pennsylvania
DEPARTMENT OF EDUCATION

# Safety Guidelines
# For
# Elementary Science
# &
# Technology Education

## January 2002

**COMMONWEALTH OF PENNSYLVANIA**
**DEPARTMENT OF EDUCATION**
333 Market Street
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# HOW TO USE THIS DOCUMENT

## Disclaimer

This Safety Guide is intended to be a convenient reference for Elementary and Technology Education teachers. The Pennsylvania Department of Education has carefully considered applicable industry practices in the development of this guide. However, the standards provided herein are by no means absolute. The Department hereby disclaims all liability incurred through the use of this document.

## How To Use This Document

It is recommended that the teacher make a copy of this guide and keep it handy for reference. All material contained in this guide may be reproduced by the teacher for use in safety instruction and for promoting safety instruction in the school. The teacher may also wish to add personal materials, lesson plans, safety instruction sheets and additional information to develop a complete safety program and lesson guide for the classroom.

When viewing this document electronically please note that all page numbers are active buttons. Clicking on a page number will take the reader to that page.

The material contained in this guide covers a wide range of topics. Some of these topics include:

1. Safety information
2. Facility considerations
3. Processes
4. Tools, equipment and materials
5. Resources
6. Teacher liability
7. Instructional suggestions
8. Materials for student use
9. Forms and checklists
10. Lists of responsibilities for safety planning

**The guide is not intended to be complete or all-inclusive. It is intended to draw your attention to the necessity for safety instruction in every aspect of technology education and to provide the teacher with the resources for upgrading and improving safety instruction.**

# For Quick Reference

The information included in this guide is extensive. To some it may appear that some of this information is unnecessary. The audience for this document will range from those individuals with minimal or no knowledge of safety to those well versed on the subject. This document

hopes to serve both populations. For those individuals familiar with safety and safety issues it is recommended that at a minimum they review the following sections:

Under the General Safety Section:

- Introduction (Page 9)
- Pennsylvania Laws and Regulations (Page10)
- Liability (Page 17)
- Eye Safety (Page 10)

It may also be useful to review the following sections for potential new information and recommendations:

- General Safety Considerations (Page 19)
- General and Specific Subject Information Sections
- General and Specific Tools & Equipment
- General and Specific Materials and Material Storage
- General and Specific Processes
- General and Specific Facility Design

There are a number of documents included in the appendix section that may be of use to those familiar with safety as well as those individuals with limited knowledge. Of particular importance is the following documents:

- Sample District Safety Policy Statement (Page 94)
- Technology Education Safety Inspection Checklist (Page 102)
- Hazardous Condition Report (Page 95)
- Accident Report Form (Page 112)

**Additional materials are included in the appendix and should be reviewed by all readers for consideration and implementation.**

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Note: Additional Equipment Safety Recommendation Sheets are available by visiting the Technology Education Association of Pennsylvania's web site at www.teap-online.org

# GENERAL SAFETY

# INTRODUCTION

With the emphasis that the Pennsylvania Academic Standards for Science and Technology Education place on hands-on minds-on inquiry instruction at all levels, it becomes more incumbent upon the technology education teachers to be as knowledgeable as possible about laboratory safety issues and their own responsibilities. As technology education teachers, their supervisors/specialists, the members of the Technology Education Association of Pennsylvania (TEAP) and the International Technology Education Association (ITEA) are constantly receiving questions from teachers and administrators about safety issues, responsibilities and liability. This document, which addresses most commonly asked questions, is one response to those inquiries. The goal of this document is to provide a handy, concise reference for technology education teachers. They can refer to it for information and resources on some of the most commonly asked questions that concern technology education teachers. Resources cited are in paper, electronic and Internet accessible forms. It should be clear that this document could not be comprehensive because of limitations of the format and purpose. It is hoped that the most important information needed about the topics is incorporated. No implication of endorsement or lack of endorsement should be read into inclusion or omission of any referenced material within this document. For more information about specific safety questions as they pertain to Pennsylvania or your local community, contact your local or state fire marshal, building commission, health department/poison control center, environmental regulatory and state Occupational Safety and Health Administration (OSHA) agency or the technology education advisor at the Pennsylvania Department of Education.

Effective safety education leads to attitudes and conscience that result in safe work practices and prevent accidents within the technology education laboratory and classroom. In addition, effective safety education is one step in the right direction toward protecting the technology education instructor, supervisor and school administrator against liability in the classroom and laboratory.

The task of overcoming the “it can’t happen to me” attitude is a big one and requires safety awareness to be an integral part of the everyday instructional program. This guide is intended to help teachers develop and institute effective safety education as a part of all technology education instruction in the schools of Pennsylvania.

It is the professional, ethical and legal responsibility of the teachers to weigh the educational value of all activities in which their students will participate against their inherent and foreseeable dangers. If these risks cannot be reduced to an acceptable level, the activity should be altered, changed in its method of delivery or eliminated.

An effective safety program centers on several key considerations.

1. Provisions for safety instruction in all activities conducted in the technology Education.

2. Supervision of students at all times in the technology education laboratory.

3. Documentation of safety instruction and student attendance at the time of instruction.

4. Assurance that all aspects of the technology education facility and its contents are safe for student activities.

This guide is intended to alert technology education teachers, teacher educators, school administrators and technology education supervisors to the importance of a strong safety program. It is also intended to provide the instructional resources for instituting safety instruction in the public schools, for the in-service training of technology education teachers and for the education of undergraduates in the teacher education programs of Pennsylvania.

# PENNSYLVANIA LAWS AND REGULATIONS

Legislation in Pennsylvania exists and is applicable to school safety and health. This includes the Eye Safety Act, Act 116 of 1965, the Worker and Community Right-to-Know Act, Act No. 159 of 1984 and the General Safety Law, Act No. 174, which has been in effect since 1937. The Right-to-Know Act is briefly covered in this guide under the section "Hazardous Substance."

