Chapter 4: Facility Design and Safety Equipment

Overview

As the previous chapters have shown, many municipal, provincial, and federal laws and regulations govern safety in schools and their science facilities. Some of these relate to the plans we put in place and the procedures we use. Others relate to the physical environment: the design of the facility and the safety supplies kept in that facility. This chapter outlines guidelines and rules surrounding facility design and safety equipment.

Assessing the Suitability of Facilities for Science

The selection and planning of science activities must take into account the strengths and limitations of available facilities. Although some introductory activities do not impose any facility requirements, many others—particularly at the secondary level—require some minimal facility characteristics (e.g., flat-topped surfaces are needed for activities with containers of liquids). For some activities, the use of purpose-built laboratory facilities is a practical necessity.

Figure 1 ***Shelving***

In this diagram, heavy objects can be seen on the top of the cupboards. Controlled products should be stored no higher than at eye level to reduce the chance of an accident.

When deciding whether a given facility is adequate, the following factors should be considered:

- How many students will be allocated to the class? Keep in mind that overcrowding increases risks.
- How is the facility configured? Does it allow the teacher to see all the students? Does it provide easy passage from one area to another without increasing the risk of bumping into one another?
- Does the facility have sinks? How many will the class need? Is the number sufficient for clean-up and emergency flushing?
- Does the facility have appropriate emergency response equipment (e.g., an eyewash fountain, a fire extinguisher, etc.)?
- Does the facility have sufficient storage and/or adjacent preparation areas that minimize the need to transport equipment and supplies through the school? Are the storage and preparation areas lockable?
- Does the facility have adequate ventilation?
- Does the facility have an effectively functioning fume hood that can be used in teacher demonstrations and lab preparation?

The following pages present required, recommended, as well as optional equipment that should be available to students and staff in a well planned, safety-conscious laboratory or multi-use laboratory.

Room Safety Equipment and Utilities

Notes	✓-Required	NR–Not Required	REC–Recommended			
Item or Component	K-4	5-8[1]	Grade 9 to 12[2]			
			General Science	Biology	Chemistry	Physics
Safety Equipment						
Fire extinguisher (Type ABC)	✓	✓	✓	✓	✓	✓
Fire blanket[3]	NR	REC	REC	REC	REC	REC
First aid kit (see details in document)	✓	✓	✓	✓	✓	✓
Emergency shower[4]	NR	NR	REC	REC	REC	NR
Eyewash[5]	NR	✓	✓	✓	✓	NR
Safety goggles	REC	✓	✓	✓	✓	✓
Safety goggle sterilizing cabinet[6]	NR	✓	✓	✓	✓	✓
Utilities						
Water	✓	✓	✓	✓	✓	✓
Sinks (stainless)	1 large	4	12	12	12	1
Hot water taps	At least 1	Min 2	12	12	12	1
Acid dilution tank[7]	NR	NR	NR	NR	NR	NR
Water master shut-off control	NR	✓	✓	✓	✓	✓
Electrical						
Duplex receptacles (GIF)	1 near sink	8	10	12	12	12
Electrical master shut-off control	✓	✓	✓	✓	✓	✓
Gas						
Duplex gas jets	NR	REC	8	REC	10	REC
Gas master shut-off valve	NR	REC	✓	REC	✓	REC

1. For Grades 5-8, the room would be a dedicated science laboratory to require the indicated equipment.
2. Although a lab may be dedicated for a specific subject, it is always better to outfit all laboratories with complete safety equipment to allow flexibility for use in all science courses.
3. All fire inspectors do not recommend fire blankets, as they require proper usage to avoid further damage to burned skin. Check with your local fire marshal.
4. Emergency shower must meet ANSI Standard Z358.1-2004.
5. Eyewash equipment must meet ANSI Standard Z358.1-2004.
6. A sterilizing cabinet is not required if other means of effective goggle sterilization are used.
7. These tanks must be serviced every three years and the servicing date recorded. Check local sewer bylaws for this requirement. Acid dilution tanks are not recommended in Winnipeg or Steinbach.

