FACILITY DESIGN & SAFETY EQUIPMENT

CONTENTS

Overview

As the previous chapters have illustrated, science safety is not governed by only one piece of legislation. It is important to remember that safety in the science classroom is covered under many laws and regulations. Some aspects relate to how things are done, the plans put in place and the procedures used, while 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. It is important to remember that the original legislation should be reviewed to ensure compliance with the legal requirements.

Assessing the suitability of facilities for science

Science activity selection and planning 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. The available facility characteristics may limit the types of science activities that can be undertaken at a location.

When deciding whether a facility is adequate for the activities selected, consider the following factors:

- Does the facility have flat topped surfaces? How much flat top surface will be necessary?
- Does the facility have sinks?
    - How many will the class need?
    - Is the number sufficient for clean-up and emergency flushing?
- How many students are in the class, and how much space does the activity require? 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 risk of bumping into each other?
- Does the facility have appropriate emergency response equipment? Such as:
    - An eyewash station.
    - A shower.
    - A fire extinguisher, and
    - A spill kit.
- Does the facility have sufficient storage and adjacent preparation areas that minimize the need to transport equipment and supplies through the school?
- Is the storage and preparation area lockable?
- Does the facility have adequate ventilation, and
- Does the facility have a functioning fume hood that can be used in teacher demonstrations and clean-ups?

In planning for science activities, teachers should also be aware of any local standards that may have been established. For example, in some cases a school or division may determine the maximum number of students for a given facility and the number of students under the guidance of one teacher in that facility.

Facility checklist

The following checklists are adapted from *Science and Safety, Making the Connection* (Council of State Science Supervisors, 2002), and the *National Science Teachers Association: Guide to Planning School Science Facilities*, 2007. This is not an exhaustive checklist and is only intended to address the needs of science laboratories for grades 7 to 12.

Layout and space

- The room has adequate space:
  - ◻ A laboratory space should have at least 1200 ft^2.
  - ◻ A combination classroom laboratory should have at least 1440 ft^2.
- Aisle width is adequate to accommodate equipment and students with additional needs.
- Workspace per student is adequate:
  - ◻ With an occupancy maximum of 24 students, the standard for just a laboratory is 50 ft^2 per occupant and 60 ft^2 per occupant for a combination classroom laboratory.
- The teacher can see students in all locations of the room, and
- The general light level is sufficient.

Safety equipment

- A telephone or intercom is available in case of emergencies.
- Fire and heat detectors are installed in laboratories, science preparation rooms, chemical storage areas, waste disposal areas, and any other high-risk areas, and
- At least one emergency eyewash station is located in areas where corrosive chemicals are used. If an eyewash or emergency shower is required, it must meet the requirements outlined in the American National Standards Institute (ANSI) Z358.1-2009 standard to be considered "approved" under *OHS Regulations, 1996*. Requirements on the flow rate, design and placement of emergency eyewash stations are outlined in the ANSI Z358.1-2009 standard.

An emergency eyewash station is defined as one that provides 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 a self contained unit. Portable bottles (squeeze bottles) do not meet this standard. Squeeze bottles, however, are also to be made available for all activities where there is risk of materials entering the eye.

See the **Safety equipment and supplies** section in this chapter for more information on eyewash stations.

Exits

- The room has two exits, both with doors that open outward and have reinforced glass viewing windows or peepholes.
- Exits are labelled, open easily and do not require a key to exit, and
- Doorway widths are sufficient to accommodate students with additional needs, allow movement of equipment carts and serve as emergency exits.

Construction materials

- Ceilings are constructed out of a material with a low flame-spread rating.
    - For example, drywall.
- Floors are even, free of cracks and have a non-skid surface.
    - Sheet flooring is preferable to tiles or carpets, and
    - Tile floors should be covered with a non-skid wax.
- Laboratory bench surfaces are made of material resistant to acids, alkalis, solvents and temperate heat.

Ventilation

- Air in the room is recycled and mixed with outside air at a rate of 4 to 12 complete laboratory air changes per hour, depending on the chemicals used, or a minimum of 15 L per second per occupant.
- The exhaust ventilation system is separate from that of the chemical fume hood.
- The hood(s) of the exhaust ventilation system is located away from doorways, windows, high traffic areas or areas with disrupted airflow.
- Exhaust hoods should not be used unless they are verified as working.
- Each exhaust hood should be posted with the date and outcome (pass or fail) of the last performance testing. If the hood failed the testing it should be taken out of service until repaired or posted with a restricted use notice, and
- Where fume hoods exist, the functional and maintenance standards that apply are those of the ANSI. These include an average face velocity of at least 0.5 m/s and all individual face velocity readings above 0.43 m/s. Exhaust is vented to the outside wall or roof vent. For more details on fume hoods, see the **Safety equipment and supplies** section in this chapter.