## Act 116 - Pennsylvania Eye Safety

Regulations Governing the Use and Care of Protective Eye Devices in the Schools of Pennsylvania.

Provide for the use of eye protective devices by persons engaged in hazardous activities or exposed to known dangers in schools, colleges and universities. The General Assembly of the Commonwealth of Pennsylvania hereby enacts as follows:

*Section 1*
Every teacher, student, visitor, spectator, and every other person in any laboratory or laboratory in public or private schools, colleges and universities who is engaged in or is within the area of known danger created by:

1. the use of hot liquids, solids or gases or caustic or explosive materials,
2. the milling, sawing, turning, shaping, cutting, grinding or stamping of solid materials,
3. the tempering, heat treatment or kiln firing of metals and other materials,
4. gas or electric welding,
5. the repairing or servicing of vehicles,

shall wear industrial quality eye protective devices at all times while engaged in such activities or exposed to such known dangers.

*Section 2*
Schools, colleges and universities shall have the power to receive Federal, State and local

moneys and to expend the same to provide such devices and shall furnish such devices to all visitors and spectators and all other persons required under the provisions of this act to wear them.

*Section 3*
Enforcement of this act shall be in accordance with standards, rules and regulations promulgated by the State Board of Education.

*Section 4*
For the purposes of this act, "industrial quality eye protective devices" mean devices meeting the standards of the American Standard Safety Code for Head, Eye and Respiratory Protection, Z2.1-1959, promulgated by the American Standards Association, Incorporated.
*Section 5*
This act shall take effect immediately.

Enforcement of Act 116 of 1965

I. An Act

To provide for the use of eye protective devices by persons engaged in hazardous activities or exposed to known dangers in schools, colleges, and universities.

II. To Whom And Where Does It Apply

To all pupils, teachers, visitors, spectators, and every other person upon entering and/or engaging in Vocational Education, Technology Education, Science Education and all other areas where known dangers exist, such as shops or laboratories in public or private schools, colleges, and universities where the activities enumerated in the Law are in progress, shall be required to wear industrial quality eye protective devices.

Known dangers are the use of hot liquids, solids or gases; caustic or explosive materials; the tempering, heat treatment or kiln firing of metals and other materials; gas or electric welding; or the repairing or servicing of vehicles. Persons exposed to these dangers shall wear industrial quality eye protective devices suitable for the specific hazards at all times while engaged in such activities or exposed to such known dangers.

Enforcement of this Act shall include custodial, service, food preparation, and other areas of school operation where eye hazards exist.

For the purpose of implementing this act, "industrial quality eye protective devices" means devices meeting the standards of the American Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1 – 1959, promulgated by the American Standards Association, Incorporated.

III. Who Is Responsible

Local boards of school directors, boards of education, college boards of trustees, and governing bodies of private schools shall adopt such rules and regulations as may be necessary for the provision, maintenance and use of eye protective devices as required to meet the provisions of the law.

IV. For Non-Compliance

In cases of non-compliance, the Superintendent of Public Instruction may take whatever action is deemed necessary. In simple terms this law states that any time that a risk of eye injury exists, all persons in the same room or other enclosed area (lab/lecture combination room) must wear "industrial quality eye protective devices."

## Act 174 – General Safety Law

General Safety Law, Act No. 174, has been in effect since 1937. The General Safety Law contains provisions aimed at controlling specific hazards. The sections of this law most applicable to technology education are as follows:

Section 2. General Safety and Health Requirements.

1. All establishments shall be so constructed, equipped, arranged, operated and conducted as to provide reasonable and adequate protection for the life, limb, health, safety and morals of all persons employed therein.
2. All belts, pulleys, gears, chains, sprockets, shafting and other mechanical power transmission apparatus, stationary engines, electrical equipment and apparatus shall be properly guarded to protect the workers from injury.
3. All cranes, joists, steam or electric shovels, plant railroads and other apparatus or devices used for moving, lifting, lowering and transporting material shall be designed, constructed, equipped and operated as to eliminate dangerous conditions.
4. The point of operation of all saws, planers, jointers or other power driven woodworking machines and all power presses, planers, shapers and other power drive machine tools and dangerous parts of any other machines or devices shall be provided with guards approved by the Pennsylvania Department of Labor and Industry. Laundry machines, extractors, washers, ironers and other machines or apparatus shall be provided with guards where, because of accident hazard, they are required by the Department.
5. All toxic and noxious dusts, fumes, vapors, gases, fibers, fogs, mists or other atmospheric impurities, created in connection with any manufacturing process, emitted into or disseminated throughout areas where persons are employed in such quantities as, in the opinion of the Department, would injure the health of employees or create other dangerous conditions, shall be removed at the point of origin or, where these impractical, personal protective devices shall be provided

and worn by persons subjected to such hazards.
6. When employees, due to the nature of employment, are subject to injury from flying particles, falling objects, sharp or rough surfaces or materials, hot, corrosive or poisonous substances, acids or caustic and injurious light rays or harmful radioactive materials, they shall be provided with, and shall wear goggles, other head and eye protectors, gloves, leggings, and other personal protective devices (as last amended by the Act of July 13, 1953. P. L. 438).

Section 3. Lighting, Heating, Ventilation and Sanitary Facilities.

All establishments shall be adequately lighted, heated and ventilated. Proper sanitary facilities shall be provided in sufficient number for the persons employed, and shall include toilet facilities washing facilities, dressing rooms, retiring rooms for women, and wholesome drinking water of approved quality.

Section 4. Not Applicable

Section 5. Floor Space.

