L of sample. The volume of acid added is adjusted accordingly.

19.4.1. A record of preservation is made on the client's worksheet, if done. The pH is recorded on the worksheet as "<2" or ">2".

19.4.2. The sample must sit for a minimum of 18 hours, before analysis.

19.4.3. If after 18 hours and the sample needs further preservatives; it is then preserved for another 18hours, after the 2nd preservation, if pH not less than 2 sample is then digested.

19.4.4. If samples are not preserved before shipment to the lab, they are noted in the worksheet as samples not preserved.

19.5. Drinking water samples are tested for sample turbidity using a turbid-meter. Results are recorded on the analysis worksheet as <1 or >1.
Samples with a turbidity of >1 must be acid digested before analysis and a spike is digested with it. Samples with a turbidity of <1 may be analyzed as received

19.6. For digestion refer to the SOP for Acid Digestion of Aqueous Samples for Analysis by Graphite Furnace, Atomic Absorption.

19.7. Inject a measured micro-liter aliquot of sample into the furnace and atomize. If the concentration found is greater than the highest standard, the sample should be diluted in the same acid matrix and reanalyzed.

19.8. The curve has to meet the criteria for the correlation coefficient; it must be a minimum of .995.

19.8.1. If the correlation coefficient does not meet the minimum, the curve is rerun.

19.8.2. If the correlation coefficient meets the standard then the sample is ready to run.

19.9. The run results give the concentration of the sample.

19.10. The concentration of the sample has to fall below the highest point of the curve**.**

19.11. If the criteria are met by the samples, the results are reported.

19.12. If the criteria is not met and the point does not fall below the highest point on the curve, the sample must be diluted to fall between the lowest and highest points of the curve.

19.13. Once the sample falls within the highest and lowest points the results can be reported.

19.14. A check standard should be run after every 10 samples injections. Standards are run in part to monitor the life and performance of the graphite tube.

20. Quality Control

20.1. Evaluating Graphite Furnace and system performance

The analyst's expertise in performing the Furnace technique is a critical element in the successful performance of the Graphite Furnace methods. Successful generation of data requires suitable preparation and analysis methods and an experienced staff to use these methods.

20.2. Calibration Protocol

20.2.1 A calibration is run at the beginning of each set of analyses.

20.2.2 The calibration curve usually consists of at least three points and a calibration blank. However, more calibration points may be analyzed as deemed necessary.

20.2.3 The calibration coefficient must be at least 0.995 or higher. The linearity of the curve must not be forced thru zero. If this evaluation criterion is not met, analysis must be stopped and recalibration performed. If the recalibration fails, the standards must be re-made and/or the equipment must be evaluated.

20.3. See the SOP for Metals Quality Control, or the published method, or EPA SW-846 Chapter 1, for information on quality control.

20.4. Daily QC requirements that are run after the curve are LRB QC, LFB QC, ICV QC, CCV QC, Cal Blank QC, and two spike QCs after every 10 samples. The concentrations of the QC depend on the specific metal.

20.5 Duplicate samples should be processed on a routine basis. A duplicate sample is a sample brought through the whole sample preparation and analytical process. Duplicate acceptance is ± 20% RPD.

20.6 For each analytical batch containing 20 or fewer samples, a (LRB) laboratory reagent blank or (MB) method blanks (deionized water and reagents) are carried throughout the entire sample preparation and analytical process.

Note: When LRB or MB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable LRB or MB values have been obtained.

20.7 Matrix Spike

20.7.1 Matrix Spike are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for soil and solids or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

20.7.2 Matrix Spikes are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MS sample, the laboratory will add a disclaimer to the final report.

20.7.3 The %R for the matrix spike should be between 85%-115%. If the recovery of the MS is outside of these limits, a post-digestion spike is performed on the sample. The recovery of the post-spike should be between 90%-110%.

20.8 Matrix Spike Duplicates

20.8.1 Matrix spike duplicates are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

20.8.2 Matrix spike duplicates are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MSD sample, the laboratory will add a disclaimer to the final report.

20.8.3 The RPD of the MS/MSD should be +/- 10%.

20.9 LCS or LFB Samples

20.9.1 The LCS is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

20.9.1 LCS samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCS takes the place of the MS for wipes and airs.

20.9.2 LCS samples are digested and handled in the same manner as the samples.

20.9.3 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%.

20.10 LCSD or LFBD Samples

20.10.1 The LCSD is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

20.10.2 LCSD samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCSD takes the place of the MSD for wipes and airs.

20.10.3 LCS samples are digested and handled in the same manner as the samples.

20.10.4 The RPD of the LCS/LCSD should be between +/- 20%.

20.11 Initial Calibration Verification

20.11.1 After the daily calibration, the initial calibration verification (ICV) standard is analyzed.

20.11.2 The ICV standard is prepared from a second source at 1000 µg/L, which is almost at the mid-range of the calibration curve.

20.11.3 The percent recovery (%R) of the ICV standard must be between 95%-105% for Aqueous and 90%-110% for Solids. If the second source fails calibration criteria, recalibration is necessary.

20.11.4 After the ICV is analyzed, an initial calibration blank (ICB) is analyzed. Target analytes should not be detected in the ICB at a concentration greater than the reporting limit.

20.12 Continuing Calibration Verification (CCV)

20.12.1 A CCV is run once every 10 samples.

20.12.2 The concentration of the CCV is at 1000 µg/L, which is the mid-range of the calibration curve for most analytes. However, higher concentrations may be analyzed for target analytes which have a higher reporting limit.

20.12.3 The %R of the CCV must be within 90%-110%.

20.12.4 After the CCV is analyzed, a continuing calibration blank (CCB) is analyzed. Target analytes should not be detected in the CCB at a concentration greater than the reporting limit.

20.13 Low-Level Continuing Calibration Verificaiton (LLCCV)

20.12.1 The LLCCV the analytes is the low level calibration standard and is analyzed after the ICB.

20.12.2 The percent recovery of the LLCCV is between 70-130%.

20 Method Performance

21.1 The above method is a modification of several EPA and Standard Method methods on which it is based, although much of the text of this SOP is verbatim.

21.2 . The method with its modifications has been used for all samples of the applicable matrix at SLGi and has been verified with quality control samples, both in-house and those which are part of nationally-recognized proficiency testing programs.

21.2 The method detect ion limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations actually achieved will vary depending on instrument sensitivity and matrix effects.

21.3 The analytical group must generate a valid MDL for each individual analyte of interest. The MDL must be below the reporting limit or low level standard for each analyte. The procedure for determination of the MDL is given in 40 CFR Part 136, Appendix B.

21.4 MDLs are determined annually per matrix. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

22 Data Analysis and Calculations

22.1 The quantitative values must be reported in the appropriate units of milligrams per kilogram (mg/kg) or milligrams per liter (mg/l) as per analysis method.

22.2 If dilutions were performed, the appropriate corrections must be applied to the sample values.

12.3. Results must be reported in units commensurate with their intended use and all dilutions must be taken into account when computing final results.

22. Pollution Prevention

22.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities exist for pollution prevention in the laboratory.

22.2 Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed of. The threat to the environment from solvents and/or reagents used in this method may be minimized when recycled or disposed of properly.

23. Waste Management

23.1. All waste will be disposed in accordance with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench

operations. Compliance with all sewage discharge permits and regulations is also required.

23.2. The storage and disposal of hazardous waste is further detailed in the SLGi SOP for The Storage and Disposal of Hazardous Waste, AD-043.

23.3. For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel," and "Less is Better: Laboratory Chemical Management for Waste Reduction," both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036.

24. Handling Non-Conformance Data

24.1 Refer to Table 3: Corrective action flowchart for Non-Conformance handling information.

25. References

25.1. EPA SW-846 Methods

25.2. Standard Methods, 18th to 20th Editions, SM 3113B

25.3. EPA Method 200.9 Method

25.4. EPA, other 200-series methods

25.5. Related Atomic Absorption, Furnace Technique Methods

Table 3: Corrective Action Flowchart

Sample Type	Test Result	Condition	Corrective Action	Note
Matrix Blank (B)	Blank Reading> Reporting Limit (RL)	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet and notify QA dept.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Air and wipe samples are consumed during extraction. In this case, notify QA dept.
Laboratory Control Sample / QC Sample (LCS)	LCS > Upper Limit	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken. Note what the %R is on the internal tracking sheet.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on internal tracking sheet and disclaimer on the final report. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed Air and wipe samples are consumed during extraction. In this case, notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
	LCS < Lower Limit	Samples are non-detect for that analyte	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Since there is no more wipe or air sample, re-extraction cannot occur so notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Disclaimer on the final report.	
Matrix Spike (MS) and MS Duplicate (MSD)	MS/MSD > or < QC Limit	Samples are positive or non-detect for that analyte.	If the MS/MSD is unacceptable, notify QA dept or follow table as listed above for LCS/QC Samples. A disclaimer is put on the final report.	NA
Duplicate Sample (D) (If used)	%RSD > Upper Limit	Samples are positive or non-detect for that analyte.	Duplicate fails then a disclaimer is placed on the final report. QC is notified of failure.	NA

Revision Page

08/09/2015 15-002

Added the following sections to the SOP:

2.10. The Limit of Quantitation (LOQ) for drinking and non-potable water samples are as follows: 1.0 ug/l for Beryllium, Cadmium and Thallium, and 5.0 ug/l for all other metals. The LOQ for soils and sediments takes into effect a final extraction volume of 50 ml and the weight of the sample. The LOQ for air samples takes into effect a final extraction volume of 10 ml and the air volume in liters.

