Safe Work Practices for Asbestos Laboratories

WorkSafeBC
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About WorkSafeBC

WorkSafeBC (the Workers' Compensation Board) is an independent provincial statutory agency governed by a Board of Directors. It is funded by insurance premiums paid by registered employers and by investment returns. In administering the Workers Compensation Act, WorkSafeBC remains separate and distinct from government; however, it is accountable to the public through government in its role of protecting and maintaining the overall well-being of the workers' compensation system.

WorkSafeBC was born out of a compromise between B.C.'s workers and employers in 1917 where workers gave up the right to sue their employers or fellow workers for injuries on the job in return for a no-fault insurance program fully paid for by employers. WorkSafeBC is committed to a safe and healthy workplace, and to providing return-to-work rehabilitation and legislated compensation benefits to workers injured as a result of their employment.

WorkSafeBC Prevention Information Line

The WorkSafeBC Prevention Information Line can answer your questions about workplace health and safety, worker and employer responsibilities, and reporting a workplace accident or incident.
The Prevention Information Line accepts anonymous calls.

Phone 604 276-3100 in the Lower Mainland, or call 1 888 621-7233 (621-SAFE) toll-free in British Columbia.

To report after-hours and weekend accidents and emergencies, call 604 273-7711 in the Lower Mainland, or call 1 866 922-4357 (WCB-HELP) toll-free in British Columbia.

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WorkSafeBC Publications

Many publications are available on the WorkSafeBC web site. The Occupational Health and Safety Regulation and associated policies and guidelines, as well as excerpts and summaries of the *Workers Compensation Act*, are also available on the web site: WorkSafeBC.com

Some publications are also available for purchase in print:

Phone: 604 232-9704

Toll-free phone: 1 866 319-9704

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Online ordering: WorkSafeBC.com and click on Publications; follow the links for ordering

Library and Archives Canada Cataloguing in Publication Data
Main entry under title:
Safe work practices for asbestos laboratories

Publisher's former name, Workers' Compensation Board of British Columbia, also appears on publication.
ISBN 978-0-7726-6009-1

1. Asbestos - British Columbia - Safety measures. 2. Asbestos industry - British Columbia - Safety measures. 3. Laboratories - British Columbia - Safety measures. 4. Industrial hygiene. I. WorkSafeBC. II. Workers' Compensation Board of British Columbia.

TA455.A6S23 2008 363.17'91 C2008-960115-7

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Introduction

This manual is intended for asbestos laboratories and laboratory analysts, including field analysts, who examine building products, other materials (brake pads, clutch pads, furniture, etc.), and air samples for the presence of asbestos. It is based on the Occupational Health and Safety Regulation, primarily Parts 5, 6, and 30. Although this manual discusses various hazards in asbestos laboratories and lists safety precautions, the Occupational Health and Safety Regulation is the formal statement of WorkSafeBC (the Workers' Compensation Board of B.C.) policy and forms the rules that WorkSafeBC officers enforce.

This manual addresses asbestos laboratory analytical methods that use polarized light and phase contrast microscopy. It does not address transmission electron microscopy or other methodologies used to identify asbestos.

Importance of the asbestos analysis laboratory

The asbestos laboratory provides information on the type and percentage of asbestos (and other materials) present in bulk samples submitted for analysis as part of a risk assessment. This is one of the most critical components of a risk assessment, and any misidentification or failure to detect asbestos could put workers at risk of exposure to asbestos or result in the unnecessary removal of non-asbestos materials.

Air samples may be collected during the removal of asbestos-containing materials for the purposes of monitoring worker exposure and final clearance. If these samples are not analyzed properly, potential worker exposures may be missed, or workers may continue to work in an environment for which they are not adequately protected.

ALARA

The ALARA principle governs worker exposure to asbestos—all exposures must be kept **a**s **l**ow **a**s **r**easonably **a**chievable. Although the Regulation specifies exposure limits and action levels, every employer must further reduce or eliminate worker exposure *if it can reasonably be done.* Improvements in technology, and new work practices and procedures will help employers to decrease worker exposures and move closer to the ultimate goal of zero exposure to asbestos.

Wording in this manual

In this manual, the word *must* means that a particular safety step is required by the Occupational Health and Safety Regulation. The word *should* indicates that a particular action, although not specified in the Regulation, will improve safety in the workplace. Please note also that the word *worker* includes supervisors, managers, laboratory analysts, and other workers.

Related manuals

WorkSafeBC has produced a number of related safe practices manuals, such as *Breathe Safer* (a respirator manual) and *Safe Work Practices for Handling Asbestos.* For copies, visit WorkSafeBC.com or contact the WorkSafeBC Bookstore (see the front of this manual).

General health and safety requirements for labs

Working in a laboratory usually involves working with various chemical, physical, and biological hazards. Because the hazards vary from lab to lab, employers must address the hazards specific to their workplaces by developing and implementing

- Written safe work and emergency procedures
- Training programs for the education of workers
- Workplace inspections (regular and special inspections of workplace equipment, methods, and practices)
- Investigation of workplace accidents (accident investigations and reports)
- First aid equipment and procedures
- Periodic management meetings to review health and safety activities
- Regular staff safety meetings or an occupational health and safety committee where required
- Records and statistics

Defining laboratories

Part 30 of the Occupational Health and Safety Regulation lists general and substance-specific requirements that apply to laboratories, which are defined as "rooms, buildings or areas in buildings equipped with apparatus, equipment, chemicals or test animals and used for research, quality control, performance of tests, experiments or measurements, photographic development, or the preparation of drugs or other products in the natural sciences."

Safe work and emergency procedures

Employers must prepare written safe work and emergency procedures for hazardous operations in laboratories. Such procedures might include:

- Methods for working with hazardous chemicals (e.g., using dispersion staining liquids, solvents, or acids during asbestos analysis) or emergency measures for dealing with asbestos or chemical spills
- Methods required to minimize or eliminate a risk from physical hazards (e.g., musculoskeletal injuries resulting from long hours using the microscope)

Worker training and education

Employers must provide workers with

- Adequate education in the hazards of the workplace
- Training and instruction on how to do their work safely

The written safe work procedures should be used as a primary source of information. Many laboratory workers may have advanced formal education, but they still need site-specific training on work methods involving particular hazards such as asbestos. The training must include proper handling and disposal of hazardous materials.

Supervisors are responsible for the adequate training and instruction of all workers under their direction and control. A supervisor is anyone who instructs, directs, and controls workers in the performance of their duties, even if he or she does not hold the title of supervisor. An experienced laboratory worker who is training another worker is acting as a supervisor within the Occupational Health and Safety Regulation definition.

Workplace inspections

Resources

See page 37 for a checklist that outlines the regulatory requirements for asbestos laboratories.

Regular inspections of the entire workplace will help ensure that unsafe conditions do not develop over time. Such inspections should be conducted by the occupational health and safety committee or, if there is no committee, by at least one employer representative and one worker representative. Special inspections must be carried out after an accident or equipment malfunction.

The purpose of a workplace inspection is to look for unsafe work conditions, practices, and procedures. Checklists may help identify common safety concerns and ensure that these concerns are consistently checked. For example, a checklist might include sections on labelling, housekeeping, and storage practices.

A complete workplace inspection program may also include the following activities:

- Monitoring air velocity in fume hoods
- Annual testing and certification of fire extinguishers
- Inspections of laboratory equipment as recommended by manufacturers

All unsafe or harmful conditions must be corrected without undue delay. In an emergency, only workers trained and qualified to take corrective action may be exposed to the hazard. Every possible effort must be made to control the hazard while such corrective action is being taken.