The floor space of workrooms in any establishment shall not be so crowded with machinery as to thereby cause risk to the life or limb of any employee. Proper, clean aisle space shall be maintained where necessary for employees to walk between machines, equipment or material. Machinery shall not be placed in any establishment in excess of the sustaining power of the floors and walls thereof.

Section 6. Removal of Guards.

No person shall remove or make ineffective any safeguard, safety appliance or device attached to machinery except for the purpose of immediately making repairs or adjustments, and any person or persons who remove or make ineffective any such safeguard safety appliance or device for repairs or adjustments shall replace the same immediately upon the completion of such repairs or adjustments.

Section 7. Prohibited Use of Dangerous Machinery.

If any machinery, or any part thereof, is in a dangerous condition or is not properly guarded, the use thereof may be prohibited by the Secretary of Labor and Industry or his authorized representative, and a notice to that effect shall be attached thereto. Only an authorized representative of the Department shall remove such notice after the machinery has been made safe and the requirement safeguards are provided, and in the meantime, such unsafe or dangerous machinery shall not be used.

Section 8. Air Space for Workroom.

The owner, agent, lessee or other person having charge or managerial control of any establishment, shall provide or cause to be provided not less than two hundred and fifty

cubic feet of air space for each and every person in every workroom in said establishment where persons are employed.

## Pennsylvania Fire and Panic Act, No. 299

Also, the Pennsylvania Fire and Panic Act, No. 299, adopted in 1927, contains safety provisions pertaining directly to the facility. The basic requirement of this Act is located in Section I and is as follows:

General Requirement

Every building enumerated in this Act, erected or adapted for any of the purposes of several classes of building covered by the act (schools and colleges are Class I), shall be so constructed, equipped, operated and maintained, with respect to type of construction and materials used, fireproofing, number and type of ways of egress, aisles and passageways, stairs and fire escapes, wall openings, exits, and exit signs, doors and doorways, shaft ways and other vertical openings, emergency lighting, automatic sprinkler systems, fire alarm systems fire drills, electrical equipment, inflammable and explosive materials, heating apparatus and fuel storage, number of occupants, ventilation, arrangement of seating and standing space, construction and equipment of stages, projection rooms, and dressing rooms, and all other fire and panic protection as to provide for the safety and health of all persons employed, accommodated, housed, or assembled therein...

## Occupational Safety and Health Administration (OSHA)

The Williams-Steiger Occupational Safety and Health Act (OSHA) or Public Law 91-596 was passed in December 1970 and became law on April 28, 1971. As it states, the law was enacted in order to:

> "assure so far as possible every working man and woman in the Nation, safe and healthful working conditions and to preserve our human resources..."

The law recognizes employee safety and health as public problems rather than private or individual concerns.

The fundamental purpose of the OSH Act was to ensure as much as possible safe and healthful working conditions for every working man and woman in the nation. The most notable OSHA legislation impacting on schools include Blood borne Pathogen and Chemical Hygiene Plan
.
The OSHA standards contain four major categories: general industry, construction, maritime and agriculture. Implementation is to be conducted in the following six ways:

1. Encouraging employers and employees to reduce hazards in the work place

and start to improve existing safety and health programs.
2. Establishing employer and employee responsibilities.
3. Authorizing OSHA to set mandatory job safety and health standards.
4. Providing an effective enforcement program.
5. Encouraging the states to assume the fullest responsibility for administering and enforcing their own occupational safety and health programs that are to be at least as effective as the federal program.
6. Providing for reporting procedures on job injuries, illness, and fatalities.

OSHA does not presently cover Pennsylvania public schools because no state plan has been developed. However, many OSHA standards have been adopted and enforced by insurance companies and other agencies. Thus, many of the OSHA standards are being enforced even without formal adoption.

Areas of operation in which school districts can and should voluntarily attempt to comply with OSHA standards include:

1. Hand-tool, Machine and Equipment Safety. The design and physical condition of every item included in a technology education laboratory must be safe and in good working order. Substandard items should be renovated or replaced by pieces known to be well designed and constructed.
2. Safety in Working with Hazardous Materials. Exposure to hazardous materials must be minimized and, if necessary, eliminated. Appropriate protective equipment, such as paint masks, should be available and its use enforced.
3. Training in Safety and Health Requirements. Teachers and students should be taught to recognize work hazards and potentially dangerous environmental conditions.

4. Fire Protection. All necessary fire protection devices and services, including fire extinguishers, sprinkler systems and fire department assistance should be available.

5. Physical Plant Design. The physical plant in which a technology education program is carried out must be planned so that it is free of safety and health hazards. Key design features of such a structure include adequate space, proper storage of materials, a good arrangement of rooms, and an effective organization of equipment.

6. Physical Plant Condition. The floors, walls, partitions, ceilings, windows, doors and other parts of a laboratory must be kept in good repair.

7. Air Environment. Students and teachers must be able to work in air that is clean, fresh, safe and comfortable. Effective heating, air conditioning, mechanical ventilation and exhaust systems are necessary.

8. Visual Environment. Natural and artificial lighting systems must be properly designed and maintained so that people working in a laboratory can see clearly and comfortably.

9. Auditory Environment. Sound intensities must be reduced to a level at which hearing will not be damaged? It should be noted that hearing damage is a factor determined by both the intensity of the sound and the duration of exposure. Since instructors cannot realistically limit lengths of exposure, it is most important that they seek preventive measures to reduce noise levels. These measures may include the use of noise absorbing materials and/or utilization of hearing protection devices that may reduce the risk of work-related hearing losses in the future.

10. Utility Service Systems. Electrical, water, gas and compressed air systems must be planned and constructed so that hazards related to the use of these utilities are minimal.

11. Housekeeping. Laboratories must be kept clean and in good working order at all times. Adequate storage of materials, especially waste products, is of major importance to laboratory safety.