Revised the following section:

3. Definitions

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.2. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference. If not enough sample is submitted then an LCS/LCSD is prepared.

3.4. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.5. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.6. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. This is performed when not enough sample is submitted for a duplicate analysis to be performed.

3.7. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

3.8. RLV or LLCCV – Is a second standard measurement to verify the reporting limit of the instrument in question.

3.9. ICV or Initial Calibration Verification – The ICV is a second source standard measured to verify the calibration of the instrument in question.

3.10. CCV or Continuing Calibration Verification – The CCV is a quality measure to ensure the instrument remains in calibration before, after, and during analysis of sample(s).

Revision:

3. Definitions

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of reagent contamination.

3.2. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3. Initial Calibration Blank – A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to auto-zero the AA instrument. The ICB is the first calibration blank analyzed after the Initial Calibration Verification analysis.

3.4. Continuing Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to auto-zero the AA instrument The CCBs are the analyzed after each Continuing Calibration Verification analysis.

3.5. LLCCV or Low Limit Continuing Calibration Verification – The LLCCV is a second standard measurement to verify the reporting limit of the instrument in question.

3.6. ICV or Initial Calibration Verification – The ICV is a second source standard measured to verify the calibration of the instrument in question.

3.7. CCV or Continuing Calibration Verification – The CCV is a quality measure to ensure the instrument remains in calibration before, after, and during analysis of sample(s).

3.8. Matrix Spike (MS) or Laboratory Fortified Matrix (LFM) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample and that is carried through the entire preparation and analytical process. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference.

3.9. Matrix Spike (MSD) or Laboratory Fortified Matrix Duplicate (LFMD) – A duplicate sample is prepared by adding a known amount of target analyte to a specified amount of the sample and that is carried through the entire preparation and analytical process. Matrix spike duplicates are used to determine the precision of the analysis.

3.10. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method. If not enough sample is submitted then an LCS/LCSD is prepared.

3.11. Laboratory Control Sample (LCS) or Laboratory Fortified Blank (LFB)- These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.12. Laboratory Control Sample Duplicate (LCSD) or Laboratory Fortified Blank Duplicate (LFBD) : This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. These take the place of MS and MSD for wipes and air samples.

3.13. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

3.14. MDL or Method detection limit. – The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero during analysis.

3.15. LOQ or Limit of Quantitation – The LOQ is the level above which quantitative results may be obtained with a specified degree of confidence. It is also refered to as the Reporting Limit (RL). Limits of quantitation are matrix, method, and analyte specific.

Revised the following section:

20. <u>Quality Control</u>

20.1. Evaluating Graphite Furnace and system performance

The analyst's expertise in performing the Furnace technique is a critical element in the successful performance of the Graphite Furnace methods. Successful generation of data requires suitable preparation and analysis methods and an experienced staff to use these methods.

20.2. See the SOP for Metals Quality Control, or the published method, or EPA SW-846 Chapter 1, for information on quality control.

20.3. Daily QC requirements that are run after the curve are LRB QC, LFB QC, ICV QC, CCV QC, Cal Blank QC, and two spike QCs after every 10 samples. The concentrations of the QC depend on the specific metal. Acceptance Limits for ICV and CCV QC is ± 5% Recovery.

20.4 Duplicate samples should be processed on a routine basis. A duplicate sample is a sample brought through the whole sample preparation and analytical process. Duplicate acceptance is ± 20% RPD.

20.5 For each analytical batch containing 20 or fewer samples, a (LRB) laboratory reagent blank or (MB) method blanks (deionized water and reagents) are carried throughout the entire sample preparation and analytical process.

Note: When LRB or MB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable LRB or MB values have been obtained.

20.5 Matrix Spiked (MS) samples should be employed to determine accuracy. A spiked sample should be included with each batch of samples processed and whenever a new sample matrix is being analyzed. Matrix spiked sample acceptance is ± 25% Recovery.

20.6. Laboratory Control Spike (LCS/LCSD) samples are prepared and carried throughout the entire sample preparation and analytical process. LCS acceptance is ± 20% Recovery. LCS/LCSD duplicate acceptance is ± 10% RPD.

NOTE: If insufficient sample volume is received to prepare a bulk spike sample, then and LCS/LCSD pair is prepared.

Revision:

20. Quality Control

20.1. Evaluating Graphite Furnace and system performance

The analyst's expertise in performing the Furnace technique is a critical element in the successful performance of the Graphite Furnace methods. Successful generation of data requires suitable preparation and analysis methods and an experienced staff to use these methods.

20.2. Calibration Protocol

20.2.4 A calibration is run at the beginning of each set of analyses.

20.2.5 The calibration curve usually consists of at least three points and a calibration blank. However, more calibration points may be analyzed as deemed necessary.

20.2.6 The calibration coefficient must be at least 0.995 or higher. The linearity of the curve must not be forced thru zero. If this evaluation criterion is not met, analysis must be stopped and recalibration performed. If the recalibration fails, the standards must be re-made and/or the equipment must be evaluated.

20.3. See the SOP for Metals Quality Control, or the published method, or EPA SW-846 Chapter 1, for information on quality control.

20.4. Daily QC requirements that are run after the curve are LRB QC, LFB QC, ICV QC, CCV QC, Cal Blank QC, and two spike QCs after every 10 samples. The concentrations of the QC depend on the specific metal.

20.5 Duplicate samples should be processed on a routine basis. A duplicate sample is a sample brought through the whole sample preparation and analytical process. Duplicate acceptance is ± 20% RPD.

20.6 For each analytical batch containing 20 or fewer samples, a (LRB) laboratory reagent blank or (MB) method blanks (deionized water and reagents) are carried throughout the entire sample preparation and analytical process.

Note: When LRB or MB values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable LRB or MB values have been obtained.

20.7 Matrix Spike

20.7.1 Matrix Spike are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for soil and solids or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

20.7.2 Matrix Spikes are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MS sample, the laboratory will add a disclaimer to the final report.

20.7.3 The %R for the matrix spike should be between 85%-115%. If the recovery of the MS is outside of these limits, a post-digestion spike is performed on the sample. The recovery of the post-spike should be between 90%-110%.

20.8 Matrix Spike Duplicates

20.8.1 Matrix spike duplicates are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

20.8.2 Matrix spike duplicates are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MSD sample, the laboratory will add a disclaimer to the final report.

20.8.3 The RPD of the MS/MSD should be +/- 10%.

20.9 LCS or LFB Samples

20.9.1 The LCS is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

20.13.1 LCS samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCS takes the place of the MS for wipes and airs.

20.13.2 LCS samples are digested and handled in the same manner as the samples.

20.13.3 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%.

20.10 LCSD or LFBD Samples

20.10.1 The LCSD is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

20.10.2 LCSD samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCSD takes the place of the MSD for wipes and airs.

20.10.3 LCS samples are digested and handled in the same manner as the samples.

20.10.4 The RPD of the LCS/LCSD should be between +/- 20%.

20.11 Initial Calibration Verification

20.11.1 After the daily calibration, the initial calibration verification (ICV) standard is analyzed.

20.11.2 The ICV standard is prepared from a second source at 1000 µg/L, which is almost at the mid-range of the calibration curve.

20.11.3 The percent recovery (%R) of the ICV standard must be between 95%-105% for Aqueous and 90%-110% for Solids. If the second source fails calibration criteria, recalibration is necessary.

20.11.4 After the ICV is analyzed, an initial calibration blank (ICB) is analyzed. Target analytes should not be detected in the ICB at a concentration greater than the reporting limit.

20.12 Continuing Calibration Verification (CCV)

20.12.1 A CCV is run once every 10 samples.

20.12.2 The concentration of the CCV is at 1000 µg/L, which is the mid-range of the calibration curve for most analytes. However, higher concentrations may be analyzed for target analytes which have a higher reporting limit.

20.12.3 The %R of the CCV must be within 90%-110%.

20.12.4 After the CCV is analyzed, a continuing calibration blank (CCB) is analyzed. Target analytes should not be detected in the CCB at a concentration greater than the reporting limit.