Electrical

- Electrical aspects are governed by *The Canadian Electrical Code (Saskatchewan Amendments) Regulations, 2012*.
- Clarification on requirements should be sought from SaskPower.
- Fume hood controls are located outside the fume hood in an immediately accessible area.
- All outlets must be grounded as per Occupational Safety and Health Administration (OSHA) and should have ground-fault interrupters to control shock and fire hazards.

Plumbing

- Plumbing is free of leaks or cracks, and drains are made of chemical resistant material.
- Counter tops are lipped toward the sink.
- A plumbed-in emergency eyewash station and shower is provided in laboratories where corrosive chemicals are used. The preferred location of the shower is in an adjacent nook that is equipped with a wastewater holding receptacle, rather than direct drainage into a sewage system, and
- Water taps may be located inside the fume hood cabinet if there is a main shutoff valve in another area of the laboratory.

Storage and preparation facilities

- Chemical storage area is adequate in size, well ventilated, secured from student access, built with low flame-spread rating materials, and has an adequate drain at the lowest point. See **Chapter 8** for more specific guidelines.
- Adequate area for the long-term storage of laboratory equipment and supplies and safety equipment.
- Preparation area, including bench space, sink and fume hood for making solutions and other materials for class use. It should also allow for storage of MSDSs, WHMIS and transportation of dangerous goods (TDG) information.
- Area for temporary storage of materials for later use, left-over materials from laboratory activities, and chemical waste storage for year-end disposal, and
- Adequate refrigeration is available for storing fresh tissue/organs, enzymes, specific chemicals, agar plates and perishables.
    - If explosive chemicals require refrigeration, the refrigerator should have an explosion proof rating.
    - Shelving in the refrigerator should have raised edges to prevent bottles from falling, and
    - Refrigerator should have a clear label to ensure no food or drink is stored inside for human consumption.

Other resources

- Additional equipment, as indicated below, may in some situations help ensure that safe and efficient procedures are followed.
- Computer to track school equipment and chemical inventories or to view the MSDS database as well as access regulations.
    - Note that *OHS Regulations, 1996* requires MSDSs to be in a database or readily accessible form meaning staff can not search for the MSDS on the internet.
- Microwave to prepare materials such as gelatin and agar and a clear label stating the microwave is for laboratory use only and not for heating food/beverage for human consumption, and
- Dishwasher to clean equipment, reducing the risk of injuries from broken glass and chemical exposure.

Safety equipment and supplies

Having the proper safety equipment and supplies in place in school science areas 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.

General safety equipment for science classrooms

With the exception of the fire blanket, 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 teachers, students and technicians are familiar with the location and use of this equipment, the equipment is easily accessible, and safety posters are displayed.

Equipment	Comments
Fire extinguisher	National Fire Protection Association (NFPA) 10 sets the regulatory requirements for fire extinguishers in Saskatchewan. NFPA 10 covers installations for Class A, B, C, D, and K hazards as well as the selection, inspection, maintenance, recharging, and testing of portable fire extinguishing equipment. It also includes a list of obsolete fire extinguishers that should be removed from service. For more information see the **Fire extinguishers** section later in this chapter.
First aid kit	According to the *OHS Regulations 1996*, every employer must provide a first aid station containing supplies set out in Table 10. This table is found in the *OHS Regulations 1996* Appendix. It is recommended that science laboratories have kits in the room because the risk for injury is higher. For more information, see the **First aid kits** section in this chapter.