12. Sanitary Facilities. Drinking fountains, wash facilities and restrooms must be well designed, in good operating condition and cleaned regularly.

13. First Aid and Emergency Procedures. Teachers, students and civil service employees should be trained in basic first aid and emergency procedures.

14. Class Discipline. Failure to have students abide by safety rules and safe practices can promote an unsafe work environment. Teachers must require the needed classroom/laboratory discipline to ensure a safe technology education program for all students.

## Civil Rights Mandate

The Rehabilitation Act of 1973, Section 504, was initially enacted into law to protect the civil rights of all handicapped Americans. The implementation regulations and enforcement provision did not become law until June 1977. Now, however, it provides greater opportunities for physically or mentally handicapped individuals.

The basic requirements of the law are summed up in the following section:

### *GENERAL PROVISION AGAINST DISCRIMINATION*
### *Section 84.4*

Any program or activity which receives federal financial assistance 1) may not exclude qualified handicapped persons from aids, benefits or services; 2) must provide equal opportunity to participate or benefit; 3) must provide services as effective as those provided to the non-handicapped and 4) may not provide different or separate services except when necessary to provide equally effective benefits.

Services need not be identical to those provided to the non-handicapped, but must be the equivalent to them and must afford an equal opportunity to achieve results in the most integrated setting appropriate to the person's "needs".

Inclusion is the result generally associated with section 504. It puts students in a "least restrictive environment," usually a regular classroom or lab situation. When one or two special needs students are included in a regular class; the teacher must take extra safety precautions. Such situations will have to be adapted to the person's "needs".

## Liability

The connection between safety and the law is founded in reasonableness. The law only requires that a person be reasonable, that is, exercise good common sense. Good safety consists mainly in behaving reasonably and exercising good common sense. A teacher does not need to worry about adopting unfamiliar habits in order to conform to what the law expects to avoid being sued. Rather, a good teacher can avoid being sued by merely being reasonable and promoting a safe learning environment. Teachers do not need to fear being held to a ridiculous standard of perfection as long as they act reasonably. What follows is a review of some legal principles to show what the law reasonably expects. The law expects reasonable people to acquire and practice safety habits, which are no more than reasonable precautions?

### *The Law Defined*
### *Pennsylvania Negligence Definitions*

The teacher, district science specialists, and administrators are legally responsible for the safety of the students in the technology education classroom. The legal principles involved are part of tort law. A tort is a wrongful act causing damages, which may rise to a civil suit. If a person is injured, they are often called personal injury cases. Concern arises when the torts are based on an allegation of negligence. Negligence is defined in *Black's Law Dictionary* as 'the omission to do something, which a reasonable person, guided by those ordinary considerations, which ordinarily regulate human affairs, would do or the doing of something, which a reasonable and prudent person would not do. The dictionary states that "one is not 'negligent' unless he/she fails to exercise the degree that would be exercised by a person of ordinary prudence under all the existing circumstances in view of probable danger of injury." The law basically requires teachers to be

reasonable and use good common sense. Teachers are required to exercise the skill and training, this would ordinarily be expected from someone in their profession. In the classroom, this requires an understanding of the substances and materials the teacher and the students will be using, whether it is a chemical or combination of chemicals, animals, plants or lab equipment. This document cannot list all possible problems, but may serve as a starting place for inquiry. Teachers must gather the information needed to reasonably assess the risk versus the benefit of any activity. As professionals, teachers are obligated to provide a healthy and safe environment in the classroom.

### *According to 42 Pa.C.S.A. §8332*

(a) Any person who renders emergency care, first aid or rescue at the scene of an emergency, shall not be liable to such person for any civil damages as a result of any acts or omissions in rendering the emergency care, first aid or rescue, except any acts or omissions intentionally designed to harm or any grossly negligent acts or omissions which result in harm to the person receiving the emergency care.

## Legal Responsibilities as a Technology Education Teacher Relating To Negligence

The LEGAL DEFINITION of "negligence" is important for every teacher to know. Negligence, as defined by the courts today, is conduct that falls below a standard of care established by law or profession to protect others from an unreasonable risk of harm, or the failure to exercise due care. It should be noted that in the absence of specific laws or local policies, the profession sets the standard of care expected.

The technology education teacher has three basic duties relating to the modern concept of negligence:

- Duty of instruction.
- Duty of supervision.
- Duty to properly maintain facilities and equipment.

Failure to perform any duty may result in a finding that a teacher and/or administrator within a school system is/are liable for damages and a judgment awarded against him/them.

DUTY OF INSTRUCTION includes adequate instruction before a laboratory activity (preferably in writing) that:

- is accurate, is appropriate to the situation, setting, and maturity of the audience, and addresses reasonably foreseeable dangers.
- identifies and clarifies any specific risk involved, explains proper procedures/techniques to be used, and presents comments concerning appropriate/inappropriate conduct in the lab. Instruction must follow professional and district guidelines. A teacher who sets a bad example by not following proper laboratory procedures may be sued if injury results from students following the

teachers' bad example.

DUTY OF SUPERVISION includes adequate supervision as defined by professional, legal and district guidelines to ensure students behave properly in light of any foreseeable dangers. Points to remember:

- Misbehavior of any type must not be tolerated.
- Failure to act or improper action is grounds for liability.
- The greater the degree of danger, the higher the level of supervision should be.
- The younger the age of students or the greater the degree of inclusion of special population students, the greater the level of supervision should be.
- Students must never be left unattended, except in an emergency where the potential harm is greater than the perceived risk to students. Even then, risk should be minimized or responsibility transferred to another authorized person if the situation allows.

DUTY OF MAINTENANCE includes ensuring a safe environment for students and teachers.