20.13 Low-Level Continuing Calibration Verificaiton (LLCCV)

20.12.3 The LLCCV the analytes is the low level calibration standard and is analyzed after the ICB.

20.12.4 The percent recovery of the LLCCV is between 70-130%.

Revised the following section:

18. <u>Sample Collection, Preservation, and Handling</u>

18.1. SLGi does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

18.2. Samples must be analyzed within 30 days of sample collection.

18.3. Samples are usually stored at room temperature until analysis.

Revision:

18. <u>Sample Collection, Preservation, and Handling</u>

18.1 SLI does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

18.2 All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

18.3 Aqueous samples must be acidified to a pH of <2 with HNO_3. The pH of all aqueous samples must be tested immediately prior to aliquoting for processing or "direct analysis" to ensure the sample has been properly preserved. If properly acid preserved, the sample can be held up to six months before analysis.

18.4 Non-aqueous samples should be refrigerated at $4^oC \pm 2^oC$ upon receipt. There is no established holding time limitation for solid samples.

18.5 Samples must be digested and analyzed within 180 days of sample collection.

Schneider Laboratories Global, Inc.
Standard Operating Procedure for ICP-OES

Reviewed by: _____
Department Manager

Approved by: _____
QA/QC Department

Approved by: _____
Laboratory/Technical Director

Schneider Laboratories Global, Inc.
Standard Operating Procedure for ICP-OES

1. Scope and Application

1.1. Inductively Coupled Plasma (ICP) - Optima Emission Spectrometer (OES) is used to determine trace metals in solution. With the exception of some drinking water samples, all aqueous and solid samples are acid digested prior to analysis.

1.2. This method describes the procedure for the setup, use, and adjustment of the Perkin Elmer ICP –OES/ iCAP 6300. Information in this method is taken from the Perkin Elmer Emission Spectrometer manuals. These manuals should be referenced when additional information is needed.

1.3. This method is based on SW-846 methods 6010C (Revision 3, February 2007), Standard Methods 3120B (20th Edition), EPA Method 200.7 (Revision 4.4), NIOSH 7300 (Issue 3, March 2003) 40CFR Part 50 Appendix G, with modifications for client specific analysis. This SOP covers the following matrices: drinking water, wastewater, soils, sediments, paint, bulk, wipe and air samples.

1.4. Use of this method is restricted to use by, or under the supervision of, spectroscopists appropriately experienced and trained in the correction of spectral, chemical, and physical interferences. Each analyst must demonstrate the ability to generate acceptable results with this method.

1.5. The LOQ for drinking and non-potable water samples are as follows: 0.20 mg/l for Calcium, Magnesium, Potassium and Sodium, 0.10 mg/l for Chromium, Boron, Copper, Iron and Zinc and 0.040 mg/l for all other metals. The LOQ for soils and sediments takes into effect a final extraction volume of 50 ml and the weight of the sample. The LOQ for air samples takes into effect a final extraction volume of 10 ml and the air volume in liters.

2. Summary of Method

2.1. Prior to analysis, samples must be solubilized or digested using the appropriate sample preparation methods. When analyzing groundwater or drinking water for dissolved constituents, acid digestion is not necessary if the samples are filtered and acid preserved prior to analysis.

2.2. Samples are aspirated by a peristaltic pump through a plasma torch. In the plasma, the sample is atomized and electrons are excited. When the electrons return from their excited state, a photon is emitted. This light then travels through a series of mirrors and filters, strikes a

grating, then an electronic diode. The signal is then translated to intensity ratios that are dependent on the concentration of the element in solution.

2.3. Background correction is required for trace metals determination. Background emission must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used should be as free as possible from spectral interference and should reflect the same change in background intensity as occurs at the analyte wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result.

3. Definitions:

3.1. Reagent Blank (RB) – Laboratory grade reagents which are carried through the entire analytical procedure. The reagent blank is used to define the level of laboratory background and reagent contamination.

3.2. Method Blank (MB) - A method blank is performed with each batch of samples. A method blank consists of a blank matrix which is carried through the entire preparation and analytical process. The method blank is used to define the level of contamination within the sample matrix.

3.3. Initial Calibration Blank – A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to auto-zero the AA instrument. The ICB is the first calibration blank analyzed after the ICV analysis.

3.4. Continuing Calibration Blank - A volume of reagent water acidified with the same acid matrix as in the calibration standards. The calibration blank is a zero standard and is used to auto-zero the AA instrument The CCBs are the analyzed after each CCV analysis.

3.5. LLCCV or Low Limit Continuing Calibration Verification – The LLCCV is a second standard measurement to verify the reporting limit of the instrument in question.

3.6. ICV or Initial Calibration Verification – The ICV is a second source standard measured to verify the calibration of the instrument in question.

3.7. CCV or Continuing Calibration Verification – The CCV is a quality measure to ensure the instrument remains in calibration before, after, and during analysis of sample(s).

3.8. Matrix Spike (MS) – A sample is prepared by adding a known amount of target analyte to a specified amount of the sample and that is carried through the entire preparation and analytical process. Matrix spikes are used to determine the effect of the sample preparation on analyte recovery and the effect of matrix interference.

3.9. Matrix Spike (MSD) – A duplicate sample is prepared by adding a known amount of target analyte to a specified amount of the sample and that is carried through the entire preparation and analytical process. Matrix spike duplicates are used to determine the precision of the analysis.

3.10. Duplicate (D) – A duplicate sample that is carried through the entire preparation and analytical process to determine the precision of the analytical method.

3.11. Laboratory Control Sample (LCS) - These are Certified Reference Material standards that are carried through the entire analytical procedure.. An LCS also serves as a means of verifying the capability or accuracy of the entire analytical process.

3.12. Laboratory Control Sample Duplicate (LCSD): This is a second aliquot of Certified Reference Material standard that is carried through the entire analytical procedure. It is used to check laboratory and instrument performance by determining the precision of the analytical method. These take the place of MS and MSD for wipes and air samples.

3.13. Certified Reference Material (CRM) - A reference material having one or more property values that are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation that is issued by a certifying authority.

3.14. MDL or Method detection limit. – The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero during analysis.

3.15. LOQ or Limit of Quantitation – The LOQ is the level above which quantitative results may be obtained with a specified degree of confidence. It is also refered to as the Reporting Limit (RL). Limits of quantitation are matrix, method, and analyte specific.

4. Interferences

4.1. Reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing reagent or method blanks.

4.2. Analyses of reagent blanks provide information about the presence of contaminants.

4.3. Spectral interferences are caused by background emission from continuous or recombination phenomena, stray light from the line emission of high concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra.

4.4. Contamination by carryover can occur whenever high-level and low level samples are sequentially digested and analyzed. After the analysis of a sample containing high concentrations of lead sufficient rinse time should follow the analysis on the ICP.

5. Safety

This SOP does not address all safety issues associated with its use. The laboratory is responsible for maintain a safe work environment and a current awareness file of OSHA regulations regarding the safe handling of the chemicals included in this method. A reference file of material data safety sheets (MSDS) is available to all personnel involved in these analyses.

5.1. General Laboratory Safety

5.1.1 The preparation of all standards, reagents, and glassware procedures that involve acids will be conducted in a fume hood with the sash closed as far as the operations will permit.

5.1.2 Equipment, goggles, or face shield must be used when employees are using acids to rinse or clean glassware.

5.1.3 Work areas should be isolated and posted with signs. Glassware and tools should be segregated.

5.1.4 Exposure of chemicals will be maintained so it is as low as reasonable possible. All samples should be opened, transferred, and prepared in a fume hood, or under other means of ventilation.

5.1.5 The acidification of samples containing reactive materials may result in the release of toxic gases, such as cyanides or sulfides. For this reason, the acidification and digestion of samples should be performed in a fume hood.

5.1.6 Waste containers must be kept closed unless transfers are being made.

5.2. Gas Handling Safety

5.2.1. Gases commonly used with the ICP are argon and nitrogen. High pressure gas cylinders can be dangerous if mishandled.

5.2.2. Gas cylinders should be stored in a vertical position only. Fasten tanks securely to an immovable bulkhead or to a wall.

5.2.3. Move gas cylinders only with an approved handcart after insuring that the valve cap is closed and secured.

5.2.4. Locate gas cylinders away from heat or ignition sources. Cylinders have a pressure relief device that will release the contents of the cylinder if the temperature exceeds

52°C (125°F). With liquid argon it is not uncommon for the relief device to activate at lower temperatures.

5.2.5. Label gas cylinders to clearly identify the contents.

5.2.6. Use only approved regulators and hose connectors.

5.3. ICP Safety

5.3.1. Perkin Elmer / Thermo Scientific provide a number of interlocks on the instruments. Defeating the interlocks may compromise operator safety and SHOULD NOT be attempted.

5.3.2. ICP spectrometers use high power levels of radio frequency energy in the power supply and torch unit which is potentially hazardous if allowed to escape. Safety device and interlocks should not be bypassed or disconnected.

5.3.3. The power supply of the ICP is capable of generating lethal voltages. No maintenance should be performed by anyone other than a Perkin Elmer / Thermo Scientific Service Representative.

5.3.4. Never directly view the ICP torch without protective eyewear.

5.3.5. It is very important to provide venting for the ICP. Toxic combustion products, ozone, and metal fumes may concentrate in the laboratory if adequate ventilation is not provided.