Workers must not wait for the regular inspection to identify a workplace hazard. If they become aware of a health and safety problem at their workplace, they are required to report it to their supervisor or employer. The person receiving the report must investigate the problem and ensure that any required corrective action is taken without delay. If the problem cannot be solved in-house, contact WorkSafeBC. Procedures for reporting unsafe conditions and for refusing to perform unsafe work are described in detail in Part 3 of the Occupational Health and Safety Regulation.

Accident investigation

Employers are required to investigate accidents that

- Result in death or a critical condition with serious risk of death
- Cause an injury or disease that requires medical attention
- Do not cause injury but have the potential for causing serious injury (a "near miss")
- Involve the release or spill of a toxic or hazardous substance

The purposes of an accident investigation are to

- Determine the cause or causes of the accident
- Identify contributing factors such as unsafe conditions, acts, or procedures
- Develop a corrective action plan to prevent similar accidents in the future

A copy of the accident investigation report must be sent to the occupational health and safety committee and to WorkSafeBC. The report must contain

- The place, date, and time of the accident
- The names and job titles of persons injured in the accident
- The names of witnesses
- A brief description of the accident
- A statement of the sequence of events that preceded the accident
- Identification of any unsafe conditions, acts, or procedures that contributed in any way to the accident
- Recommended corrective action to prevent similar accidents
- The names of the persons who investigated the accident

First aid equipment and services

Laboratory employers must provide equipment, supplies, facilities, first aid attendants, and services that are adequate and appropriate for

- Promptly rendering first aid to workers if they suffer an injury at work
- Transporting injured workers to a place of medical treatment

The employer must conduct an assessment of the workplace to determine what first aid services are needed. Many laboratories can be classified as having a moderate hazard rating. Table 1 summarizes the recommended minimum levels of first aid for laboratories that are at most 20 minutes surface travel time to hospital. See Part 3 of the Occupational Health and Safety Regulation and the associated guidelines for details.

Table 1: Minimum first aid recommendations for a moderate risk workplace, at most 20 minutes surface travel time to hospital

Number of workers present	Supplies, equipment, and facility	First aid certificate required for attendant
1	Personal first aid kit	
2–5	Basic first aid kit	
6–25	Level 1 first aid kit	Level 1
26–75	Level 2 first aid kit Dressing station	Level 2
76 or more	Level 2 first aid kit First aid room	Level 2

Occupational health and safety committee

An occupational health and safety committee is required for laboratories with a workforce of 20 or more workers. Occupational health and safety committees must have at least four regular members, representing both the workers and the employer. Their duties are specified in Part 3, Division 4(130) of the *Workers Compensation Act.*

Laboratories with less than 20 workers do not need to have an occupational health and safety committee. They must, however, hold monthly staff meetings to discuss health and safety matters. In addition, a worker health and safety representative is required in each workplace where 10 to 19 workers are employed regularly. To the extent practicable, a worker health and safety representative has the same duties and functions as a joint committee.

General records

Laboratories must maintain adequate records and statistics including first aid records, reports of inspections, and accident investigations. This information must be available to the occupational health and safety committee, to a WorkSafeBC officer, and to the laboratory workers themselves.

Bulk sample analysis

WorkSafeBC currently accepts the following methods for the purposes of bulk asbestos analyses by polarized light microscopy:

- NIOSH (National Institute for Occupational Safety and Health) Method 9002 Asbestos (bulk) by PLM
- EPA (Environmental Protection Agency) Test Method for the Determination of Asbestos in Bulk Building Materials (EPA/600/R-93/116, July 1993)
- EPA Research Method for Sampling and Analysis of Fibrous Amphibole in Vermiculite Attic Insulation (EPA/600/R-04/004, January 2004)

These methods describe the techniques used for the qualitative identification of asbestos and the semi-quantitative determination of asbestos in bulk samples, and they include sections outlining

- The accuracy of the method (e.g., range, precision, limit of detection)
- Interferences (e.g., other fibres that look like asbestos)
- Equipment required (e.g., microscopes, slides, tools)
- Reagents (e.g., dispersion staining liquids)
- Ventilation (fume) hood requirements
- Sample preparation
- Calibration and quality control (mandatory provisions for intra-laboratory quality control systems, and recommendations for inter-laboratory quality control programs)
- Reporting of results (e.g., consideration of layers of materials and the estimation of asbestos percentages)

A copy of the analytical method(s) used in the laboratory must be available on-site for reference.

Equipment for bulk sampling analysis

The following is a list of the equipment and materials recommended for the accepted bulk analytical methods:

- Polarized light compound microscope capable of 100–400X magnification, with a 360-degree rotatable stage
- Compensator plate: ca. 550 nm retardation (“first order red” compensator)
- Eyepiece reticule (crosshair)
- Dispersion staining objective lens

Defining asbestos-containing material

Section 6.1 of the Occupational Health and Safety Regulation defines an asbestos-containing material as “any manufactured article or other material which contains 1% or more asbestos by weight at the time of manufacture, or which contains 1% or more asbestos as determined in the *National Institute for Occupational Safety and Health Manual of Analytical Methods, Method 9002, Issue 2* (microscopy, stereo and polarized light, with dispersion staining) or other method acceptable to the Board.”

- Stereo microscope capable of 10–45X magnification
- Light source for the stereo microscope
- Refractive index liquids for dispersion staining:
  - High-dispersion series 1.550, 1.605, and 1.620
  - Standard-dispersion series 1.670, 1.680, and 1.700
- Microscope slides and cover slips
- Tools to manipulate samples (e.g., tweezers, dissecting needles, spatulas, probes, and scalpels)
- Tools to grind non-friable samples (e.g., mortar and pestle)
- Sharps container for used slides or broken glassware
- Sealable plastic bags and wet wipes (talc-free) to clean the interior of the fume hood between samples
- Fume hood equipped with a HEPA filtration system
- HEPA vacuum for emergency cleanups
- Sealed waste container, labelled for asbestos waste
- Asbestos reference samples
- In-house standard asbestos samples
- Additional equipment for specialized procedures
  - Point counting stage
  - Laboratory balance (sensitivity to 0.0001 gram) for conducting gravimetric analysis
  - Drying oven (capable of drying samples at 100°C)
  - Ducted muffle furnace (capable of temperatures of 300°C to 500°C) for ashing samples
  - Ducted fume hood for organic solvents or acids
  - Laboratory glassware (e.g., beakers, test tubes, centrifuge tubes, etc.)
  - Filtration apparatus
  - Centrifuge
  - Ultrasonic bath
  - Hydrochloric acid (reagent-grade concentrated)
  - Other reagents (e.g., tetrahydrofuran)

Analysis and reporting of results

To identify fibrous materials, measure the following properties using polarized light microscopy, and record these properties for each sample:

- Morphology
- Colour and pleochroism
- Indices of refraction (parallel and perpendicular), using dispersion staining or other means

- Birefringence
- Extinction characteristics
- Sign of elongation

Matrix materials (e.g., quartz, calcite, and gypsum) must also be identified, using optical properties where possible.

When reporting the analytical results, the following should be included for each sample:

- **Unique lab sample number.**
- **Location** where the sample was collected (e.g., main floor, rear-right bedroom).
- **Material sampled** (e.g., drywall mud, texture coat, floor tile, etc.) Where there is more than one layer, each layer should be listed separately.
- **Type of asbestos present and the percentage.** Percentages can be estimated using broad ranges (for example, 10–20%, 30–40%, 50–60%). However, asbestos concentrations ranging from less than 1% to 10% should be estimated with greater accuracy. NIOSH Method 9002 includes a "percent estimate comparator" that illustrates estimates of 3%, 5%, and 10% asbestos in amosite and chrysotile carbonate mineral matrices. Percentages can also be estimated by comparison with calibrated standards. The point counting technique (described in EPA/600/R-93/116) will allow an even more accurate percentage estimate at low concentrations. Point counting is recommended for drywall mud and texture coat materials that might contain asbestos in the 1–5% range or lower.
- **Identity of other fibrous materials and matrix materials** (if known), and percentages.
- **Name or initials of the analyst.**

The lab report should include a copy of the chain-of-custody form and other important information, such as the date the samples were analyzed and the analytical method(s) used. Any accreditations held by the laboratory (e.g., NVLAP, AIHA, or CALA) should also be indicated on the lab report.