- Never use defective equipment for any reason.
- File written reports for maintenance/correction of hazardous conditions or defective equipment with responsible administrators.
- Establish regular inspection schedules and procedures for checking safety and first aid equipment.
- Follow all safety guidelines concerning proper labeling, storage and disposal of chemicals.

By keeping files of all hazard notifications and maintenance inspections, teacher liability in the event of an accident is minimized in cases where no corrective actions were subsequently made.

# GENERAL SAFETY CONSIDERATIONS

## Responsibility

The school board, superintendent, the district safety coordinator, the administrator (principal and/or department head) and the teacher are all responsible for a safe working environment.

The school board, the administration and the instructor have the legal responsibility to provide a safe environment for students to work while they are participating in technology education activities.

To protect yourself and your school district from liability, you should be familiar with the codes and regulations applicable to your program. This would be an excellent topic for a department staff development program.

To protect you against financial loss, liberal liability insurance limits should be carried, either through a school district policy or individually.

Liability insurance can vary substantially among school districts. You should be aware of the limitations of your school district's liability policy.
Individual coverage may be expanded through the American Federation of Teachers, Pennsylvania State Education Association, the International Technology Education Association, other professional associations or through your personal insurance agent or broker.

## *School Board and Superintendent*

The school district controls budget, curriculum and personnel policy to a major degree. Without district level support, safety program effectiveness will at best be spotty--conducted by dedicated personnel and ignored by others.

The following functions are considered the responsibility of the school board and the superintendent in a comprehensive technology education program:

1. A policy statement similar to that found in the Appendix should be adopted by the board of school directors.
2. Appoint a safety coordinator for the school district and adopt a job description that reflects that responsibility. A suggested job description appears on the following page.
3. Provide separate funding for facility maintenance and improvements and safety supplies and equipment necessary to produce a safe instructional environment.
4. Provide for the in-service training of teachers in the area of safety.

## *District Safety Coordinator*

Each school district should have a safety coordinator. Teachers and the building administrator should rely on the district safety coordinator for assistance and consultation in their accident prevention endeavors.

The following functions are considered the responsibility of the District Safety Coordinator:

1. Coordinate school safety functions.
2. Establish a school safety committee.
3. Provide for and participate in school safety inspections.
4. Establish a communication system to keep teachers and administrators abreast of new standards and procedures.
5. Provide for and assist in establishing teacher in-service training programs.
6. Provide for and assist in the implementation of safety instruction programs for students.
7. Provide for and assist in the investigation and recording of accidents and injuries.
8. Research special safety problems.
9. Obtain and disseminate regulatory material (policies, guidelines, inspection

checklist, posters, etc.).
10. Maintain a liaison with the local government and industrial agencies and the Pennsylvania Department of Labor and Industry and other related agencies and organizations.
11. Analyze and report all accidents. See suggested accident report in this document

## *Administrator, Principal and/or Department Head*

The individual school is the central unit of an educational enterprise. Therefore, the building principal is likely to be the administrator who is most directly responsible for the school's technology education laboratory safety program. If a specialized supervisor or department head functions with the principal and works directly with teachers, some of the responsibilities for the safety program may be delegated.

The following functions are considered the responsibility of the school administrator in a comprehensive technology education program:

1. Secure support from and maintain liaison with Central Office administration.
    a. Secure approval for the safety education program.
    b. Secure adequate budgetary support.
    c. Expedite building and equipment changes necessary for safe operation.
    d. Arrange for the procurement of safety equipment.
    e. See that appropriate staff members are kept informed of the specific maintenance requirements for safe operation of technology education facilities.
    f. Arrange for administrative measures to reduce liability exposures of technology education staff members.
2. Provide leadership in safety program planning.
    a. Initiate a specific program of safety education.
    b. Establish teacher accident prevention staff development training.
    c. Encourage the instructional staff to maintain first aid proficiency. Require the safety supplies and emergency handling procedures to be current and properly organized.
    d. Encourage the instructional staff to be knowledgeable and proficient in the use of fire extinguishers.
    e. Instruct the technology education staff members in the use of this safety manual and the development of a comprehensive safety program.
3. Secure action on a program of safety education that will involve not only the technology education student but also the entire student body. This should be coordinated by the district safety officer.
    a. Check periodically to make sure an adopted safety education program is in effect.
    b. Observe teachers for assurance that safety instruction is a functioning part of the course of study.
    c. Stimulate the discovery, analysis and prompt correction of unsafe conditions or practices.

d. Support teachers in enforcing safety regulations.
e. Receive and review accident reports.
f. Utilize district procedure for investigating and analyzing accidents.

4. Provide safe facilities and services.
    a. Report to Central Office administration personnel unsafe conditions that cannot be corrected at the school level.
    b. Plan with teachers for the correction of unsafe conditions and other hazards and for the installation of safety devices.
    c. See that the technology education facilities are inspected regularly for condition of equipment and safety devices, proper housekeeping, adequacy of exits, and ventilation and material handling systems. Make necessary improvements as indicated by the inspection review.
    d. See that safety and applicable safety regulations are specifically reviewed in the planning of new or remodeled facilities.
    e. Provide class sizes that are in keeping with the capacity, square footage and number of workstations available in each facility. (Refer to the general facility planning section.)
    f. Provide a procedure for the removal of students who repeatedly violate established safety rules and regulations and are identified as safety hazards.
    g. Provide necessary funds for the repair or replacement of defective equipment.
5. Secure cooperation of outside personnel and agencies.
    a. Assist teachers in locating qualified community personnel and services that can provide resources for the safety program.
    b. Encourage qualified outside individuals to become involved in the school laboratory safety program. Establish communication with parents and members of the community for developing a positive attitude safety and the technology education program.
    c. Establish communications with parents and members of the community for the purpose of developing a positive attitude toward safety and the technology education program.