5.4. In the event of a known or potential problem with the safety or health of an individual working in the laboratory, all work must be stopped. The situation must be reported to a laboratory supervisor or the laboratory manager immediately.

6. Apparatus and Materials

6.1. Gases, Argon and Nitrogen, high purity

6.2. ICP System: Perkin Elmer Optima 4300 DV Emission Spectrometer / Thermo Scientific iCAP 6300 – the systems are comprised of four parts, the spectrometer, the plasma source, the radio frequency (RF) power supply, and the application software.

6.3. Gases, Argon and Nitrogen, high purity

6.4. Syringes, plastic, disposable, 20 mL

6.5. Filters for syringes, plastic, disposable, 25 mm, 1.5 µm glass fiber

6.6. Centrifuge tubes, plastic, 15 ml and 50ml

6.7. Volumetric flasks, Class A, and/or plastic, various sizes

6.8. Beakers, 250ml or equivalent

7. Reagents and Standards

7.1. Nitric Acid, 69.0-70.0%, for trace metals analysis

7.2. Nitric acid, concentrated, HNO_3, reagent grade

7.3. Hydrochloric acid, HCl, reagent grade

7.4. Deionized water

7.5. Stock solutions: Stock solutions are purchased as certified solutions. Store, at room temperature and protected from light. Stock solutions may also be prepared from pure standard materials. All purchased certified stock standards solutions have a manufacturer's expiration date on the label.

7.6. Secondary dilution standards - Using stock standard solutions, prepare in 10% nitric acid, secondary dilution standards containing the compounds of interest. Secondary dilution standards are stored at room temperature, protected from light and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them. **Secondary dilution standards should be replaced after three months or sooner if indicated.**

7.7. Second Source Standards – Purchased as certified solutions from another lot as the stock solutions or from another vendor. Second source standards should be checked frequently for signs of degradation or evaporation. Protect from light. All purchased second source standards solutions have a manufacturer's expiration date on the label.

7.8. ICP Rinse Solution – 10% nitric acid rinse. In a 4L container, place approximately 2L-deionized water. Add 400 mL concentrated nitric acid and djust volume to 4L with deionized water.

7.9. Internal Standard Solution- For the Perkin Elmer: Yttrium (Y) or Scandium (Sc): prepare a working solution by adding 100 mL of concentrated nitric acid and 2 mL of the 10,000 ug/ml stock into some deionized water in a 2L container. Adjust final volume to two liter with deionized water. Mix well. For the Thermo: Yttrium (Y) / Indium (In): prepare a working solution by adding 50ml of conc HNO3, 25ul of 10,000 ug/ml Yttrium stock and 5ml of 10,000 ug/ml Indium stock into deionized water in a 1L container. Adjust final volume to one liter with deionized water. Mix well.

7.10. Calibration Standards

7.10.1. Daily Calibration Standards – Prepare working solutions from purchased 100ug/mL certified standard solutions for the calibration curve according to the table below.

Calibration Level	Amount trace HNO_3 Added (mL)	Amount conc. HCl Added (mL)	Amount 100 µg/mL Stock Standard Added (µL)	Final Volume (mL)	Final Concentration (µg/L)
1	10	10	80	200	40
2	10	10	200	200	100
3	10	10	2000	200	1000
4	10	10	10,000	200	5000

7.10.2. Initial Calibration Verification (ICV) Solution – Prepare a 1000 µg/L solution by adding 2 mL of the 100 ug/mL second source standard to a 200 mL volumetric. Add 10 mL trace HNO_3 and 10mL concentrated HCl. Adjust final volume to 200 mL using deionized water. Final Concentration is 1000 µg/L.

7.10.3. Continuing Calibration Verification (CCV) Solution – Prepare a 1000 µg/L solution by adding 2 mL of the 100ug/ml first source (calibration stock solution) stock standard to a 200 mL volumetric. Add 10 mL trace HNO_3 and 10 mL of concentrated HCl. Adjust final volume to 200 mL using deionized water. Final Concentration is 1000 µg/L.

7.10.4. Low–Level Continuing Calibration Verification (LLCCV) Solution – Prepare a 40µg/L and 100 µg/L working solution as indicated in Table above. The LLCCVs are prepared from the same stock solution as the daily calibration.

7.10.5. Reporting Limit Verification (RLV) – Prepare a 40µg/L matrix matched solution. See table below

Matrix	Preparation
Wipe	Place a blank ghost wipe in a 50-mL centrifuge tube and then spike it with 20 µL of 100 µg/mL Multi-Element Stock Standard
Bulk/Soil	Place a blank soil material in a 50-mL centrifuge tube and then spike it with 20 µL of 100 µg/mL Multi-Element Stock Standard
Paint	Place a blank bulk material in a 50-mL centrifuge tube and then spike it with 20 µL of 100 µg/mL Multi-Element Stock Standard
Air	Place a blank air filter in a 50-mL centrifuge tube and spike with 40 µL of 10 µg/mL Multi-Element Stock Standard

7.10.5.1. The RLVs are digested in the same manner as the samples using the appropriate SLI SOP.

7.10.6. Laboratory fortified Blank (LFB) – Prepare a 250µg/L solution using serial dilution by adding 25 µl of 100 ug/ml stock standard to a 10 ml tube. Add 1ml of trace HNO_3 and adjust final volume to 10ml with DI H_2O.

7.10.7. Interference Check Standard Solution – Prepare the interference standard according to the following table.

Amount conc. HCl Added (mL)	Amount trace HNO_3 Added (mL)	Amount Standard Added		Final Volume (mL)	Final Concentration (µg/L)	
		1000 µg/L Stock (multi Element) (mL)	Interference Check Standard (mL)		Analytes	Interferents
10	10	1	2	200	500	Al, Ca, Fe, Mg, and Na at various concentrations

7.11 Matrix Spike (MS) Solution – Purchase a 100 µg/ml certified stock standard solution. The certified solutions should contain all the target analytes. Multiple solutions may be used in order to spike all compounds being analyzed for. Add 500µl /1 ml of calibration solution to the sample chosen as the MS sample. Final volume of the MS sample is 50ml / 100 mL respectively resulting in a 1000 µg/L spike.

7.12 Post Spike (PS) Solution – The same calibration stock solutions used for the MS sample are used for the post spike sample. Add 100 µL of the 100 ug/ml MS solution to 10 mL of the sample chosen for the post spike analysis. This results in a 1000 µg/L spike.

7.13 Laboratory Control Spike (LCS/LCSD) – The same stock standard solution used as the MS spiking solution is used as the LCS spiking solution. For aqueous sample add 1 ml of this solution to the blank matrix and dilute with de-ionized water to 100 ml. Add 100 ul of this solution to a blank air matrix and dilute to a final volume of 10 ml. For wipe, soil, bulk, and paint LCS / LCSD, add 500 ul of this stock standard solution and dilute to a final volume of 50 mL. This results in a LCS/LCSD spike concentration of 1000 ug/L.

7.14 Blanks – Two types of blanks are required for the analysis of samples. The calibration blank is used in establishing the analytical curve and the method blank is used to identify possible contamination resulting from either the reagents or the equipment used during sample processing and filtration.

7.15 Continuing Calibration Blank (CCB) and Initial Calibration Blank (ICB) – The CCB and the ICB are prepared the same way as rinse solution. The rinse solution is prepped using 400ml of acid diluted to 4 L with de-ionized water.

7.16 The method blank must contain all reagents in the same volumes as used during the processing of the samples. The method blank must be carried through the complete procedure and contain the same acid concentration in the final solution as the as the sample solution used for analysis.

8 Sample Collection, Preservation, and Storage

8.1 SLI does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2 All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3 Aqueous samples must be acidified to a pH of <2 with HNO_3. The pH of all aqueous samples must be tested immediately prior to aliquoting for processing or "direct analysis" to ensure the sample has been properly preserved. If properly acid preserved, the sample can be held up to six months before analysis.

8.4 For the determination of the dissolved elements, the aqueous sample must be filtered through a 0.45 µm pore diameter membrane filter at the time of collection or as soon thereafter as practically possible. (Glass or plastic filtering apparatus are recommended to avoid possible contamination. Only plastic apparatus should be used when the determinations of boron and silica are critical.) Use a portion of the filtered sample to rinse the filter flask, discard this portion and collect the required volume of filtrate. Acidify the filtrate with (1+1) nitric acid immediately following filtration to pH

8.5 For the determination of total recoverable elements in aqueous samples, samples are not filtered, but acidified with (1+1) nitric acid to pH 2, more acid must be added and the sample held for 16 hours until verified to be pH(normally, 3 mL of (1+1) acid per liter of sample is sufficient for most ambient and drinking water samples). Preservation may be done at the time of collection, however, to avoid the hazards of strong acids in the field, transport restrictions, and possible contamination it is recommended that the samples be returned to the laboratory within two weeks of collection and acid preserved upon receipt in the laboratory. Following acidification, the sample should be mixed, held for 16 hours, and then verified to be pH 2, more acid must be added and the sample held for 16 hours until verified to be pH <2.