Air sampling analysis

WorkSafeBC accepts the following method for the purpose of asbestos air sampling analysis: NIOSH (National Institute for Occupational Safety and Health) Method 7400, "Asbestos and Other Fibers by PCM" (August 1994).

Asbestos air sampling

Section 6.12 of the Occupational Health and Safety Regulation requires that during high-risk work activities, air monitoring must be conducted

- Outside of the containment
- Within the clean room
- On workers inside the contaminated areas (occupational sampling during the course of the work)
- Within the containment after the work has been completed (clearance)

This method describes the techniques used for the quantitative determination of asbestos fibres in air samples, and includes sections outlining

- The accuracy of the method (e.g., range, precision, limit of detection)
- Equipment required (e.g., microscopes, slides, tools)
- Reagents (e.g., acetone and glycerol triacetate)
- Sample preparation
- Calibration and quality control (mandatory provisions for intra-laboratory quality control systems, and recommendations for inter-laboratory quality control procedures)
- Reporting of results

A copy of the analytical method used in the laboratory must be available on-site for reference.

Equipment for air sampling analysis

The following is a list of the equipment and materials recommended for the accepted air sampling analysis method described above:

- Positive phase contrast compound microscope capable of 400X magnification
- Phase contrast objective lens (40X to 45X magnification)
- Phase telescope for ocular phase-ring centering
- Walton-Beckett graticule (100 µm field of view) Type G-22
- Phase-shift test slide (HSE/NPL)
- Stage micrometer (0.01-mm divisions)
- Acetone vaporization unit
- Acetone (reagent grade) and glycerol triacetate (triacetin—reagent grade)
- Microscope slides and cover slips
- Tools to manipulate samples (e.g., scalpels, tweezers, etc.)
- Micropipettes or syringes (5 µL and 100 to 500 µL)
- Sharps container for used slides and pipettes
- In-house reference slides

Analysis and reporting of results

Fibres should be counted as follows using phase contrast microscopy (refer to the NIOSH 7400 method for a complete description):

- Count only fibres within the area of the graticule that are longer than 5 µm with a length-to-width ratio greater than 3:1.

- For fibres that cross the boundary of the graticule field, count as one-half fibre any fibre with only one end lying within the graticule area (do not count any fibre which crosses the boundary more than once).
- Count bundles of fibres as one fibre, unless individual fibres can be identified by observing both ends of a fibre.
- Count enough graticule fields to yield 100 fibres. Count a minimum of 20 fields, and stop at 100 fields, regardless of the count.

When the analytical results are reported, the following should be included for each sample:

- Unique lab sample number
- Date the sample was collected and the date analyzed
- Type of air sample (e.g., ambient, occupational, blank)
- Flow rate of the pump (litres per minute)
- Total sampling time (minutes)
- Volume of air collected (litres)
- Number of fibres counted and number of fields counted (e.g., 25 fibres in 100 fields)
- Fibre density (fibres/mm^2)
- Fibre concentration (fibres/cm^3 or fibres/mL)
- Name or initials of the analyst
- Information as to whether or not the occupational exposure limit was exceeded

The lab report should include a copy of the chain-of-custody form and reference the analytical method used. Any accreditations held by the laboratory (e.g., AIHA or CALA) should also be indicated on the lab report.

Analyst qualifications and training

It is critical that laboratory analysts be properly qualified and trained to perform their work, as is expected of other workers who handle asbestos.

It is recommended that asbestos identification analysts have, at a minimum, a bachelor's degree in the sciences (e.g., biology, chemistry, physics). In addition, they should have credit for an internationally recognized, 40-hour course of instruction in the microscopical identification of asbestos. Courses accepted by WorkSafeBC would include those presented by the McCrone Research Institute (www.mcri.org) and MICA—Microscope Instruction, Consultation and Analysis (phone: 773-334-2240).

In the Regulation

Section 30.2 of the Occupational Health and Safety Regulation states, "Operators of laboratory equipment must be adequately instructed and trained in the safe use of laboratory equipment and the precautions to be taken when the equipment is used."

Asbestos fibre counting analysts should have credit for a NIOSH 582 course (Sampling and Evaluating Airborne Asbestos Dust). The American Industrial Hygiene Association maintains a list of AIHA-approved NIOSH 582 equivalency courses and providers at http://admin.aiharegistries.org/niosh582/Pages/default2.aspx.

If an employer chooses to implement an in-house training program for air sampling analysis, this training must be supported by an instruction manual and performance criteria (exercises and examinations). Training should include a minimum of 30 hours of contact and analytical time by a qualified instructor. The instructor should have taken a NIOSH 582 equivalent course from an approved vendor within the previous three years.

If the analysts cannot demonstrate that they have been adequately trained, WorkSafeBC officers will not accept the laboratory results.

Quality control programs

The analytical methods for asbestos identification and fibre counting accepted by WorkSafeBC require the implementation of a quality control program. A quality assurance officer should be appointed to oversee the program. A quality assurance officer's duties would include

- Obtaining and/or creating sets of reference slides (for fibre counting) and asbestos reference standards (for asbestos identification)
- Overseeing blind recounts on a minimum of 10 percent of filters counted and asbestos bulk samples analyzed
- Identifying any sample custody errors (lost samples, mixed up samples, etc.)
- Checking chemicals (e.g., refractive index liquids) for contamination
- Analyzing blank filters for the presence of asbestos contamination
- Performing proficiency checks on analysts (which could include the use of statistics and control charts)
- Maintaining quality assurance manuals for both asbestos identification and fibre counting (including sample custody procedures, microscope resolution and calibration checks, equipment maintenance records, results from blank samples, records of analyst proficiency, etc.)

The quality control program manual and the latest set of quality control results must be available for inspection by a WorkSafeBC officer.

Laboratories that offer asbestos identification and/or fibre counting services should also participate in external proficiency testing programs. The American Industrial Hygiene Association offers the following proficiency analytical testing (PAT) programs for both asbestos fibre counting and asbestos identification:

- Proficiency Analytical Testing Program for Asbestos (http://admin.aihapat.org/ihpat/Pages/default.aspx)
- Bulk Asbestos Proficiency Analytical Testing Program (http://admin.aihapat.org/bapat/Pages/default.aspx)
- Asbestos Analyst Registry—designed to recognize individual fibre counting analysts outside of established laboratories (http://admin.aiharegistries.org/documents-policies-fees/Documents/AARAnalysts.pdf)

Accreditation programs

National Voluntary Laboratory Accreditation Program (NVLAP)

The National Voluntary Laboratory Accreditation Program (NVLAP) for laboratories analyzing bulk samples by polarized light microscopy (PLM) was established by the National Institute of Standards and Technology (NIST) in 1989. Participating laboratories receive four test samples twice yearly, and are evaluated on their qualitative and semi-quantitative analyses (including a determination of the optical properties of asbestos types present). Proficiency test results are coupled with results of a NVLAP-conducted, on-site assessment to determine a laboratory's accreditation status. Information on NVLAP is available at http://ts.nist.gov/standards/accreditation/index.cfm.