Equipment	Comments
Eyewash station, emergency and personal (squeeze bottle)	The OHS document "Guidelines for emergency shower and eyewash in the workplace" should be referenced by each school division to ensure compliance. See **Appendix 4**. OHS legislation outlines that eye flushing equipment must be readily accessible if there is a corrosive or other harmful substance in the environment. Eyewash stations must meet ANSI specifications. See the **Facility checklist** section in this chapter for more detail. The water supply should be lukewarm water or another appropriate liquid. Once the unit is activated, it should run without further use of the operator's hands. All emergency eyewash stations, whether fixed or portable, require routine maintenance to ensure proper functioning and cleanliness. This requires regular testing to verify that it is 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. In areas with hard water, keeping a plumbed in system operable is a major challenge. Two options that should be investigated to reduce rapid and frequent corrosion of the system is the use of a water softener or the attachment of the system to its own supply of distilled or buffered water, which can be replenished as required. 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 are filled with buffered solution supplied by the manufacturer and changed regularly as per manufacturer's instructions. Also available for purchase is a buffered saline solution preserved with a suitable antibacterial agent. The antibacterial agent prolongs the shelf life of the bottle contents and the buffered saline solution is less irritating to the eyes than water out of the tap.
Simple/hand washing facilities	Hand washing facilities should be available in or near each science classroom. Proper hand washing techniques should also be taught.
Emergency shower	Depending on chemical type, lesser volumes of very harmful substances (for example, hydrofluoric acid) can cause sever or lethal effects even if small areas of the skin are contaminated. If chemicals such as these or large amounts of caustic or flammable stock are used, a deluge shower is required as specified on chemical's MSDS. The water must be delivered at least 75 L/Min for at least 15 minutes in both plumbed and self contained units. The water temperature should be kept constant and between 15°C and 35°C. Refer to ANSI standard for all requirements of approved emergency showers. It should also be noted that a telephone shower is acceptable for removing offensive substances and some substances that could be harmful if chronic exposure occurs. Regular showers can be modified to meet ANSI requirement for flow rate.

Equipment	Comments
Fume hood	One is strongly recommended for science preparation rooms in middle years and secondary levels. The inclusion of a fume hood in secondary school chemistry laboratories is also recommended. In middle years, science programs and textbook resources do not call for chemicals requiring use of a fume hood. Fume hoods should meet ANSI specifications and should be inspected at least once a year by a qualified person. The date and outcome of this inspection should be posted on the hood. Fume hoods are invaluable when dispensing volatile liquids, and more toxic powdered chemical to minimize inhalation of fumes and air-borne power. In secondary school chemistry, fume hoods become more useful in performing reactions that generate toxic fumes.
Ultraviolet goggle sterilizing cabinet	A sterilizing cabinet is recommended in middle and secondary schools and one cabinet can serve several classrooms. The cabinet should have interlocking doors. A cabinet is not needed if each student has his or her own goggles or if other methods of sterilization such as a disinfectant solution are used.
Discretionary Fire blankets (not a Fire Code requirement)	Fire blankets are not recommended by all fire inspectors and require proper usage to avoid further damage to burned skin. Check with your local Fire Chief for more details. Blankets containing asbestos should be removed from the school.

Personal protective equipment

The following list identifies personal protective equipment (PPE) 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 use PPE, negligence may be claimed. As part of a routine with students, prior to each laboratory activity, the teacher should discuss the appropriate PPE measures. Refer to **Chapter 4 Student safety training** for more information on use of PPE.

Equipment	Comments
Protective goggles, glasses or plastic face shields (one per student and teacher)	The OHS guidance document “Eye injury prevention” helps assess risk and choose appropriate eye protection. This document may be referenced by each school division. See **Appendix 10**. OHS legislation dictates that Canadian Standards Association approved eye or face protectors are to be used in science laboratories due to the nature of hazards present. 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. Protective equipment should be splash proof if used for chemistry. Under no circumstances are regular eyeglasses to be considered a substitute for approved eye protection.

Equipment	Comments
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 in other science activities such as biology. Coats are preferable to aprons.
Sleeve protectors	Sleeve protectors should be worn when required.
Non-latex disposable gloves (neoprene, nitrile or tactylon)	Gloves should be worn when handling hazardous chemicals and in biological experiments. Check the MSDS to ensure the gloves used are compatible with the chemicals in a particular experiment. Gloves should be used in combination with other measures because gloves may only slow down transmission of some materials, not completely prevent it. Latex gloves should not be used as some students and staff may have latex allergies.
Heat resistant gloves	Gloves should be made of treated texture silica or woven fabric. Do not use asbestos gloves.
One pair of beaker tongs	Use tongs with heat resistant gloves when handling very hot equipment.
UV filtering glasses	Appropriate eye protection should be worn when UV sources are in use, such as discharge tubes, mercury or ion arcs, or lamps for fluorescent ‘black light’ experiments. Appropriate glasses include Shields sunglasses or any glasses labelled “Blocks 99% or 100% of UV rays,” “UV absorption up to 400mm,” “Special Purpose,” “BS” or “Meets ANSI UV requirements.”
Hearing protection	Whether in the classroom or lab environment or during a field trip or demonstration, if noise levels are above 85 dBa, hearing protection must be provided to staff and students. Either ear plugs or ear muffs may be used. If ear protection is shared, it must be cleaned with a disinfecting wipe or solution after use.