8.6 Non-aqueous samples should be refrigerated at $4^{o}C \pm 2^{o}C$ upon receipt. There is no established holding time limitation for solid samples.

8.7 Samples must be digested and analyzed within 180 days of sample collection.

9 Procedure

9.1 Preparation and Digestion of Samples

9.1.1 Aqueous, solid, paint, and air samples are prepared using the appropriate SLI SOP.

9.2 Calibration of ICP Instrument

The ICP source consists of a RF generator and a demountable source. Every function of the source is controlled by the system computer. Parameters such as RF power, argon flow rates, and plasma viewing are regulated through use of the computer. Plasma ignition is fully automatic and occurs following one keystroke. The RF generator is located in the main chassis of the system below the plasma torch compartment. Proper RF shielding and filters are provided to assure that the system complies with FCC and VDE regulations regarding radiation. In addition to RF shielding, the system has numerous safety interlocks for operator protection. The devices insure that the plasma is stable, cooling water is flowing, argon flows and pressures are correct, and covers are secure. The system shuts down automatically if any interlock is interrupted. In the event of an interrupted interlock, the analyst is alerted immediately to the faulty condition to minimize plasma down time.

The plasma source comprises a demountable torch and sample introduction system. All of the assembly components are housed in an enclosure that provides maximum shielding and protects the environment from RF radiation. The plasma can be viewed during operation through a UV blocking, low transmittance window situated in the sliding door. The sample introduction system is comprised of the spray chamber and nebulizer. The nebulizer is a well proven cross-flow design that incorporates wide bore sampling capillaries to minimize blockage due to particulate matter and high dissolved solids. A computer controlled peristaltic pump provides constant sample delivery to the nebulizer.

9.2.1 Set up the instrument with proper operating conditions established as detailed below. The instrument should be allowed to become thermally stable before beginning (usually 30 minutes for ICP-PE).

NOTE: The Emergency Cut-off switch for the ICP-PE is a Red Button located in the upper left hand corner of the front panel. Thermo on/off switch is at the back of the instrument.

9.2.2 Daily Instrument Checks: The following items are checked daily before calibration of the instrument.

9.2.2.1 Argon Gas Level – Verify that the argon tank has sufficient pressure and that a spare tank is ready, if needed.

9.2.2.2 Cooling Water – Check the water supply system and the water filter. Change water filter if needed.

9.2.2.3 Torch – Inspect the torch, glassware, and aerosol injector tube. The glassware should be clean with no traces of deposits or signs of melting.

9.2.2.4 Drain - Verify that the drain bottle is not full. Keep the drain tubing clear with as few bends as possible. Ensure that the drain tube fits tightly to the spray chamber drain. There must be some liquid in the tube.

9.2.2.5 Nebulizer - the nebulizer must not be clogged and the sample capillary tubing must be clean and in good condition.

9.2.2.6 Peristaltic Pump-Replace the pump tubing as needed. Inspect the tubing after a few hours of operation and replace if flat spots develop. Remove the tubing from the peristaltic pump when it is not in use to prevent flat spots from forming. Check each pump roller to ensure that it is not binding. Binding can cause poor precision.

9.2.3 Perkin Elmer

9.2.3.1 Instrument Start Up

9.2.3.1.1 Perform daily checks

9.2.3.1.2. Double click on the "ICP WinLabs32" software icon on the computer. The program will automatically establish connection with the plasma generator, the spectrometer, and the automated sampler. After communication is established, click on the "WRKSPC" icon. Choose the file labeled as "Sli.icp" and hit "OK". This will open the Plasma Control Automated Analysis Control, and Results Windows.

9.2.3.1.3 Go to the Plasma Control Window and click on the "PUMP" icon. Check the flow of the peristaltic pump to make sure liquid is flowing properly. Click on the "PUMP" icon again to stop the pump.

9.2.3.1.4 Click on "File" in top left corner. Click on "Open". Click on "Method". Click on the method called "MY". The MY method uses Yttrium as the internal standard. Click "OK".

9.2.3.1.5 Click on the "METHOD" icon. Choose the element to be analyzed for (e.g. lead) and chose "Yttrium". Delete all other analytes in the method that are not to be analyzed. Click on the "Calibration" button on the bottom of the Method Window. Click on "Define Standards" on right side of Method window. Review and edit, if needed.

9.2.3.1.6 Click on the "Calibration Units" and "Conc" on right side of method Window. Review and edit, if needed. Click on the "QC" tab on bottom of method window. Click on the "QC Sample Definition". Review and edit, if needed. Click on the "Check Conc and Limits". Review and edit, if

needed. Click on "Schedule QC" tab on right side of Method window. Review and edit, if needed. Close out of window when done.

9.2.3.1.7 On toolbar in the top left corner of screen, choose "File", "New", then "Sample Info File". Choose "autodatacollect.sid". Hit "OK".

9.2.3.1.8 In window, enter the batch ID which is the date followed by a letter. (e.g. 011810A – signifies the date of Jan 18, 2010 and A signifies the first analysis of the day. B would be the second analysis of the day, etc.) Type in Analysts initials.

9.2.3.1.9 An RLV run must be done before the daily run. Name the batch ID for the RLV run as the date followed by "RLV." (e.g. 011810-RLV)

9.2.3.1.10 Once both the sample info file and method have been chosen, click on the "Automated Analysis Control Window" at the top of the "ICP WinLabs" software tool bar. The sample info file should have automatically transferred to the window on the lower left side of the auto analysis window. If not then type in the sample info file name that you saved earlier. Directly to the right of the sample info window is the results window. Double click this window then type the name of the results file you want to save your results to. This should mirror the sample info file description of month date year letter designation.

After the files are loaded into the automated analysis portion of the winlab software click the bottom tab that reads "analyze". This takes you to the screen to run the calibration and the samples. Click "Calibrate" to start calibration. Refer to Calibration of Instrument.

9.2.3.1.11 Once calibration is complete, on the toolbar, go to "File", "Open", "Sample Info File". Now open the sample information file that was saved earlier (e.g. 011810A) and list samples to be analyzed and QC to be run. Save this file by clicking the file button in the top right of software then scroll down to "Save As" the scroll to "Sample Info File" then name this file in the format of the current month day year and a letter designation as to which order the file is. Example: 011810A.

9.2.3.1.12 In Columns on same page enter the following: In the Sample ID Column – type in the SLi sample numbers. The SLi samples begin in position #38.

9.2.3.1.13 In the Matrix Check Sample column, double click next to the sample that is the DUP sample. Click on Duplicate. Click on Reference Sample # and enter location of native sample, then click on Current Sample # and enter

location of duplicate sample. This lets the instrument know that the sample is a duplicate of the sample that has run before it.

9.2.3.1.14 In the Matrix Check Sample column, double click next to the sample that is the MS. Click on "Recovery Set #1", Click on "Reference Sample #" and enter position of the native unspiked sample, then click on "Current Sample #" and enter position of the spiked sample. This lets the instrument know that the sample is a matrix spike of the sample that has run before it.

9.2.3.1.15 Enter the initial volume (10 mL), enter any dilution factor, enter the sample prep volume (10 mL), enter volume units (mL).

9.2.3.1.16 About the 11th sample in the sequence, in the Analyze QCs before column, type in "6,7". This lets the instrument know to analyze a CCV and CCB before analyzing the next batch of 10 samples. The CCV and CCB are in positions 6 and 7, respectively, in the automated sample unit. Go to "File", Save As", and save as file used earlier in day (e.g. 011810A).

9.2.3.1.17 After the next 10 samples, analyze all QCs 6,7 when you have more than 20 samples.

9.2.3.2 Calibration of Instrument

9.2.3.2.1 Load the standards and RLVs in the automated sample. An example of the RLV Sequence is listed below.
Example RLV Sequence

1. Calibration Blank
2. 40 ppb Standard
3. 100 ppb Standard
4. 1000 ppb Standard
5. 5000 ppb Standard
6. 1000 ppb ICV QC– Second Source
7. ICB QC
8. 40 ppb LLCCV QC
9. 500 ppb ICS QC
10. CCV – 1000 ppb QC
11. CCB QC
12. RLV Paint QC
13. RLV Air QC
14. RLV Soil/Bulk QC
15. RLV Wipe QC
16. 500 ppb ICS QC
17. CCV – 1000 ppb QC
18. CCB QC

9.2.3.2.2 To be considered acceptable, the calibration curve should have a correlation coefficient of 0.998 or better. If the correlation coefficient is less than 0.998, then the instrument must be recalibrated.

9.2.3.3 Once the calibration criterion of 0.998 has been met, the analyst may proceed with the analysis of the ICV, the ICB, the LLCCV, the ICS, the CCV, CCB, and then the RLVs. Press the "Analyze Samples" button on the Automated Analysis Control window when ready to analyze samples. All criteria for these standards and blanks must be met before the analysis of samples. See the Quality Control Section for specific guidelines on acceptance criteria. When all criteria has been met continue with the daily calibration and sample analysis

9.2.3.4 Load the standards in the automated sample. An example of the Analytical Sequence of the standards and samples is listed below.