Industrial Hygiene Laboratory Accreditation Program (IHLAP)

The American Industrial Hygiene Association offers bulk asbestos accreditation as part of their IHLAP program. AIHA personnel carry out site visits to laboratories to assess specific analysts as well as the facility. Participation in the AIHA Bulk Asbestos Proficiency Analytical Testing Program is a prerequisite to qualify for IHLAP accreditation. Information on IHLAP is available at http://admin.aihaaccreditedlabs.org/accredprograms/IHLAP/Pages/default.aspx.

Canadian Association for Laboratory Accreditation Inc. (CALA)

CALA (formerly CAEAL) delivers laboratory accreditation for asbestos fibre counting (www.cala.ca/accred_program.html). The association also

operates two other programs that help laboratories meet international accreditation requirements: the Proficiency Testing Program and the Training Service. The granting and maintenance of accreditation is based on satisfactory participation in the site assessment program and in proficiency testing, where such testing is offered as part of the accreditation program.

Asbestos reference materials and calibration standards

National Institute for Standards and Technology

The National Institute for Standards and Technology (NIST) certifies and provides more than 1,300 Standard Reference Materials (SRM), including asbestos standards, which are used to perform instrument calibrations as part of overall quality assurance programs (www.nist.gov/srm).

- SRM 1866a/1866b consists of a set of three asbestos materials—chrysotile, amosite, and crocidolite—and one glass fibre sample.
- SRM 1867a consists of a set of three less common asbestos materials: anthophyllite, tremolite, and actinolite.

The NIOSH and EPA methods recommend the use of asbestos reference standards such as NIST SRM 1866.

RTI International (Research Triangle Park, North Carolina)

RTI International has a repository of reference materials that includes nearly 300 asbestos-containing building materials and asbestos substitutes. They offer a set of bulk reference standards that contains the following:

- Common and uncommon asbestos types, in amounts ranging from 0.3 to 7%
- A variety of binders and matrices
- Common asbestos look-alike fibres
- Non-friable materials

RTI also offers slide mounts of asbestos and other fibre types. For more information, visit www.rti.org and enter “calibration standards” in the search box.

Making your asbestos laboratory safe

There are many types of laboratories, each with very different hazards. But many common control measures can be implemented to prevent accidents, injuries, and disease. The following processes can be used to address health and safety hazards in asbestos laboratories:

- Identify and assess hazards
- Implement an exposure control plan
- Use personal protective equipment
- Prepare for emergencies
- Dispose of wastes properly

Identifying and assessing hazards

Employers need to identify hazards and conduct a hazard assessment before any equipment, machinery, or work process is used or started. Potential hazards include exposure to chemicals, heat, noise, vibration, violence, and ergonomic problems. The hazard assessment should be done in consultation with an occupational health and safety committee or, if there is no committee, a worker representative for health and safety issues.

Once hazards have been identified and assessed, employers need to either eliminate or minimize exposure to the hazards by

- Substituting with safer materials or equipment where feasible
- Using administrative controls (e.g., performing hazardous work away from other workers or after normal working hours)
- Using engineering controls (enclosing the hazardous process or material, providing local exhaust ventilation, etc.)

Personal protective equipment (e.g., respiratory protection) is only used if other control measures cannot provide adequate protection.

Exposure control plan

An employer must develop and implement an exposure control plan (ECP) if a worker has or may have occupational exposure to asbestos. Strict adherence to the ALARA principle, as well as exposure limits and appropriate respiratory protection, are essential elements of exposure control plans. Employers must also ensure that a qualified person performs a formal risk assessment to determine which workers may be exposed to asbestos and the extent of any exposure. The requirements for exposure control plans are found in sections 5.54 and 6.3 of the Occupational Health and Safety Regulation.

An effective exposure control plan for asbestos would include the following five elements:

1. **Statement of purpose and responsibilities:** The purpose of an asbestos exposure control plan is to prevent harmful exposure of workers (including laboratory analysts) to asbestos. Assignment of responsibilities for applying the ECP would depend on the scope of the work and the size of the workplace. For example, a small laboratory may only employ a supervisor and a second analyst. The responsibility for administering the ECP would fall on the supervisor, but the analyst's duties must still be listed. Larger sites may require that responsibilities for different aspects of the ECP be divided between several people.

2. **Risk identification and assessment:** A key step in developing an asbestos exposure control plan is to identify the work activities that would put workers at risk of exposure. A risk assessment takes into account
   - *Route of exposure:* For asbestos, the route of exposure is through the generation of airborne fibres.
   - *Identification of the workers at risk of exposure:* Asbestos analysts are generally at a low risk of exposure, provided that proper engineering controls and work procedures are in place.
   - *Work methods or procedures that may result in exposure:* Working with very friable asbestos samples in a fume hood, cleaning up an asbestos spill, or replacing contaminated fume hood ducting would result in an elevated risk of exposure.

   Periodic air monitoring for asbestos should be conducted during typical work activities (e.g., analysis of friable samples, removal of asbestos waste, and changing the filter in a HEPA vacuum) to assess the potential for analyst or worker overexposure.

   Persons who conduct risk assessments and develop safe work procedures must have experience in the practice of occupational hygiene as it relates to asbestos exposure and should be certified and educated as follows:
   - Certified Industrial Hygienist (CIH) or Registered Occupational Hygienist (ROH) *with education specific to asbestos exposure and work procedures*
   - Certified Safety Professional (CSP), Canadian Registered Safety Professional (CRSP), or a Professional Engineer *with education specific to asbestos exposure and work procedures*
   - Other combinations of education, training, and experience *specific to asbestos exposure and work procedures*

3. **Risk control:** The required controls may range from personal protective equipment (e.g., lab coat, disposable gloves, respirator, and eye protection) to more extensive measures that include engineering controls (all asbestos identification analytical work should be conducted in a HEPA-filtered fume hood/cabinet).

4. **Education and training:** The employer must ensure that workers are informed about the contents of the ECP and provided with adequate education and training to work safely with, and in proximity to, materials that contain asbestos.

   The employer must inform all affected workers of the following:
   - The risk of exposure to asbestos
   - Safe work procedures to be followed
   - Use of respirators and other personal protective equipment
   - How to seek first aid
   - How to report an exposure to airborne asbestos fibres

5. ***Written procedures, hygiene/decontamination facilities, health monitoring and other documentation:*** Written safe work procedures and programs tell workers how to perform their duties safely. Employers must ensure that all workers understand these procedures well enough to perform their duties competently.

   The requirements are as follows:
   - Employers must develop written work procedures for controlling the risk of exposure to asbestos (e.g., disposal of asbestos waste, changing contaminated fume hood ducting, cleanup of an asbestos spill). These procedures must be made readily available to workers.
   - Hygiene facilities to permit proper handwashing, whenever required, are a basic expectation under all ECPs. Decontamination procedures will be needed when cleaning reusable personal protective equipment such as respirators and goggles.
   - A record must be kept of all workers who are exposed to asbestos while on the job, and of worker education and training sessions on the hazards of exposure to asbestos.

The exposure control plan must be reviewed at least annually, and updated as necessary by the employer, in consultation with the workplace health and safety committee or the worker health and safety representative.

Personal protective equipment

Lab coats

Lab coats should be worn in laboratories at all times as part of good general practice. To prevent contamination, protective clothing must not be stored with clean work clothes and personal clothing. Employers must provide regular laundering (based on hazard) or disposal of all required protective clothing.

When sending articles for laundering or dry cleaning, the employer must provide the following written information to the operator of the laundry or dry cleaning facility:

- Identity of any hazardous materials included with the article
- Nature of the hazard
- Any general precautionary measures to be followed when handling the materials

For example, lab coats from an asbestos laboratory might include the following label information:

DANGER!