## *The Teacher*

The **major** responsibility for laboratory safety instruction and accident prevention falls on the teacher. The following are considered to be part of the responsibilities of the teacher in a comprehensive accident prevention program in school laboratories.

1. NOTE: DO NOT LEAVE THE CLASSROOM UNSUPERVISED AT ANY TIME WHEN STUDENTS ARE PRESENT.
2. The teacher should emulate safe practices and techniques at all times.
3. Incorporate safety instruction in the course of study and maintain documentation as to who received instruction and when instruction was given.
4. Present instruction on potential hazards and accident prevention specific to the particular school laboratory.
5. Instigate a comprehensive safety program for your particular school laboratory.

6. Develop specific safe practices, rules and regulations relating to your facilities and provide for their enforcement.
7. Keep informed of new and accepted safe practices for accident prevention.
8. Provide proper instruction for the use of all tools, machines and equipment. keep a record of each student's attendance, safety training and safety evaluation.
9. Require that a student be enrolled in the technology education program and receive the required safety instruction prior to working in the laboratory.
10. Insist that adequate eye protection be worn in all technology education laboratories at all times in accordance with Act 116 as found in this document.
11. Insist on proper protective equipment in all laboratory areas and require students to wear proper clothing, eye protection and adequate hair guards while working in the laboratory.
12. Remove and/or secure all jewelry while working in the laboratory.
13. Devise and enforce safe housekeeping procedures.
14. Insist that guards meeting accepted standards be provided and used whenever a machine is operated.
15. Establish and maintain the safest possible working environment.
16. Have set, pre-planned procedures in case of an accident or emergency.
17. Provide prompt and thorough reports of accidents including:
    a. Written report by instructor.
    b. Written accounts by witnesses.
    c. Photographs of accident scene and conditions.
18. Always provide for the supervision of students in the classroom or laboratory in accordance with legal requirements.
19. Regularly review laboratory facilities to maintain safe conditions. Give special attention to these items:
    a. Layout
    b. Utilities and building services
    c. Equipment guarding
    d. Storage and conditions of tools
    e. Storage, labeling and handling of materials
20. Submit written recommendations to the administration for improving safety conditions.
21. Review all IEP's on a regular basis to address the needs of all students enrolled in all technology education classes.
22. Criteria for scheduling special needs students into laboratory classes should be established by a team of counselors, technology education teachers, special education teachers and school administrators. Aides or special equipment should be made available to the technology education teacher. This should also include the appropriateness of placement of the student.

## *Communication of Safety to Parents/Guardians*

For years, technology education teachers have used "permission slips" that were sent home and signed by the parents/guardians permitting their child to participate in the

laboratory. Many teachers believed that these "policy statements" relieved them of some or all of their responsibilities and liability should an accident occur. **IT DOES NEITHER OF THESE**. The purpose of this type of communication is to:

1. **Inform** the parent/guardian of his/her child's participation in a technology type activity.
2. **Outline** the safety instruction and procedures followed by the teacher and the district.
3. **Obtain** from the parent/guardian relevant information regarding any health problems having a bearing on the child's performance.
4. **List** the parent/guardian's telephone number(s) where he/she can be reached during school hours and list the name of the family doctor.

A sample of this type of communication to the parent/guardian is included in the Appendix on page 110.

# Emergency Action

Emergency situations can arise anywhere in the school environment and the procedures for dealing with these events should be developed and approved by the individual administration unit (district or building) prior to the start of the school year. These procedures should be reviewed and revised periodically to determine their effectiveness and to make necessary modifications. The following information is provided to serve as guides for the individual district in the development of their own emergency procedures.

## *General Guidelines In The Event of Student Accidents*

In the event of accident, teachers should act promptly and decisively, following a preexisting, approved local previously practiced emergency plan! This plan might include the following general steps:

- Check the scene, assess the general situation and take whatever immediate action is necessary to remove the hazard and prevent students from being further exposed to injury.
- Check the injured party with a quick scan to assess the severity of the injury and decide on a course of action.
- Notify school authorities (school principal and school nurse) and call 911 or other pre-determined emergency or medical personnel, if injury appears to make the action necessary.
- Have a properly trained person appropriately care for the injured party.
- Ensure that a parent, guardian, or designated alternate person and/or the family physician has been contacted.

After the emergency has passed, record the facts and obtain witness reports. Provide copies of records (accident reporting forms) to an administrator and keep records on file in a safe place.

**Primary Concerns**

These relate directly to the injured party and the reduction of hazard to that person. The degree of the emergency care would be dependent on the injury and the **qualifications of the person administering** the care. If the teacher is not qualified in first aid, he/she must only do the things that will assure no further damage to the injured person/s and immediately seek trained help. This might be limited to stopping the bleeding or covering a person in shock with a blanket. Although every teacher should be trained in basic emergency first aid, many are not. Serious damage to the injured student/s can sometimes result when a nervous, untrained and panic-ridden teacher treats them. The following basic steps are recommended as the first steps when an injury occurs:

1. Determine the extent and type of injury. If this is not possible, immediately obtain professional help.
2. Restore breathing, restore heartbeat and stop bleeding if trained in these areas; if not, send for help.
3. Apply only the first aid necessary to preserve life. Do no more until trained help arrives.
4. Disperse crowd and keep injured and the surrounding area as quiet as possible.
5. Notify school nurse, principal and immediate supervisor by sending other students to these people. **Do not leave the injured person alone.**
6. If the injury is minor (e.g., splinter, slight cut), send the student to the school nurse accompanied by another student. Do not send the injured student alone.
7. If a foreign particle has entered the eye, seek professional help. A teacher should never try to remove something from a student's eye. If a liquid has entered the eye (e.g., acid), immediately wash the eye in eyewash and contact the nurse.
8. Notify parents/guardian and school officials.