Item or Component	K-4	5-8	Grade 9 to 12			
Communication						
Emergency telephone	✓	✓	✓	✓	✓	✓
Wireless computers[1]	REC	REC	REC	REC	REC	REC

Room Design						
Item or Component	K-4	5-8[2]	Grade 9 to 12			
			General Science	Biology	Chemistry	Physics
Lab size of 112m[2]	N/A	REC	REC	REC	REC	REC
Demonstration table[3]	NR	REC	REC	REC	REC	REC
Movable tables[4]	REC	REC	REC	REC	REC	REC
Source of natural light (windows)	REC	REC	REC	REC	REC	REC
Two exits from room	REC	REC	REC	REC	REC	REC
Fume hood[5]	NR	NR	REC	REC	✓	REC
Work station for students with special needs	NR	✓	✓	✓	✓	✓
Chemical-resistant countertop or tabletop with storage cabinets	NR	✓	✓	✓	✓	✓
Storage (See Storage Facilities for Chemicals, Chapter 10)						
Separate chemical storage room including locking acid/base and flammables cabinets, and continuous room fan	NR	NR	✓	✓	✓	NR
Storage and Preparation Areas						
Science preparation area consisting of a large sink with h/c water, general storage shelves, and ventilation (not to be used as general teacher office area/ working station or chemical storage)	NR	✓	✓	✓	✓	✓
Adequate GFI electrical outlets to accommodate specialized equipment	NR	✓	✓	✓	✓	✓

1. To reduce the number of cables, which can cause clutter and accidents, consider using battery-operated computer equipment and wireless Internet.
2. For Grades 5-8, the room would be a dedicated science laboratory to require the indicated equipment.
3. The demonstration table would contain a large sink, hot and cold water, electrical duplex plugs, drawers, cupboards, and a heat-resistant top.
4. For dedicated labs in Grades 9 to 12, alternate pods or similar designs may be preferred.
5. Fume hoods must meet or exceed CSA and ANSI standards.

Safety Equipment and Supplies

Having the proper safety equipment and supplies in place in science areas of a school is critical to managing risks and dealing with emergencies that may arise. This section discusses essential safety equipment and some basic procedures for using these resources. Appendix D provides a laboratory safety checklist.

General Safety Equipment for Science Laboratories and Multi-use Laboratories.

This list identifies general safety equipment that is either essential or highly recommended in the science area of the school. Safety can be further enhanced by making sure that teachers, students, and technicians are familiar with the location and use of this equipment, that the equipment is easily accessible, and that safety posters are displayed. Consider assembling a "safety cart" that contains materials to handle spills, self-protection equipment, and a first aid kit. See Equipment for Clean-up and Disposal of Chemical Spills (on page 54) later in this chapter. Have this cart in an easily accessible, central location so it can be wheeled in to handle a safety situation.

Equipment	Comments
ABC-type dry chemical fire extinguisher	Install only extinguishers that are required by existing fire codes. Note that the number in the extinguisher type refers to its volume capacity and the letters identify the class of fire(s) that can be put out. Refer to the Fire Extinguishers section of this chapter for *Manitoba Fire Code* specifications on location of extinguishers. After use, the extinguisher will require service. Demonstrations should not be done with this extinguisher; a spare extinguisher should be reserved for that purpose.
First aid kit	One kit per lab is strongly recommended for schools. Please refer to the First Aid Kits section for more information.