MAY CONTAIN ASBESTOS DUST
INHALATION HAZARD
AVOID BREATHING THE DUST

Foot protection

Footwear must be of a design, construction, and material appropriate to the protection required. Shoes with non-slip soles should be worn in laboratories. Open-toed shoes and sandals must not be worn by laboratory workers. Workers who need to stand for long periods while working need shoes that provide enough cushioning and support for their feet.

Respiratory protection

Employers must provide appropriate respiratory protective equipment if workers are, or may be, exposed to concentrations of an air contaminant (e.g., asbestos) above the occupational exposure limit. For a list of

exposure limits, see the "Table of Exposure Limits for Chemical and Biological Substances" in Guideline 5.48-1 to Part 5 of the Occupational Health and Safety Regulation.

In general, it should not be necessary for asbestos laboratory workers to wear respiratory protection. Respirators may be required, however, during emergency response procedures such as cleanup of hazardous materials, or during the changing of contaminated ductwork and HEPA filters. Workers who are required to use a respirator must be trained to properly use and maintain it. They must know the limitations of the respirator and be properly fit tested.

If laboratory workers are required to use a respirator, the laboratory must have a respirator program. The program would include worker training on the proper use, care, and cleaning of respirators, as well as regular fit testing. For more information on respiratory protection and respirator programs, see the WorkSafeBC publication *Breathe Safer.*

Emergency preparedness

Laboratories must have written emergency procedures for accidental releases or spills of chemicals or other harmful substances. Employees must be trained in these procedures, which should be posted in work areas where there is a potential for such emergencies. Employers must conduct drills at least once a year to ensure that:

- Emergency exit routes and procedures are effective, and employees are aware of them
- Workers and supervisors are familiar with their roles and responsibilities

Written emergency procedures should include the following:

- Assignment of specific responsibilities to individuals and teams
- Instructions for immediate evacuation of workers
- Instructions for providing first aid to and transporting injured workers
- Appropriate emergency telephone numbers, including telephone numbers of nearby medical facilities so that they can be alerted when injured workers are on their way
- Instructions for safely cleaning up spills and properly disposing of the waste afterwards
- A list of agencies to notify in case of a major release of a toxic or hazardous substance, e.g., WorkSafeBC and the Provincial Emergency Program (www.pep.bc.ca)

- Re-entry procedures for maintenance and cleanup work
- Instructions for scheduling emergency drills and testing of emergency equipment
- Provisions for worker training (for example, on the availability and use of personal protective equipment during an emergency, and how to extinguish small fires)

Spill cleanup

Accidental releases and spills of chemicals or other harmful substances (e.g., asbestos) must be controlled immediately. Workers who clean up spills of hazardous materials must be adequately instructed in safe procedures. The cleanup operation must be supervised by someone who is knowledgeable in the hazards involved and the precautions required. Any personal protective equipment that will be required during emergency cleanup or escape must be stored in a condition and location that make it immediately available.

Emergency washing facilities

Laboratories that handle or store corrosive chemicals or other chemicals harmful to the eyes or skin (e.g., dispersion staining liquids) must have appropriate emergency washing facilities. The facilities must be within either six or 30 metres of work areas, depending on the level of risk.

For low-risk workplaces (e.g., asbestos laboratories) where chemicals or other materials are used in a manner and quantity that present a risk of mild eye or skin irritation, any effective means of eye flushing (e.g., a portable eyewash station) may be used. For specific information on risk assessment and requirements for provision of emergency washing facilities, see Tables 5-2 and 5-3 in the Occupational Health and Safety Regulation.

All workers must know where the eyewash facilities are, and must be trained in their proper use. Each facility must have signs clearly identifying the location and providing clear instructions for proper use.

Eyewash facilities must be tested according to the manufacturer's instructions when first installed, and must be maintained in good working order. Records of maintenance work and testing should be kept.

Fire protection

Laboratories must be equipped with portable fire extinguishers that are immediately accessible wherever flammable materials are used or stored. Workers who may be required to use the fire extinguishers must be trained in their use. Firefighting equipment must be maintained according to manufacturers' instructions.

Table 2: Fire Classes and Types of Extinguishers

Class	Source	Examples	Extinguisher type	Extinguisher characteristics
A	Ordinary combustibles	Wood, paper, cloth	Water, A-B-C dry chemical	Water is dangerous when used in many laboratory situations
B	Liquid fuels	Solvents, oil, gasoline	Carbon dioxide, A-B-C dry chemical	Carbon dioxide dissipates so quickly that hot fuel may reignite; A-B-C dry chemical is the most versatile, but leaves a residue that must be cleaned
C	Electrical	Fuse boxes, motors	Carbon dioxide, A-B-C dry chemical	Carbon dioxide dissipates so quickly that hot fuel may reignite; A-B-C dry chemical is the most versatile, but leaves a residue that must be cleaned
D	Combustible metals	Sodium, potassium, phosphorus	Class D dry chemical	Class D dry chemical is designed for metal fires only
K	Cooking media	Oils, lards, fats	Class K wet chemical	Class K wet chemical is designed for commercial kitchens and reduces the fire's temperature while extinguishing the flames by reacting with cooking oils

A fire safety plan must be in place. Contact the local fire department for the specific requirements. Fire exits and exit routes must be clearly marked and kept free of obstructions at all times. All workers must be properly trained in the fire prevention and emergency evacuation procedures of their workplace.

If a laboratory uses or stores hazardous materials that may endanger firefighters, the employer must notify the local fire department. The fire department needs to know the nature and location of the hazardous materials and how to handle them safely. As part of the fire safety plan, there should be a list of any chemicals stored on-site. In facilities with sprinklers, water-reactive chemicals should be protected from exposure to water.

Waste disposal

Laboratories must have proper waste disposal procedures to prevent injury to laboratory workers and to those who handle laboratory waste.

Asbestos waste

Asbestos waste should be double-bagged and placed in a clearly marked container with an asbestos hazard label. Waste should not be allowed to accumulate in asbestos fume hoods or in the laboratory. Asbestos waste must be properly disposed of in compliance with the *Transport of Dangerous Goods Act* and provincial environmental regulations. *Do not dispose of asbestos waste as regular garbage.*

Glass and sharps

Damaged or broken glassware can cause serious cuts and can spread infection. Broken glass, metal, or other sharp objects (e.g., glass microscope slides and cover slips) that can cut or puncture the skin must be disposed of separately from other laboratory waste, in leak-proof, puncture-resistant containers. These containers must be identified and labelled, and should be located near the area where the waste is generated. Sharps contaminated with asbestos must be disposed of as asbestos waste.

Do not overfill sharps containers. Containers should have a maximum fill line clearly marked.

Fume hoods

An important exposure control measure used in many laboratories is the ventilated work enclosure commonly called a *fume hood.* Fume hoods protect workers from hazardous exposure to airborne contaminants (e.g., asbestos) by capturing fumes, dusts, vapours, and gases generated inside the hood and discharging them safely. Because of the large amounts of air that pass through an operating fume hood, the fume hood is also an important component of the laboratory's general ventilation system.

Fume hoods in asbestos laboratories are of the *conventional* type in which air velocity is affected by the height of a vertically travelling sash or the lateral positioning of two or three horizontal sashes.

Defining laboratory fume hoods

Section 30.7.1 of the Occupational Health and Safety Regulation states that a laboratory fume hood "means an enclosed and mechanically ventilated workspace located in a laboratory, that is designed to

(a) draw air into the workspace and to prevent or minimize the escape of airborne contaminants out of the workspace, and

(b) allow a worker to conduct physical, chemical and biological manipulations inside the workspace."