Example Analytical Sequence

1. Calibration Blank
2. 40 ppb Standard
3. 100 ppb Standard
4. 1000 ppb Standard
5. 5000 ppb Standard
6. 1000 ppb ICV QC– Second Source
7. ICB QC
8. 40 ppb LLCCV QC
9. 100 ppb LLCCV QC
10. 500 ppb ICS QC
11. CCV QC – 1000 ppb
12. CCB QC
13. 10 samples
14. DUP on one of 10 samples above
15. MS on one of 10 samples above
16. CCV QC – 1000 ppb
17. CCB QC
18. 10 samples
19. DUP on one of 10 samples above
20. MS on one of 10 samples above
21. 500ppb ICS QC
22. CCV QC – 1000 ppb
23. CCB QC

9.2.3.5 Several analytes have more than one wavelength that can be used to quantify a sample.

9.2.3.5.1 The following table lists the Analytes, the primary wavelength and the secondary wavelength.

Analyte	Primary Wavelength	Secondary Wavelength
Calcium	315.887	317.933
Cadmium	214.438	228.802
Copper	324.754	327.396
Iron	239.562	261.187
Magnesium	279.079	285.213
Zinc	206.200	213.856

9.2.3.5.2 The primary wavelength is used for the majority of analyses. The only time the secondary wavelength is chosen is if the QC for the primary wavelength fails and the QC for the secondary wavelength passes.

9.2.3.6 Data reporting

9.2.3.6.1 When analysis is finished, export data by going to the Toolbar and clicking on “File”, “Utilities”, “Data Manager”.

9.2.3.6.2 Highlight the desired file (e.g. 011810A)

9.2.3.6.3 Click on “Export”. Click on “Use Existing Design”. Click on “Browse”. Click on “Export.xpt” file then hit “Open” then “Next”.

9.2.3.6.4 To export data to SLI Applications, open SLI Applications. Click on “Metals” then “Imports”.

9.2.3.6.5 Select instrument from dropdown menu, which is the “Optima 4300”. Type in run ID and choose initial from dropdown menu. The run ID is the run established earlier as the date and letter (e.g. 011810A).

9.2.3.6.6 Click “Copy and Check results”. Close window when done.

9.2.3.6.7 To unclick the desired dilutions click on “Check Results/Current Batch”. Close window when done.

9.2.3.6.8 Click on “View and Import QC” to uncheck QCs unwanted QCs for the run.

9.2.3.6.9 Click on "Data/Analysis Report", if you want to preview the report, click on "Preview Only" button underneath. Click "Import SLI Data", "Yes", "Yes".

9.2.4 **Thermo iCAP**

9.2.4.1 Perform Daily checks

9.2.4.2 Turn on the chiller on and automated sampler.

9.2.4.3 Double click on iTEVA center software icon on the computer and choose a user name –admin. The program will automatically establish connection with plasma generator, the spectrometer, and the automated sampler and initialize the instrument. After initialization is established, click on the "Flame" icon (next to admin at the bottom corner). Click on instrument status (all icons must be green). Then click on plasma on or fix the icon that is not activated and then click on plasma on and hit "OK".

9.2.4.4 Double click on the Analyst application on the left on control center and this will open the method window. Choose the method needed and this will open the Analysis (results page), method and sequence windows.

9.2.4.5 Go to the Sequence Window to setup sample information file. Click on auto session at the top left corner on screen and choose new auto sampler.

9.2.4.6 Under list of sequence to run: choose new and add the number of samples and sample name, then click OK. Then ok on new auto sampler.

9.2.4.7 The auto sampler can be viewed in two different formats either as a list (where samples information are typed) or as auto sampler location. When auto sampler page opens, locate standards and samples.

9.2.4.8 Additional samples can be added on the list view. In Columns on same page enter the following: In the Sample ID Column – type in the SLi sample numbers, to locate duplicates and spikes click on a sample and and auto locate the samples.

9.2.4.9 Click on auto session and save sample information file with batch ID, which is the date, followed by a letter (e.g. 030111A – signifies the date of March 1st, 2011 and A signifies the first analysis of the day. B would be the second analysis of the day, etc.).

9.2.4.10 An RLV run must be done before the daily run. Name the batch ID for the RLV run as the date followed by "RLV QC." (e.g. 030111-RLV QC).

9.2.4.11 Once both the sample info file and method have been chosen, The sample info file should have automatically transferred to the window on the lower left side of the auto analysis window. If not then type in the sample info file name that you saved earlier.

9.2.4.12 Click on the "Run auto session icon" at the top of the "ICP iTEVA" software tool bar to run the calibration standards and samples and click on the Analysis icon at the bottom right of the auto session window to view the results. Refer to calibration of Instrument in section 9.2.5.

9.2.4.13 Once calibration is complete, go to method icon next to the analysis icon to view the calibration correlation coefficient. Click on method icon, method reports, element calibration reports and print the report.

9.2.4.14 Go back to sequence icon to add more samples and matrix DUP, SPK and LCS to sample information list. Place the cursor on the sample to add DUP and click the fourth icon to insert duplicate (sample_DUP), Place cursor on another sample and click the third icon on top left to insert recovery (sample_RQ) and drag the SPK to the right location and do the same for LCS. Then, rename the DUP, SPK and LCS according (e.g. 31114444 DUP QC, 31114444 SPK QC and LCS SOIL QC). Insert blank as unknown sample just like the sample and then rename as BLK MATRIX QC (e.g. BLK SOIL QC).

9.2.4.15 Enter the initial volume (10 mL), enter any dilution factor, enter the sample prep volume (10 mL) enter volume units (mL).

9.2.4.16 QCs (CCV and CCB) are analyzed after every ten samples in the sequence, the method is already set up to generate CCV and CCB after every ten samples, remember to drag the QCs into the right locations.

9.2.5 Calibration of Instrument

9.2.5.1 Load the standards and RLVs in the automated sample. An example of the RLV Sequence is listed below in section 9.2.3.2.1.

9.2.5.2 To be considered acceptable, the calibration curve should have a correlation coefficient of 0.998 or better. If the correlation coefficient is less than 0.998, then the instrument must be recalibrated.

9.2.5.3 Once the calibration criterion of 0.998 has been met, the analyst may proceed with the analysis of the ICV, the ICB, the LLCCV, the ICS, the CCV, CCB, and then the RLVs. Press the "Analyze Samples" button on the Automated Analysis Control

window when ready to analyze samples. All criteria for these standards and blanks must be met before the analysis of samples. See the Quality Control Section for specific guidelines on acceptance criteria. When all criteria has been met continue with the daily calibration and sample analysis .

9.2.5.4 Load the standards in the automated sample. An example of the Analytical Sequence of the standards and samples is listed in section 9.2.3.4.

9.2.5.5

9.2.5.6 Data reporting

9.2.5.6.1 The network is setup to transfer the analyzed data automatically into LIMS

9.2.5.6.2 To import data to SLI Applications, open SLI Applications. Click on "Metals" then "Imports".

9.2.5.6.3 Select instrument from dropdown menu, which is the "Thermo". Type in run ID and choose initial from dropdown menu. The run ID is the run established earlier as the date and letter. Importing data is specific to the analyzed date, if a run was done on the 15th and needs to be imported on the 16th (e.g. 03/15/2011) in order for the correct data to show up.

9.2.5.6.4 Click "Copy and Check results".

9.2.5.6.5 To unclick the desired dilutions click on "Check Results/Current Batch". Close window when done.

9.2.5.6.6 Click on "View and Import QC" to uncheck QCs unwanted QCs for the run.

9.2.5.6.7 Click on "Data/Analysis Report", if you want to preview the report, click on "Preview Only" button underneath. Click "Import SLI Data", "Yes", "Yes".

10 Quality Control

10.1 Matrices of Standards

10.1.1 Standards have relatively the same acid concentration as the samples being analyzed. All digested samples have a final nitric acid content of approximately 10% and a final hydrochloric acid content of 10%. Likewise, calibration standards have a final concentration of 10% and blanks have a final concentration of 5% of each acid.

10.1.2 Because variation from the 5% acid concentration tends to give the physical interference of viscosity effects, this interference is eliminated by an internal standard that is run in each and every sample, automatically correcting for physical interferences.

10.2 Calibration Protocol

10.2.1 A calibration is run at the beginning of each set of analyses or at least once daily.

10.2.2 The calibration curve usually consists of at least three non-zero points (40, 100, 1000 and 5000 µg/L) and a calibration blank. However, more calibration points may be analyzed as deemed necessary.

10.2.3 The calibration coefficient must be at least 0.998 or higher. The linearity of the curve must not be forced thru zero. If this evaluation criterion is not met, analysis must be stopped and recalibration performed. If the recalibration fails, the standards must be re-made and/or the equipment must be evaluated.