It is the responsibility of the teacher to know what to do in case of an accident and also to know what not to do. This kind of information is best obtained through a variety of first aid courses offered through the Red Cross or other agencies. The first few seconds or minutes following a student's injury are sometimes the most critical, and the action or lack of action that the technology teacher may take could be crucial to the student's life.

**Secondary Concerns**

When the injured student has been administered to by professional help (e.g., nurse, ambulance crew or doctor), the concerns of the teacher are focused on the remaining students and the follow-up procedures in regards to the injury. Some action is necessary in the following areas:

1. Calm the other members of the class. Restore the situation to a safe environment. If the accident was serious, discontinue instruction for remainder of the period. The students will be too upset to perform effectively and may in fact be "accident repeaters" due to the accident.
2. Complete the accident report in accordance with school district policies. It is

recommended that, at very least, copies should be forwarded to the school nurse, the building principal and immediate supervisor. Retaining one copy for the teacher's permanent file is also recommended. The copy should be retained until the injured student reaches age 18 or graduates.

3. Analyze the accident to determine the root cause and effect of the accident and make **written** recommendations to the principal of corrective measures to be taken. (Retain a copy of the communication and subsequent action.)
4. Review and record safety practices, procedures, instruction and student evaluation delivered, and intended to prevent this type of accident from happening.
5. Follow-up in your classes with a discussion and instruction regarding the safe practices that were violated and contributed to the accident.

The procedures mentioned should also be followed for "almost accidents" or accidents without injury to assure the conditions that almost caused an accident are treated and eliminated from the laboratory environment.

**Student on Fire – Fire Suppression:**

Remember a panicky student on fire will probably not be cooperative! You may need assistance from other students or faculty. If you are near an emergency shower, obtain assistance in getting the student under the drench shower and douse flames with water. If not near an emergency shower, drop and roll the student and smother the flames with a retardant-treated wool fire blanket. (Never wrap a standing student in the blanket, because this creates a "chimney" effect.) Stop Drop and Roll and/or Shower.

**Materials on Fire –Fire Suppression**

For materials on fire, obtain the nearest ABC fire extinguisher, remove safety pin and approach the fire. Only when 5–6 feet (1.5–1.8 meters) from the fire should you begin to discharge the extinguisher. Remember that the average fire extinguisher only operates 8–10 seconds at maximum efficiency. Take care to smother, not scatter, the burning chemical material. Smother burning alkali metals with clean, dry sand. Keep a covered sand bucket for that purpose.

**Flammable and Combustible Liquids**

Flammable and combustible liquids are categorized by their ease of ignition. Flammable liquids are more easily ignited than combustible ones. Examples of flammables are gasoline, acetone and lacquer thinner. Examples of combustibles are kerosene, fuel oil, mineral spirits and brake fluids.

Flammable and combustible liquids are essential in many technology education classes. They must be stored and used in a manner that will provide a high degree of safety. Always read the label on the container before using any of these materials. Flammable and combustible liquids are potentially dangerous because:

1. Many produce vapors that are heavier than air and can accumulate along floors or other low points, lying in wait for a stray spark.
2. Many are readily oxidized, or can release heat, so rags or waste coated with them can catch fire spontaneously.
3. Vapors from some have harmful effects and can cause damage to nervous and/ or waste elimination systems of the body.
4. All are poisonous if taken internally.
5. Most will remove protective oils from the skin and repeated exposure can cause dermatitis (skin rash).

Nearly flammable and combustible liquids will burn violently. Such fires are difficult to extinguish without proper extinguishing agents.

**Specific Chemical Recommendations**

The following actions are recommended for specific emergencies. Remember you must assess the situation and determine what is appropriate to the immediate situation. Always refer to the appropriate Material Safety Data Sheet (MSDS) for information regarding health hazards, reactivity, disposal, and personal protective equipment before using a chemical for personal or class use.

***Chemical in the Eye:***
Call 911 and send someone to notify the school nurse and an administrator. Flush the eye immediately with potable aerated 60°F–90°F (15.5º–32.2ºC) water at a rate of 3–5 gallons/minute (11.4–18.9 liters/minute). Hold eyelids apart as wide as possible and flush for at least 15 minutes or until emergency personnel arrive. Do NOT try to neutralize acids or bases, but wash the offending chemical out of the eye as quickly as possible to prevent further damage. If contact lenses are being worn, the water should wash them away. If the lens chemically adheres to the eye, do NOT try to remove it. Let a professional do that.

***Acid/Base Spills:***
Neutralize spilled acids with powdered sodium hydrogen carbonate (sodium bicarbonate/baking soda) and bases with vinegar (5% acetic acid solution). Avoid breathing vapors. Spread diatomaceous earth to absorb neutralized chemicals, sweep up, and dispose of properly. If the spill is directly on skin, flush the area as soon as possible with copious amounts of cold water from faucet or drench shower for at least 5 minutes. If the spill is on clothing, drench with water and cut/remove the clothing to remove the chemical from contact with the skin as soon as possible. If the skin appears acid-burned, daub a paste of sodium hydrogen carbonate on the affected area and obtain medical attention as soon as possible. If the skin appears burned by a strong base, daub vinegar on the affected area and obtain medical attention as soon as possible. Do NOT cover with bandages.

## Emergency Communications

Procedures should be established for communications of an emergency situation. Each technology education room should have access to a telephone with direct outside line for ambulance, fire and police emergencies.

1. All students should know the location of the telephone and be familiar with the emergency procedures and numbers.
2. All personnel in the laboratory should have access to the phone for emergency communications. (The telephone should **not** be locked in the teacher's office.)
3. Emergency procedures, police, ambulance, fire department numbers and the procedure for dialing on an "outside" line should be posted at each phone location.