Airflow monitoring

Air velocities across the operational face of a fume hood must be measured and recorded at least once a year. Air velocities must also be measured if the system does not seem to be working well, and after any repairs or maintenance that could have affected the airflow. For example, as fan belts age, they may loosen and slip, resulting in a loss of airflow.

Air velocities can be measured with direct reading air velocity meters such as a hot-wire anemometer. To determine the average and minimum fume hood air velocity, it is usually enough to measure the air velocity at about nine points in a grid pattern across the operational face.

Fume hoods in asbestos laboratories should provide average air velocities over the operational face of between 0.4 and 0.6 metres per second (80 and 120 feet per minute). Part 30 of the Occupational Health and Safety Regulation specifies flow rates for fume hoods.

(**Note** It might be necessary to temporarily lower the airflow in an asbestos fume hood in order to prevent friable samples from being sucked off the microscope stage and into the exhaust ducting.)

Cross drafts created by personnel traffic, air supply inlets, or the opening and closing of doors or windows can disrupt the airflow across the operational face. Fume hoods must be located so as to prevent or minimize these and other disruptive forces. Smoke testing (for example, using air current tubes) should be carried out to visually assess the uniformity of air currents entering the fume hood. The baffles of the hood should be adjusted to provide a uniform airflow across the operational face.

Design and construction requirements

Fume hoods must be constructed of materials compatible with their use. Asbestos fume hoods can be constructed using Plexiglas.

Location of controls

The controls for operating a fume hood or filtration system must be located outside the fume hood and must be immediately accessible to the laboratory worker.

Ducting

In general, a fume hood must not be connected to a common exhaust duct if

- There is a danger that an explosion may occur in the duct
- Carcinogenic or radioactive materials are used in the fume hood
- There is a danger of backdrafts, which can cause contaminants from one fume hood to be discharged into the laboratory through another fume hood

Fume hoods in separate rooms must not be connected to a common exhaust duct unless there are effective controls to prevent pressure imbalances, and WorkSafeBC has given written permission.

Fume hood local exhaust ventilation systems must discharge to the atmosphere in such a manner that the discharged air will not be recirculated into the laboratory or other work areas. However, under Part 5 (Table 5-1) of the Regulation, recirculation of discharged air is permitted without written approval from WorkSafeBC for *"Asbestos fibre or other particulate, except a biological contaminant, provided that it is exhausted from a portable vacuum cleaner or bench-top containment unit, fitted with an effective HEPA filter."* The efficiency of the HEPA filter should be tested using a suitable indicator chemical, such as dioctyl phthalate (DOP) or polyalphaolefin (PAO) aerosols, at least once per year.

Local ventilation of equipment

Laboratory equipment or instrumentation that may emit harmful airborne quantities of a substance must be equipped with effective local exhaust ventilation. Some analytical equipment (such as gas chromatographs) and some process equipment (such as microwave ovens, muffle furnaces, and reaction vessels) may require this control measure.

The Workplace Hazardous Materials Information System (WHMIS) legislation ensures that workers are provided with adequate health and safety information. Products covered under WHMIS legislation are called *controlled products,* and fall into one or more of the following categories:

- Compressed gas
- Flammable or combustible material
- Oxidizing material
- Poisonous or infectious material (including biohazardous material)
- Corrosive material
- Dangerously reactive material

To help ensure that workers have the required health and safety information to work safely around hazardous chemicals, WHMIS focuses on three main elements:

- Proper labels (supplier labels and workplace labels)
- Material safety data sheets (MSDSs)
- Worker education and training

The two main sources of health and safety information are supplier labels and material safety data sheets. As defined by WHMIS legislation, suppliers are responsible for preparing and providing supplier labels and material safety data sheets for all WHMIS controlled products that they manufacture, import, or sell. For example, when a laboratory imports a specialty chemical that is also a controlled product, the laboratory becomes a supplier under WHMIS. This means the laboratory must provide an up-to-date MSDS and attach a supplier label.

For more information on WHMIS, see the WorkSafeBC publications *WHMIS at Work* and *WHMIS Core Material*.

Labels

All controlled products other than those that are partially or totally exempt must be labelled according to WHMIS regulations. Two types of labels are required under WHMIS:

- Supplier labels, produced by the supplier of the controlled product
- Workplace labels, produced by the employer for use in the workplace

Supplier labels

Supplier labels carry brief statements to inform workers about the risk posed by the chemical, the precautionary measures they should take, and

first aid measures in the event of injury. A supplier label is *not* meant to provide complete health and safety information about a product.

There are four different types of supplier labels. They apply to

- **Laboratory chemicals:** Products from a laboratory supply house, packaged in quantities of less than 10 kilograms, and intended for use in a laboratory
- **Laboratory samples:** Samples of a controlled product that are intended solely to be tested in a laboratory (such as for analytical or research-and-development purposes), packaged in quantities of less than 10 kg
- **Workplace chemicals (> 100 mL):** Products other than laboratory chemicals or samples, and packaged in containers of more than 100 mL
- **Workplace chemicals (< 100 mL):** Products other than laboratory chemicals or samples, and packaged in containers of less than 100 mL

Table 3 summarizes the information required on different supplier labels.

Table 3: Information required on supplier labels

Information required on a supplier label	Laboratory chemical	Laboratory sample	Workplace chemical > 100 mL	Workplace chemical < 100 mL
Product identification (usually the name of the product)	✔	✔ (an emergency phone number must also be provided)	✔	✔
Hazard symbols (classification)			✔	✔
Risk phrases	✔		✔	
Precautionary statements	✔		✔	
First aid measures	✔		✔	
Supplier identification		✔	✔	✔
Reference to availability of MSDS	✔		✔	✔

Chemical identification and workplace labels

If a chemical is transferred from the original container and is for use exclusively within the laboratory, or if the chemical is a controlled product undergoing analysis, the employer must ensure that the contents are clearly identified on the container.

Workplace labels must include

- The product identity
- Safe handling information
- Reference to material safety data sheet

Labels must be replaced if they become illegible.

Material safety data sheets (MSDSs)

A material safety data sheet is a technical bulletin provided by suppliers for each controlled product they sell. It contains detailed, product-specific hazard, precautionary, and emergency information that workers need to read, understand, and use. The data sheet supplements the information provided on supplier labels. For general information on material safety data sheets, refer to the WorkSafeBC publication *WHMIS at Work*.

Employers must ensure that they have a material safety data sheet for each controlled product used or stored in the laboratory. An MSDS, a hazardous waste profile sheet, or an equivalent data sheet must be prepared for hazardous waste containing a controlled product. Employers who produce a controlled product for use in the laboratory must develop an MSDS for the product.

Employers must also ensure that no MSDS is more than three years old. Chemicals are constantly being studied, and new information can affect the health and safety information on an MSDS.

Material safety data sheets must be readily available at the workplace as a reference for workers and for the occupational health and safety committee.

Worker education and training

Employers are responsible for providing worker education and training. WHMIS education must include the

- Elements of the WHMIS program
- Hazards of the chemicals used
- Rights and responsibilities of employers and workers
- Information required on labels and material safety data sheets, and the significance of the information

Workers must be trained in how to read and understand supplier labels and material safety data sheets. All employees who work with or near controlled products must have specific training for all such products.

Employers must develop training programs based on written safe work procedures for routine handling of chemicals as well as on detailed emergency procedures. Such programs must include all controlled products used, including those partially exempt from WHMIS that do not require supplier labels and material safety data sheets.

Maintenance and cleaning staff who may be exposed to spills and other accidental releases of controlled products must also be given the training.