10.3 Initial Calibration Verification

10.3.1 After the daily calibration, the initial calibration verification (ICV) standard is analyzed.

10.3.2 The ICV standard is prepared from a second source at 1000 µg/L, which is almost at the mid-range of the calibration curve.

10.3.3 The percent recovery (%R) of the ICV standard must be between 95%-105% for Aqueous and 90%-110% for Solids. If the second source fails calibration criteria, recalibration is necessary.

10.3.4 After the ICV is analyzed, an initial calibration blank (ICB) is analyzed. Target analytes should not be detected in the ICB at a concentration greater than the reporting limit.

10.4 Low-Level Continuing Calibration Verification (LLCCV)

10.4.1 The LLCCV of 40µg/L for most analytes is analyzed after the ICB. However, other concentrations of LLCCVs may be analyzed as deemed necessary for other analytes with higher reporting limits.

10.4.2 The percent recovery of the LLCCV is between 70-130%.

10.5 Interference Check Sample (ICSAB)

10.5.1 The Interference Check Sample (ICSAB) is run at the beginning and end of every run and should be must be within 20% of the true value.

10.5.2 The concentration of target analytes in the ICSAB is 500 µg/L. The interferents (aluminum, calcium, iron, magnesium, and sodium) are also contained in this solution at varying concentrations.

10.6 Continuing Calibration Verification (CCV)

10.6.1 A CCV is run once every 10 samples.

10.6.2 The concentration of the CCV is at 1000 µg/L, which is the mid-range of the calibration curve for most analytes. However, higher concentrations may be analyzed for target analytes which have a higher reporting limit.

10.6.3 The %R of the CCV must be within 90%-110%.

10.6.4 After the CCV is analyzed, a continuing calibration blank (CCB) is analyzed. Target analytes should not be detected in the CCB at a concentration greater than the reporting limit.

10.7 LCS Samples

10.7.1 The LCS is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

10.7.2 LCS samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCS takes the place of the MS for wipes and airs.

10.7.3 LCS samples are digested and handled in the same manner as the samples.

10.7.4 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%.

10.8LCSD Samples

10.8.1 The LCSD is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

10.8.2 LCSD samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A

batch can be no greater than 20 samples. The LCSD takes the place of the MSD for wipes and airs.

10.8.3 LCS samples are digested and handled in the same manner as the samples.

10.8.4 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%. The RPD of the LCS/LCSD should be between +/- 20%.

10.9 Matrix Spike

10.9.1 Matrix Spike are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for soil and solids or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.9.2 Matrix Spikes are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MS sample, the laboratory will add a disclaimer to the final report.

10.9.3 The %R for the matrix spike should be between 75%-125%. If the recovery of the MS is outside of these limits, a post-digestion spike is performed on the sample. The recovery of the post-spike should be between 80%-120%.

10.10 Matrix Spike Duplicates

10.10.1 Matrix spike duplicates are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.10.2 Matrix spike duplicates are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MSD sample, the laboratory will add a disclaimer to the final report.

10.10.3 The %R for the matrix spike should be between 75%-125%. The RPD of the MS/MSD should be +/- 20%.

10.11 Post Spikes

10.11.1 Post spikes are analyzed whenever MS recoveries are unacceptable.

10.11.2 Post spikes are analyzed in the same manner as the original sample.

10.11.3 Post spike samples are spiked with 100 µL of a 100 µg/mL spiking solution in a 10ml tube.

10.11.4 The recovery of the post-spike should be between 80-120%.

10.12 Reporting Limit Verification (RLV)

10.12.1 This must be a matrix matched sample and analyzed after the daily calibration/run for lead in paint, soil, airs and wipes under the AIHA ELLAP program. The RLV is analyzed after the CCB.

10.12.2 The RLV is a solid certified reference material spiked onto a blank matrix and is put through the entire preparation and analytical process.

10.12.3 The %R of the RLV must be within 80%-120%.

10.13 Blank Analyses

10.13.1 Method Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

10.13.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask go through the entire preparation and analytical process.

10.13.3 If for Solid Samples the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

10.13.4 For Aqueous samples, when the blank values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable blank values have been obtained.

11 Method Performance

11.1 The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDL concentrations actually achieved will vary depending on instrument sensitivity and matrix effects.

11.2 The analytical group must generate a valid MDL for each individual analyte of interest. The MDL must be below the reporting limit or low level standard for each analyte. The procedure for determination of the MDL is given in 40 CFR Part 136, Appendix B.

11.3 MDLs are determined annually per matrix per each analyst. The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience.

12 Data Analysis and Calculations

12.1 The quantitative values must be reported in the appropriate units of milligram per kilogram (mg/kg), microgram per feet squared (ug/ft2), microgram per meter cubed (ug/m^3) or milligram per liter (mg/l).

12.2 If dilutions were performed, the appropriate corrections must be applied to the sample values.

13.3. Results must be reported in units commensurate with their intended use and all dilutions must be taken into account when computing final results.

13 Corrective Actions and Handling of Non-Conformance Data

13.1 Refer to *Table 4*: Correction action flowchart for Non-Conformance handling information

14 Pollution Prevention

14.1 Pollution prevention encompasses any technique that reduces or eliminates the quantity and/or toxicity of waste at the point of generation. Numerous opportunities exist for pollution prevention in the laboratory.

14.2 Standards should be prepared in volumes consistent with laboratory use to minimize the volume of expired standards to be disposed of. The threat to the environment from acids and/or reagents used in this method may be minimized when recycled or disposed of properly.

15 Waste Management

15.1 All waste will be disposed in accordance with all Federal, State, and local regulations governing waste management, particularly the hazardous waste identification rules and land disposal restrictions, and to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations. Compliance with all sewage discharge permits and regulations is also required.

15.2 The storage and disposal of hazardous waste is further detailed in SLGi AD-043.

15.3 For further information on waste management, consult "The Waste Management Manual for Laboratory Personnel," and "Less is Better: Laboratory Chemical Management for Waste Reduction," both available from the American Chemical Society's Department of Government Relations and Science Policy, 1155 16th Street N.W., Washington, D.C. 20036.

16 References

16.1 United States Environmental Protection Agency, “Method 6010C: Inductively Coupled Plasma-Atomic Emission Spectrometry, SW846 Online, Revision 3, February 2007.

16.2 T.D. Martin, C.A. Brockhoff, J.T. Creed, and EMMC Methods Work Group , “Method 200.7: Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry”, Revision 4.4, 1994

16.3 National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods, “Method 7300: Elements by ICP”, Issue 3, March 2003.

16.4 Code of Federal Register (CFR), Title 40 (40 CFR), Subchapter C (Air Programs), Ch. 2, Part 50—National Primary and Secondary Ambient Air Quality Standards for Lead, February 2010.

Table 4: Corrective Action Flowchart

Sample Type	Test Result	Condition	Corrective Action	Note
Matrix Blank (B)	Blank Reading> Reporting Limit (RL)	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet and notify QA dept.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Air and wipe samples are consumed during extraction. In this case, notify QA dept.
Laboratory Control Sample / QC Sample (LCS)	LCS > Upper Limit	Samples are non-detect for that analyte.	Note on internal tracking sheet. No action is taken. Note what the %R is on the internal tracking sheet.	NA
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on internal tracking sheet and disclaimer on the final report. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed Air and wipe samples are consumed during extraction. In this case, notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
	LCS < Lower Limit	Samples are non-detect for that analyte	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Re-extract samples if possible as noted in next column.	If the sample is a soil, paint, bulk, or aqueous sample and there is more sample left, re-extraction of the batch is needed. Since there is no more wipe or air sample, re-extraction cannot occur so notify QA dept. Report the batch that has passing QC. If both batches fail, notify QA dept. QA dept will decide what to do.
		Samples are positive for that analyte.	Note on internal tracking sheet. Notify QA dept. Note what the %R is on the internal tracking sheet. Disclaimer on the final report.	
Matrix Spike (MS) and MS Duplicate (MSD)	MS/MSD > or < QC Limit	Samples are positive or non-detect for that analyte.	If the MS/MSD is unacceptable, notify QA dept or follow table as listed above for LCS/QC Samples. A disclaimer is put on the final report.	NA
Duplicate Sample (D) (If used)	%RSD > Upper Limit	Samples are positive or non-detect for that analyte.	Duplicate fails then a disclaimer is placed on the final report. QC is notified of failure.	NA

Revision Page

08/06/2015 (15-002)

Revised the following section:

1.3 This method is based on SW-846 methods 6010C (Revision 3, February 2007), Standard Methods 3120B (20th Edition), EPA Method 200.7 (Revision 4.4), NIOSH 7300 (Issue 3, March 2003) 40CFR Part 50 Appendix G, with modifications for client specific analysis.

Revision:

1.3 This method is based on SW-846 methods 6010C (Revision 3, February 2007), Standard Methods 3120B (20th Edition), EPA Method 200.7 (Revision 4.4), NIOSH 7300 (Issue 3, March 2003) 40CFR Part 50 Appendix G, with modifications for client specific analysis. This SOP covers the following matrices: drinking water, wastewater, soils, sediments, paint, bulk, wipe and air samples.