Equipment	Comments
Eyewash station, emergency and personal (squeeze bottle)	According to occupational health and safety regulations, an emergency eyewash station is required in areas where corrosive chemicals are used. Eyewash stations should meet Canadian Standards Association (CSA) and American National Standards Institution (ANSI) specifications. The water supply should be tempered by mixing hot and cold water and, once activated, should run hands-free. The eyewash station must provide a continuous flushing fluid to both eyes at a minimum of 1.5 L per minute for 15 minutes. It can be plumbed in or portable. Portable bottles (squeeze bottles) do not meet this standard. All emergency eyewash stations, whether fixed or portable, require routine maintenance to ensure proper functioning and cleanliness. This requires that they be tested regularly to verify that they are operating properly. Such testing also prevents growth of microbes in stagnant residual water, and flushes out any dirt, rust, or pipe scale that may be present. To reduce rapid and frequent corrosion of the system in hard water areas, use a water softener or a system with its own supply of distilled or buffered water. In some situations, the most practical solution may be to purchase a portable emergency eyewash unit with its own water supply. Where portable eyewash squeeze bottles are provided, the bottles must be filled with buffered solution supplied by the manufacturer and changed regularly as per the manufacturer's instructions. A buffered saline solution preserved with a suitable antibacterial agent is also available.
Hand-washing facilities	Hand-washing facilities should be available in or near each science classroom.
Emergency shower	If large amounts of caustic or flammable controlled products are used, an emergency shower is required. This washing equipment must meet the requirements and be installed, tested, and maintained in accordance with ANSI Standard Z358.1-04 and the equipment manufacturer's specifications. The chemical preparation area should have a shower. However, because small quantities of chemicals are used by students, showers are not necessary in classrooms.
Fume hood	A fume hood is required for high school chemistry laboratories or any lab where there is a need to dilute corrosive substances, dispense volatile liquids, as well as dispense more toxic powdered substances to minimize inhalation of caustic fumes and air-borne powder. Fume hoods should meet ANSI specifications and should be inspected at least once a year by a qualified person. Inspections should be recorded on a tag attached to the fume hood.

Equipment	Comments
Safety shield	This is a portable, clear, free-standing screen that can be set up between a dangerous demonstration and the classroom. The shield should be polycarbonate (for strength) with a base that is sturdy and heavy. It should also be large enough to adequately screen the apparatus/equipment in the demonstration. If there is a possibility of an explosion or spray from the demonstration, the shield should be securely clamped or fastened to the table or desk to prevent it from being knocked over.
Ultraviolet goggle sterilizing cabinet	The cabinet must have interlocking doors and be locked while UV sterilization is running. Cabinet not required if other sterilization procedures are in place.
*Fire blankets (discretionary item)	Fire blankets are not a fire code requirement. They require proper usage to avoid further damage to burned skin. Check with your local fire marshal for more details. Blankets containing asbestos should be removed from the school.
Personal Protective Equipment (students)	
The following list identifies personal protective equipment that should be present in every classroom that is used as a science laboratory. If injuries to students result from the failure to have or to use personal protective equipment, negligence may be claimed. Appropriate safety equipment should be identified for use prior to each laboratory activity as part of a routine with students. Refer to Student Safety Training (on page 27) in Chapter 2 for more information on the use of personal protective equipment.	
Protective goggles	Eye protection must be CSA-approved and must be worn whenever there is the risk of eye injury. Goggles should be designed to completely enclose the eye area; fitted side-shields are one such option. If glasses are normally worn, goggles should fit over them. Goggles should be sterilized in a sterilizing cabinet after each use.
Laboratory coats or aprons	Laboratory coats and aprons should be made of approved material only, and should be worn when working with chemicals and, when appropriate, during other science activities (e.g., biology). Coats are preferable to aprons.
Non-latex disposable gloves (Neoprene®, nitrile, or Tactylon®)	Gloves should be worn when handling hazardous chemicals and in biological experiments. Gloves should be used in combination with other measures because gloves may only slow down transmission of some materials, not completely prevent it. Note that some students and staff may have latex allergies.