Storage facilities

The first step in organizing chemical stocks in laboratories and storerooms is to establish an inventory. All containers should be labelled with a purchase date and, where applicable, an expiry date. Chemical stocks should be reviewed at least once a year. Chemicals that have expired or deteriorated must be disposed of safely.

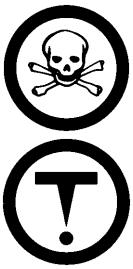
Laboratories should have separate storage facilities for chemicals. Working quantities (small containers of chemicals that are used daily or frequently) can be stored in cupboards or low shelving (below eye level) equipped with either sliding doors or lips that will prevent containers from falling off the shelves. Containers of chemicals stored in laboratories should be the smallest size practicable. Do not store extra containers of the same chemical in the laboratory unless they are being used daily.

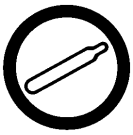
Do not store chemicals in a fume hood unless the fume hood is used exclusively for this purpose and is labelled as a storage area only. Do not store chemicals other than dilute reagents in work areas such as open workbenches or shelving on the workbenches.

Special storage requirements

Chemical storage facilities may require special cabinets and modified shelving, depending on the chemicals being stored. Table 4 summarizes the laboratory use and storage recommendations for specific categories of chemicals.

Table 4: Chemical storage recommendations

Category	Laboratory use	Storage recommendations
Toxic chemicals 	• Use only single, small, daily-use-sized containers.	• Store according to manufacturer's recommendations, away from incompatible chemicals.
Flammable and combustible liquids 	• The maximum quantity allowed in open lab areas is a one work shift supply. • Daily working quantities should be kept to a minimum. • Use only single, small, daily-use-sized containers. • Use safety cans or approved containers whenever practical.	• Not more than 454 litres (120 gallons) of flammable and combustible liquids should be stored in a storage cabinet. • Storage cabinets must be conspicuously labelled to indicate that they contain flammable liquids, and that open flames must be kept away. • Containers should not exceed 4.6 litres (use safety cans or approved containers whenever practical). • No combustible material is permitted in storage rooms. • Do not store in or adjacent to exits, elevators, or routes that provide access to exits. • Consult the B.C. Fire Code and your local fire department for specific details.
Explosive and highly reactive chemicals 	• Keep only the amount needed for the workday. • If explosions or implosions may result from laboratory work, provide adequate shielding for equipment used in such work. Workers must wear personal protective equipment.	• Store in a cool, dry area away from normal work areas and protected from shock, vibration, incompatible chemicals, elevated temperatures, and rapid temperature changes.
Oxidizing agents 	• Use only single, small, daily-use-sized containers.	• Store in a fire-resistant, cool, and well-ventilated area. • Store according to manufacturer's recommendations, away from incompatible chemicals.
Corrosive chemicals 	• Use only single, small, daily-use-sized containers.	• Store in cool, dry, well-ventilated areas on corrosion-resistant material. • Segregate acids and bases.

Category	Laboratory use	Storage recommendations
Water-sensitive chemicals	• Use only single, small, daily-use-sized containers.	• Store in cool, dry areas designed to prevent accidental contact with water and other incompatible substances. • Storage construction should be fire-resistant. • Protect chemicals from water from sprinkler systems.
Compressed gases 	• Keep in the lab only the number of cylinders in daily use. • Label cylinders with the rated pressure and type of gas. • Keep all compressed gas cylinders upright and fully secured against falling. • Keep valve caps on all cylinders not in use. • Before using cylinders, check all fittings and regulators for defects, leaks, oil, and grease. • Use acetylene cylinders in upright position only. If such cylinders have been stored or transported horizontally, let them stand upright at least one hour before use.	• Store compressed gas cylinders in a well-ventilated area, segregated from flammable and corrosive materials. • Separate flammable gases from oxidizing gases with non-combustible partitions. • Protect cylinders from excessive variations in temperature, ignition sources, and direct contact with the ground. • Keep all compressed gas cylinders upright and fully secured against falling. • If pressure testing is required, indicate on the cylinder when it was pressure tested. • Label empty cylinders and store them separately from other cylinders.

Incompatible chemicals

It is not good practice to simply store chemicals on shelves in alphabetical order by name. Each chemical must be evaluated to determine where and how it should be stored. Manufacturers' recommendations should be followed. As a general rule, flammable or combustible liquids, toxic chemicals, explosive chemicals, oxidizing agents, corrosive chemicals, water-sensitive chemicals, and compressed gases should be segregated from each other. They must be stored in such a way that they will not mix with each other if a container leaks or breaks.

Cleaning up chemical spills

Cleanup of chemical spills must be supervised by workers who are knowledgeable about the hazards involved, and who have been trained in safe cleanup procedures. Before attempting to clean up a particular spill, workers must consult the material safety data sheet for information on specific spill cleanup procedures and personal protective equipment required.

Workers must be aware of all hazards associated with the chemical or chemicals that require cleanup. For example, when cleaning up flammable solvents, use an absorbent material that controls flammable vapours as well as the flammable liquid. Commercial spill kits are available for cleaning up hazardous chemicals such as flammable liquids, acids, bases, cyanide, mercury, and hydrofluoric acid.

Handling chemicals

Containers

Containers must be compatible with and resistant to their contents. For example, hydrofluoric acid must not be stored in glass containers, and tetrahydrofuran-chlorinated solvent mixtures must not be stored in stainless steel safety cans.

Inspect chemical stocks regularly. Dispose of damaged containers or those that have deteriorated. Keep containers securely closed, although some—for example, lithium aluminum hydride, formic acid, nitric acid, and chromic acid—may need to be vented periodically to prevent a potentially explosive build-up of gases.

It is good practice to label containers with the purchase date of the chemical and the date when the container was opened. Apply the same labelling practices to containers holding chemicals that have been transferred from their original containers.

In general, keep containers sealed or covered when not in use.

Transporting chemicals

Containers of dangerous chemicals must be transported through the laboratory in a safe manner, so that there is no risk of damage to the containers. Use carrying cases of rubber or plastic to transport corrosive materials, such as acids and bases, in laboratory and storage areas. If a bottle breaks, these cases help contain the spill.

Labelling

Employers must comply with WHMIS requirements regarding both supplier and workplace labels. Labels must be replaced if they become illegible or damaged. Illegible labels can create first aid, handling, and disposal problems.

Factors other than chemical hazards cause a significant proportion of injuries suffered by laboratory workers. These factors include

- The physical requirements of a job, coupled with the workplace environment, that increase the risk of musculoskeletal injuries
- Sharps

Musculoskeletal injury (MSI)

Like most workers, laboratory workers are at risk for MSI, which can result in sprains, strains, and inflammation of soft tissues such as muscles, tendons, and ligaments. Employers must identify and assess the factors in the laboratory that may expose workers to this risk. They must then try to eliminate or minimize the risk using engineering or administrative controls.

Risk factors to consider for MSI include the following:

- **Physical demands of the work being performed,** such as the force needed, the amount of repetitive motion, the duration of such tasks, the postures employed, and exposure to local contact stresses
- **Layout and conditions of the workplace or workstation,** such as how far workers are required to reach, the height of the work surface compared with that of the worker, seating conditions, and floor surface conditions
- **Characteristics of objects handled,** such as size, shape, weight distribution, and types of handles and grips
- **Environmental conditions,** such as illumination and exposure to cold and vibration
- **Organization of the work,** such as work-recovery cycles, the amount of variability in the tasks, and the rate at which workers are required to work

Control measures may include mechanical aids, work procedures, and appropriate use of personal protective equipment. Workers must be educated in the signs and symptoms of MSI, and trained in the use of the control measures. The following tips will help reduce the risk of MSI in laboratory workers:

- Use an ergonomically designed workstation (height-adjustable chair and workbench, good back and elbow support, etc.).
- Ensure that lighting is proper for the task being performed, and that glare is avoided.
- Use appropriate personal protective equipment if necessary (for example, gloves that improve your grip if you have to grasp slippery objects).