Added the following sections:

1.5 The LOQ for drinking and non-potable water samples are as follows: 0.20 mg/l for Calcium, Magnesium, Potassium and Sodium, 0.10 mg/l for Chromium, Boron, Copper, Iron and Zinc and 0.040 mg/l for all other metals. The LOQ for soils and sediments takes into effect a final extraction volume of 50 ml and the weight of the sample. The LOQ for air samples takes into effect a final extraction volume of 10 ml and the air volume in liters.

3.12 LOQ or Limit of Quantitation – The LOQ is the level above which quantitative results may be obtained with a specified degree of confidence. It is also refered to as the Reporting Limit (RL). Limits of quantitation are matrix, method, and analyte specific.

Added the following section and renumbered:

9.2.3.5 Several analytes have more than one wavelength that can be used to quantify a sample.

9.2.3.5.1 The following table lists the Analytes, the primary wavelength and the secondary wavelength.

Analyte	Primary Wavelength	Secondary Wavelength
Calcium	315.887	317.933
Cadmium	214.438	228.802
Copper	324.754	327.396
Iron	239.562	261.187
Magnesium	279.079	285.213
Zinc	206.200	213.856

9.2.3.5.2 The primary wavelength is used for the majority of analyses. The only time the secondary wavelength is chosen is if the QC for the primary wavelength fails and the QC for the secondary wavelength passes.

Revised the following section:

8 **Sample Collection, Preservation, and Storage**

8.1 SLI does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2 All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3 Aqueous samples must be acidified to a pH of <2 with HNO_3.

8.4 Non-aqueous samples should be refrigerated at $4^oC \pm 2^oC$ upon receipt and analyzed as soon as possible if it contains organic testing.

8.5 Samples must be digested and analyzed within 180 days of sample collection.

Revision:

8 **Sample Collection, Preservation, and Storage**

8.1 SLI does not collect samples on behalf of its clients. It is the responsibility of the client to provide a representative sample.

8.2 All sample containers must be prewashed with detergents, acids, and deionized water, or purchased as certified clean. Plastic and glass containers are both suitable.

8.3 Aqueous samples must be acidified to a pH of <2 with HNO_3. The pH of all aqueous samples must be tested immediately prior to aliquoting for processing or "direct analysis" to ensure the sample has been properly preserved. If properly acid preserved, the sample can be held up to six months before analysis.

8.4 For the determination of the dissolved elements, the aqueous sample must be filtered through a 0.45 µm pore diameter membrane filter at the time of collection or as soon thereafter as practically possible. (Glass or plastic filtering apparatus are recommended to avoid possible contamination. Only plastic apparatus should be used when the determinations of boron and silica are critical.) Use a portion of the filtered sample to rinse the filter flask, discard this portion and collect the required volume of filtrate. Acidify the filtrate with (1+1) nitric acid immediately following filtration to pH

8.5 For the determination of total recoverable elements in aqueous samples, samples are not filtered, but acidified with (1+1) nitric acid to pH 2, more acid must be added and the sample held for 16 hours until verified to be pH(normally, 3 mL of (1+1) acid per liter of sample is sufficient for most ambient and drinking water samples). Preservation may be done at the time of collection, however, to avoid the hazards of strong acids in the field, transport restrictions, and possible contamination it is recommended that the samples be returned to the laboratory within two weeks of collection and acid preserved upon receipt in the laboratory. Following acidification, the sample should be mixed, held for 16 hours, and then verified to be pH 2, more acid must be added and the sample held for 16 hours until verified to be pH <2.

8.6 Non-aqueous samples should be refrigerated at $4^oC \pm 2^oC$ upon receipt. There is no established holding time limitation for solid samples.

8.7 Samples must be digested and analyzed within 180 days of sample collection.

Removed the following section and renumbered:

9 RLV Pb Procedures

Revised the following section:

11.12.3 If the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

Revison:

11.12.3 If for Solid Samples the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

11.12.4 For Aqueous samples, when the blank values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable blank values have been obtained.

Revised the following section:

11.1 Reporting Limit Verification (RLV)

11.1.1 This must be a matrix matched sample and analyzed before the daily calibration/run. The RLV is analyzed after the CCB.

11.1.2 The concentration of the RLV is at 40 ppb, which is the reporting limit of the calibration.

11.1.3 The %R of the RLV must be within 80%-120%.

Revision:

10.12 Reporting Limit Verification (RLV)

10.12.1 This must be a matrix matched sample and analyzed after the daily calibration/run for lead in paint, soil, airs and wipes under the AIHA ELLAP program. The RLV is analyzed after the CCB.

10.12.2 The RLV is a solid certified reference material spiked onto a blank matrix and is put through the entire preparation and analytical process.

10.12.3 The %R of the RLV must be within 80%-120%.

Revised the following sections and renumbered:

11.7 LCS Samples

11.7.1 The LCS is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

11.7.2 LCS samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

11.7.3 LCS samples are digested and handled in the same manner as the samples.

11.7.4 The %R of the LCS must be between 80-120% except for drinking water samples analyzed by method 200.7, where the %R must be between 90%-110%.

11.8 Duplicates

11.8.1 Duplicates are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

11.8.2 Duplicate samples are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a duplicate sample, the laboratory will prepare a LCS/LCSD pair instead.

11.8.3 Duplicates monitor analysis precision. The results of the duplicate analyses should match the original results within 25% Relative Percent Difference (RPD).

11.9 Matrix Spikes

11.9.1 Matrix spikes are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

11.9.2 Matrix spikes are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MS sample, the laboratory will prepare a LCS/LCSD pair instead.

11.9.3 The %R for the matrix spike should be between 75%-125%. If the recovery of the MS is outside of these limits, a post-digestion spike is performed on the sample. The recovery of the post-spike should be between 80%-120%.

Revision:

10.7 LCS Samples

10.7.1 The LCS is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

10.7.2 LCS samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCS takes the place of the MS for wipes and airs.

10.7.3 LCS samples are digested and handled in the same manner as the samples.

10.7.4 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%.

10.8 LCSD Samples

10.8.1 The LCSD is one or more solutions containing all target analytes to verify the efficiency of the digestion and analysis.

10.8.2 LCSD samples are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid, wipe and air samples or 1 per batch, whichever is greater. A batch can be no greater than 20 samples. The LCSD takes the place of the MSD for wipes and airs.

10.8.3 LCS samples are digested and handled in the same manner as the samples.

10.8.4 The %R of the LCS must be between 80-120% except for aqueous samples analyzed by method 200.7, where the %R must be between 90%-110%. The RPD of the LCS/LCSD should be between +/- 20%.

10.9 Matrix Spike

10.9.1 Matrix Spike are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for soil and solids or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.9.2 Matrix Spikes are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MS sample, the laboratory will add a disclaimer to the final report.

10.9.3 The %R for the matrix spike should be between 75%-125%. If the recovery of the MS is outside of these limits, a post-digestion spike is performed on the sample. The recovery of the post-spike should be between 80%-120%.

10.10 Matrix Spike Duplicates

10.10.1 Matrix spike duplicates are prepared and run at a frequency of 1 per 10 for aqueous samples and 1 per 18 for solid or 1 per batch, whichever is greater. A batch can be no greater than 20 samples.

10.10.2 Matrix spike duplicates are digested and handled in the same manner as the original sample. If insufficient sample volume is received to prepare a MSD sample, the laboratory will add a disclaimer to the final report.

10.10.3 The %R for the matrix spike should be between 75%-125%. The RPD of the MS/MSD should be +/- 20%.

Revised the following section:

11.12 Blank Analyses

11.12.1 Method Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

11.12.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask go through the entire preparation and analytical process.

11.12.3 If the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

Revision:

10.13 Blank Analyses

10.13.1 Method Blank - For each analytical batch containing of 20 wipe samples a method blank (blank wipe matrix) is carried throughout the entire sample preparation and analytical process.

10.13.2 Reagent Blank - For every analytical batch of 18 paint, soil or bulk sample or 20 wipe samples a reagent blank is prepared by having an empty centrifuge tube or Erlenmeyer flask go through the entire preparation and analytical process.

10.13.3 If for Solid Samples the blank is less than the lower level of quantitation or less than 10% of the lowest sample concentration for the analyte, whichever is greater, then the blank would be considered acceptable. If the blank cannot be considered acceptable, the blank should be re-run once and if still unacceptable then all samples after the last acceptable method blank must be reprepped and reanalyzed along with the other appropriate batch QC samples. These blanks will be useful in determining if samples are being contaminated.

10.13.4 For Aqueous samples, when the blank values constitute 10% or more of the analyte level determined for a sample or is 2.2 times the analyte MDL whichever is greater, fresh aliquots of the samples must be prepared and analyzed again for the affected analytes after the source of contamination has been corrected and acceptable blank values have been obtained.