Fire extinguishers

In general, the initial selection and placement of a school’s fire extinguishers is determined by design engineers prior to construction of a school. This is done in accordance with *The Saskatchewan Fire Code Regulations* as well as the NFPA regulations. Schools contemplating renovations, placing additional extinguishers, or changing placement of existing units should contact local Amerex fire equipment distributors who are qualified and equipped to help evaluate and implement NFPA recommendations or the local Fire Chief.

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 for all school locations because they avoid the need to classify the fire and select the appropriate extinguisher, and because 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 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 material 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 fire extinguishers installed on site, and
- Having fire extinguishers inspected once a year by the local fire department or an approved agency, with inspection records kept by the principal or division administrator.

A fire extinguisher is useless if one does not know where to find and how to use it. Having competently trained staff is vital to being prepared and staying safe.

First aid kits

Kits are available from St. John Ambulance, Canadian Red Cross and most science supply companies. The OHS guidance document "First Aid in Saskatchewan Workplaces" summarizes first aid requirements, exemptions, training, supplies and transportation. It also has tables outlining the quantity of supplies and equipment in proportion to the number of workers employed in a workplace. Tables one through four should be referenced to ensure each school division has appropriately trained staff and first aid supplies on site. This document can be found in **Appendix 2**.

First aid kits are required by schools under the *OHS Act, 1993* and *OHS Regulations 1996*. There are two classes for first aid services: Class A and B. The contents of first aid kits are legislated and outlined in Tables 10, 11 and 12 of the *OHS Regulations, 1996* Appendix.

As part of proactive field trip safety, and possibly as part of the school division's safety policy, a risk assessment should be done prior to the field trip to determine what first aid equipment should be taken and what number of first aiders should go along if there is increased levels of risk.

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. There should also be a first aid log inside or next to the kit to keep track of items being used and the reason for each use. This is beneficial for recording first aid attention to site incidents and after the fact hazard analysis.

Equipment for clean-up and disposal of chemical spills

The OHS guidance document "Laboratory Chemical Storage" can be referenced by divisions to help establish safe practices and meet requirements regarding the storage area and generic spill kits. This document can be found in **Appendix 11**.

Prior to clean-up, ensure staff handling the spill are appropriately certified, competent and trained to use the equipment and chemicals involved. It should also be noted that if a school is still using mercury thermometers a mercury spill kit should be present on site (other options include safely removing and disposing of all mercury thermometers.) The following table summarizes recommended items to keep in the laboratory in a clearly identified and accessible location for clean-up and disposal of spills. See **Chapter 7** for further clean-up and disposal procedures for different kinds of chemical spills.

Items	Comments
Acid, base, solvent and mercury spill kits	Spill kits are used for absorbing spills or diluting solution of chemical solutions. Use these kits for small spills clean-ups. (Follow manufacturer's instructions).
Hazard spill control pillows	Universal pillows absorb most aggressive and non-aggressive liquids, which could include: oils, fuels, solvents, water, coolants, acids, bases, and so on.
Several litres asbestos-free vermiculite or diatomaceous earth container with scoop	Vermiculite will absorb liquid spills of all kinds. Diatomaceous earth is 50% more absorbent per pound than clay alternatives and is designed for quick clean up of liquid spills. 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 only be collected in a safety disposal can with automatic pressure release closure.
Waste container for glass and sharp objects	A separate container for these items reduces the chance of injury to maintenance and janitorial staff responsible for normal garbage disposal.
Large container for dry $NaHCO_3$ (baking soda)	Baking soda can be used to neutralize strong acids before disposal.
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.
45-cm long chemically-resistant rubber gloves	Gloves should be worn whenever dealing with spills, especially when broken glass is involved. Gloves are usually included in spill kits.
Heavy-duty garbage bags	Use 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	Use for disposal of biological specimens and cultures.
Respirator and appropriate cartridges	Use for pickup of certain spilled chemicals, as noted on MSDS. Schools offering science programs at grades 9 to 12 should have at least one respirator per preparation room or department and proper training must be kept up to date.

Generic spill kit

A generic spill-kit mixture can be simply made 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. This type of generic spill kit is referenced in the OHS guidance document **Appendix 11** – “Laboratory Chemical Storage” and laboratory manuals at the Universities of Regina and Saskatchewan. See **Chapter 7 Managing the release or spill of toxic or corrosive substances** for more information.

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 incidents. Monitoring and assessment activities can take place through periodic inventory of equipment and materials, the completion of laboratory checklists such as the one provided in **Appendix 8**, or during regular OHC inspections.

When an incident or emergency occurs, one must know what to do. Being prepared will ensure effective and efficient responses.