- Keep your head aligned with your spine.
- Avoid slouching or bending forward or to the side.
- Design tasks so that they encourage you to change positions frequently.
- Place materials at a comfortable working level, at or slightly below elbow height.
- Organize the work area so that materials and actions are within easy reach.
- Avoid handling heavy or unbalanced objects while sitting down.
- Avoid sitting for more than 30 minutes at a time.
- Use rest periods to relax or move around.

Working safely with microscopes

- Sit back in the chair instead of perching on it.
- Adjust the chair so that your feet rest comfortably—flat on the floor or on a footrest.
- Adjust the seat to put even pressure along the backs of your thighs.
- Adjust the chair back to keep your back in an upright position.
- Adjust the chair's tilt control to ensure that the chair supports your lumbar (lower back) region, or use a lumbar cushion if necessary.
- Ensure that the microscope eyepieces are in line with, or extend over, the front edge of the workbench.
- For comfort, set the vertical position of the eyepieces a little high. This will force you to keep your head upright and prevent strain on your neck.
- If necessary, raise the chair so you can see into the eyepieces. (You may need a footrest to keep your feet in the correct position.)
- Gaze slightly downward into the eyepieces instead of tilting your head down and looking straight ahead. Keep your back vertical and your head and neck upright.
- Ensure that there is no clutter around your legs.
- If the workbench is suitable for microscopy, your thighs should not touch its undersurface.
- The most comfortable position for your hands is to hold them as if you were shaking hands. Your forearms should rest on the workbench to avoid the static loading problems that result if you hold your arms above the bench for long periods.
- To reduce eye strain, adjust the eyepieces for your interpupillary distance, and adjust each individually so that the image in each is sharp.
- Make sure the eyepieces are clean.

- Make sure to correct any personal vision problems. Often microscopy makes vision problems such as astigmatism, nearsightedness/ farsightedness, and poor eye coordination more obvious.
- Reduce glare and reflection, both in your surroundings and in the microscope image. Reposition your workstation, use blinds, and remove highly reflective surfaces. Adjust the transformer or use filters to ensure an appropriate level of light and contrast in the microscope.
- Take regular breaks, and focus your eyes on a distant object periodically.
- To reduce the risk of repetitive strain injuries, take a two- to three-minute break every 30–40 minutes when working at the microscope. Try to rotate work activities to reduce the amount of time you spend at the microscope.
- During your work breaks, do simple stretching exercises.

Appendix

Occupational Health and Safety Regulation checklist for asbestos laboratories

The following checklist outlines the parts and sections of the Occupational Health and Safety Regulation that apply to laboratories that analyze asbestos samples. The checklist is intended for laboratory managers and/or quality control officers to help their laboratories comply with the Regulation. WorkSafeBC occupational hygiene officers may also reference the checklist. The checklist should be completed at least annually as part of a laboratory's exposure control plan.

Regulatory requirements	Yes/No	Regulation Section
Rights and responsibilities		
Are there regular meetings with workers to discuss matters of health and safety?	❑ Yes ❑ No	3.2(a)
Has the employer conducted regular inspections of the workplace(s) for unsafe working conditions?	❑ Yes ❑ No	3.5
Is there provision for occupational first aid?	❑ Yes ❑ No	3.16
General conditions		
Are fire extinguishers present?	❑ Yes ❑ No	4.1
Have workstations (e.g., microscope workstations) been evaluated to minimize the risk of musculoskeletal injuries (MSIs)?	❑ Yes ❑ No	4.47, 4.48, 4.49, 4.50, 4.51, 4.52
Chemical and biological substances		
Does the laboratory have a WHMIS program?	❑ Yes ❑ No	5.5
Have workers received WHMIS training?	❑ Yes ❑ No	5.6
Have workers been trained in the safe use, handling, storage, and disposal of controlled chemicals?	❑ Yes ❑ No	5.7(1)(a)
Have chemicals been labelled with workplace laboratory labels?	❑ Yes ❑ No	5.13(1)
Are material safety data sheets for controlled products present and available to workers?	❑ Yes ❑ No	5.14(1)
Has the employer conducted workplace monitoring for substances listed in the Table of Exposure Limits for Chemical and Biological Substances (e.g., asbestos)?	❑ Yes ❑ No	5.48
Does the employer have an exposure control plan for substances listed in the Table of Exposure Limits for Chemical and Biological Substances? This would include engineering controls (see below), administrative controls, education and training, safe work procedures, personal protective equipment (see below), etc.	❑ Yes ❑ No	5.54
Are engineering controls (e.g., local exhaust ventilation) in use to reduce worker exposure to asbestos?	❑ Yes ❑ No	5.55, 5.64
If the laboratory fume hoods are exhausted into the workplace, are they equipped with a HEPA filter (to filter the discharged air)?	❑ Yes ❑ No	5.70
Is the HEPA filter tested on an annual basis (to ensure that the filter is *effective*)?	❑ Yes ❑ No	5.70
Are emergency eyewash facilities or equipment present?	❑ Yes ❑ No	5.85

Regulatory requirements	Yes/No	Regulation Section
Substance specific requirements—asbestos		
Is the laboratory following analytical methods acceptable to WorkSafeBC (e.g., *National Institute for Occupational Safety and Health Manual of Analytical Methods, Method 9002*)?	❑ Yes ❑ No	6.1
Does the employer have an exposure control plan for asbestos?	❑ Yes ❑ No	6.3
Are there procedures/equipment in place (e.g., fume hoods) to control the release of asbestos fibres?	❑ Yes ❑ No	6.8
Have the workers received training in the hazards of asbestos?	❑ Yes ❑ No	6.11
Are asbestos waste containers properly labelled and sealed?	❑ Yes ❑ No	6.25
Personal protective clothing and equipment		
Is safety eyewear available and in use?	❑ Yes ❑ No	8.14(1)
Are workers wearing protective footwear (e.g., no open-toed shoes)?	❑ Yes ❑ No	8.22(1)
Are workers wearing respirators when exposed to asbestos (e.g., during the replacement of HEPA filters and/or contaminated ducting)?	❑ Yes ❑ No	8.32
Have the respirators been fit tested?	❑ Yes ❑ No	8.40
Laboratories		
Have the analysts been properly trained in the use of the laboratory equipment?	❑ Yes ❑ No	30.2
Is laboratory equipment (e.g., fume hoods and furnaces) equipped with an effective local exhaust ventilation system?	❑ Yes ❑ No	30.7
Is fume hood airflow monitoring conducted on an annual basis?	❑ Yes ❑ No	30.9(1)
Is the airflow into the fume hoods within the range specified in the Regulation?	❑ Yes ❑ No	30.8
If the fume hoods are connected to a common exhaust, has the ducting been designed in accordance with established engineering principles?	❑ Yes ❑ No	30.10(3)
Does the laboratory have written safe work procedures for the handling and disposal of hazardous chemicals?	❑ Yes ❑ No	30.14
Does the laboratory have a proper chemical storage facility?	❑ Yes ❑ No	30.17(1)
Have workers received training in safe work procedures for the handling and disposal of hazardous chemicals?	❑ Yes ❑ No	30.17(5)
Does the laboratory have procedures in place for emergency spill cleanup?	❑ Yes ❑ No	30.18(1)
Does the laboratory have procedures and equipment in place for the safe handling and disposal of sharps (e.g., glass slides and cover slips)?	❑ Yes ❑ No	30.25

Notes

Notes

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R06/06

R06/08 Printed in Canada BK114