Equipment	Comments
Heat-resistant gloves	Heat-resistant gloves should be available when necessary. These gloves should be made of treated texture silica or woven fabric. Do not use asbestos gloves.
Beaker tongs	Use tongs with heat-resistant gloves when handling very hot beakers.
UV filtering glasses	Eye protection should be worn when UV sources are in use (e.g., discharge tubes, mercury, or ion arcs, lamps for fluorescent "black light" experiments). Appropriate glasses include any glasses labelled "Blocks 99% or 100% of UV rays," "UV absorption up to 400 mm," "Special Purpose," "BS," or "Meets ANSI UV requirements."
Personal Protective Equipment (for school staff)	
Acid-proof gloves (Gauntlets)	There should be one pair of acid-proof, elbow-length gloves for each staff member who uses a school laboratory in which acids and bases are used in any concentration. These should clearly be labelled for size and user. These gloves would be used for working with corrosive materials in the fume hood or for transporting acids and bases. These gloves must be ANSI standard approved.
Face shield	There should be at least two safety shield face masks for each high school chemistry and biology laboratory. These face shields must be ANSI standard approved.
Acid-proof aprons	There should be at least two acid-proof aprons available in any laboratory where acids and bases are used. These aprons must be ANSI standard approved.
Respirators	**It is not recommended that teachers handle major spills that require respirators.** If staff members are willing to deal with chemical spills and are trained to do so, they must be fit-tested with a respirator. These respirators should be labelled with the name of the staff member for whom the respirator has been fitted. Fit testing should be repeated every three years.

General Facility Equipment

Fire Extinguishers

The *Manitoba Fire Code* indicates that the number and location of fire extinguishers should be governed by factors such as floor space, hazard levels, and the physical design of the building. It also requires that a fire extinguisher be located in strategic sites along corridors, as well as in either the chemical storage room or just outside this room (and recommends one in both locations, given the increased hazard level in the area). Although not compulsory by code, placement of a fire extinguisher in every laboratory is recommended.

Figure 2 **Fire Extinguisher**

The following chart shows fire extinguisher types that may be appropriate for use in schools (the type will be identified on an inspection label on the unit). ABC extinguishers are recommended (a fire code recommendation) for all school locations because they avoid the need to classify the fire and select the appropriate extinguisher and only one operational procedure must be learned and remembered.

Type	Extinguishing agent	Use
Class A	Water	Fires involving ordinary combustible materials such as wood, cloths, or paper.
Class B	Dry chemical foam, carbon dioxide	Fires involving flammable liquids such as solvents, grease, gasoline, or oil, and fires involving ordinary combustible materials.
Class C	Dry chemical and carbon dioxide	Fires involving electrical equipment.
Class D	Special dry powder, medium or dry sand.	Fires involving combustible metals, magnesium, sodium, lithium, or powdered zinc.
Class ABC	Dry chemical	All materials and fire types.

Schools can maximize the value of fire extinguishers by

- placing extinguishers near an escape route, not in a 'dead end' location
- ensuring all teachers and support staff working in the science area know the location of all fire extinguishers, and understand when and how to use the kinds of fire extinguishers installed on-site
- having fire extinguishers inspected once a year by the local fire department or an approved agency, with inspection records kept by the principal or district administrator

First Aid Kits

First aid kits are required by schools under the *Workplace Health and Safety Regulations*. The following table indicates the number of kits that must be provided according to the number of workers employed at a workplace. These regulations do not apply to students but can serve as a guide. In addition to having a kit at a central location, schools will normally maintain additional kits at or near facilities where activities may pose particular risks. To meet the needs of science laboratories, the recommended approach is to stock a kit in each laboratory or at a location readily accessible to several laboratories.

Figure 3 **First Aid Kit**

Kits are available from St. John Ambulance, Canadian Red Cross, and most science supply companies.

The contents of first aid kits should be checked and replenished regularly. The kit container should be clearly marked and readily accessible, and should keep the contents dry and dust-free.

According to Schedule B of the *Workplace Safety and Health Regulations*, first aid kits must contain the following items:

Manitoba regulations require first aid kits in accordance with the following table

Total number of workers employed	Number of Schedule B first aid kits
24 or fewer	1
25–50	2
51–75	3
76 or more	4

All schools must have at least one first aid kit located in the office.

First aid kits should also be located in higher risk areas such as industrial arts classes and dedicated science laboratories.

General:

- A recent edition of first aid manual
- A pair of impervious disposable gloves
- A disposable resuscitation mask with a one-way valve
- A disposable cold compress
- 12 safety pins
- Splinter forceps
- One pair of 12 cm bandage scissors
- 25 antiseptic swabs
- Waterless hand cleaner
- Waterproof waste bag

Dressings (must be sterile and individually wrapped):

- 16 surgical gauze pads (7.5 cm squares)
- 4 pads (7.5 cm X 10 cm, non-adhesive)
- 32 adhesive dressings (2.5 cm wide)
- 2 large pressure dressings

Bandages:

- 3 triangular bandages (1 m each)
- 2 conforming bandages (10 cm each)
- 2 rolls of 7.5 cm tensor bandage
- 2 rolls of 2.5 cm adhesive tape
- 1 roll of 7.5 cm elastic adhesive bandage

Equipment for Clean-up and Disposal of Chemical Spills

The following list identifies items to keep in the laboratory in a clearly identified and accessible location for clean-up and disposal of spills. See Chapter 8 for clean-up and disposal procedures for different kinds of chemical spills.

Items	Comments
Acid, base, and solvent spill kits	Spill kits are used for absorbing spills or diluting solutions of chemicals. Use these kits for clean-up of small spills (follow manufacturer's instructions).
Hazorb spill control pillows	These pillows are available from most safety supply companies. Pillows are used to absorb spilled liquids (follow manufacturer's instructions).
Several litres of asbestos-free vermiculite, bentonite, or diatomaceous earth in container with scoop	These materials can be used for spills of solid chemicals, especially powders and viscous or sticky liquids. Containers should be clearly labelled and contents disposed of safely.
Containers suitable for waste chemicals and solvents	Each chemical must be collected separately and labelled according to WHMIS specifications. Waste solvents should be collected only in a safety disposal can with an automatic pressure release closure.
Waste container for glass and sharp objects	A separate container for these items must be available to reduce the chance of injury to maintenance and janitorial staff responsible for normal garbage disposal.
Large container of dry $NaHCO_3$ (baking soda)	Baking soda can be used to neutralize strong acids before disposal. Swimming pool and spa suppliers stock inexpensive, large-volume containers of $NaHCO_3$.
Plastic dustpan and brush	Use the dustpan and brush for sweeping up used sand, vermiculite, or broken glass. Wash and dry both thoroughly after use.
Heavy-duty garbage bags	For disposal of all solid waste, including used sand, vermiculite, and contaminated broken glass. Dispose of each spill separately. Tie bags very securely, double bag if necessary, and label for disposal.
Biohazard bags or extra-thick garbage bags	For disposal of biological specimens and cultures.

Generic Spill Kit

A generic spill-kit mixture can be made simply by mixing equal volumes of sodium carbonate, bentonite (clay cat litter), and dry sand in a plastic container with a lid. Shake the container until the components are mixed. The contents can be mixed again just prior to use when cleaning up a chemical spill. This mixture is effective in the clean-up of the majority of spills. See Chapter 8, Managing the Release or Spill of Toxic or Corrosive Substances (on page 108), for more information on use.

Monitoring and Assessment

Ongoing monitoring and assessment are important steps in maintaining and improving the condition of science facilities, equipment, and materials. Regular performance of these activities supports a proactive approach to repairs and maintenance, which in turn reduces risks for accidents. Monitoring and assessment activities can take place through periodic inventory of equipment and materials and the completion of laboratory checklists such as the one provided in Appendix D.