## Accident Reporting

Any accident that occurs during technology education activities and in the laboratory must be reported. This applies to after school accidents as well as those during the school day. Any accident must be reported since this indicates corrective action that must be taken by the teacher, administrator or both.

A form for the reporting of these accidents can be adapted from the one included in the Appendix on page 111. This report should be completed in accordance with school district policy.

### Accident Analysis

1. Require student to report all accidents to the teacher, regardless of the nature or severity.
2. Keep a record of all technology education accidents resulting in injury to? students, regardless of the nature or severity.
3. Analyze all accident reports for the purpose of aiding in the prevention of other accidents.
4. Use your school district's printed form to record the details of accidents and forward to the appropriate personnel.

## Protective Equipment That Should Be Kept/Provided in a Laboratory:

1. Master shut-off valves/switches should be located within each laboratory, preferably in one secure location accessible only to the instructor. Water, gas and electricity should be turned off when not in use.
2. Adequate numbers of multi-purpose ABC fire extinguishers should be strategically placed within 30 steps or 15 seconds of any location in the room. These should be checked and certified as fully charged and in working order at least every six months.

3. Multiple faucet-type portable eyewash stations should be strategically placed within 30 steps or 15 seconds of any location in the room. Eyewash stations should be forearm or foot-operated for hand-free operation. Flow rate of potable water at 1.5 gallons/minute (5.7 liters/minute) at pressure below 25 psi. is recommended if a standard eyewash unit is installed.
4. Forearm or foot-operated face/body sprayers, with adequate flexible hoses and water pressure, should be strategically placed within 30 steps or 15 seconds of any location in the room. If a standard plumbed safety shower unit is used, it should provide potable water at a flow rate of 30–60 gallons/minute (113.6–227.2 liters/minute) at a pressure of 20–50 psi.
5. Appropriate local exhaust ventilation, vented through the roof to at least 8 feet (2.4 meters) above the roofline, should have a face velocity of 60–100 feet/minute (18.3–30.5 meters/minute) of air through the hood. The hood should not be within 10 feet (3.1 meters) of an exit or on a main aisle.
6. All electrical outlets within 5 feet (1.5 meters) of sinks and serving delicate electrical equipment should be fitted with Ground-Fault Interrupters (GFI). Where thunderstorm activity is a regular meteorological phenomenon, it is essential that outlets be equipped with GFIs, and placed along walls or counters at intervals of 6–8 feet (1.8–2.4 meters).
7. Retardant-treated wool fire blankets, asbestos free, should be prominently labeled and strategically placed within 30 steps or 15 seconds of any location in the room.
8. A bucket of dry, organic-free sand should be available for alkali metals fires.
9. American National Standards Institute (ANSI) coded Z87 of approved safety goggles should be provided for each student when there is danger of chemical or projectile hazard. Specially marked, non-vented goggles should be available for contact lens wearers.
10. Sanitizing and/or sterilizing equipment or materials, (e.g., ultraviolet cabinets, alcohol swabs), should be available and used between classes to clean all protective eyewear.
11. Non-absorbent, chemical-resistant aprons should be provided for each student during laboratory activities where there is a danger of spillage or spattering of chemicals or hot liquids.
12. Heavy-gauge metal storage cans with an internal flame arrester (heat sump) should be used for storage and dispensing of flammable chemicals by the teacher only.
13. Corrosives (primarily for acids) should be separated in approved flammables cabinets (primarily for alcohol and solvents); then separate the cabinets in the storeroom.
14. A container should be provided and clearly marked for the disposal of broken glass only.
15. Containers of diatomaceous earth should be kept available for general chemical spills. Vinegar and sodium hydrogen carbonate (sodium bicarbonate/baking soda) is needed for neutralization of bases and acids respectively. An aspirator and a mercury spill kit should be available for mercury spills. Disinfectants and 10% Clorox bleach solutions should be used to sterilize equipment and wash

down counter tops.
16. An adequately stocked first-aid kit for teacher use should be easily accessible in an emergency.
17. Emergency procedures and telephone numbers should be prominently posted in the room.

## Personal Health Considerations/Directions

1. Wear an approved respirator while spray painting or abrading materials such as fiberglass and other hazardous materials.
2. Do not clean hands in solvent, parts' cleaning fluid or gasoline. These materials are explosive and may irritate the skin.
3. Lift heavy objects properly to avoid back strain.
4. Never place any part of your body in front of a high-pressure grease gun or high-pressure air hose. Do not use compressed air to dust off work areas.
5. Keep all open wounds dressed and free of dirt.
6. Do not wear loose clothing or jewelry. Confine hair so that it will not be a hazard to you.
7. Never aim an air hose at another student.
8. Never use compressed air to blow dirt away from your skin or clothing.
9. Use ladders and devices designed for stepping when obtaining access to areas outside of the normal reach.

# FACILITY DESIGN

## Sick Building Syndrome

Sick building syndrome is a general term for poor air exchange rates within a building, which result in unexplained health problems for its occupants. There are many resources being developed to address this problem. Below is an annotated listing of some of the more representative ones. If non-specific health problems exist within classrooms or laboratories that cannot be associated with a cause, teachers may wish to consider checking these references.

Indoor Air Quality Tools for Schools Action Kit, published by the US Environmental Protection Agency (EPA), Indoor Air Division and co-sponsored by a number of nonprofit organizations, including the National Education Association. This is a very complete and user-friendly resource including checklists for environmental conditions, fact sheets on air pollution sources and solutions, booklets, and an Air Quality Problem Solving Wheel. Videos may also be ordered separately, including "IAQ Tools for Schools – Taking Action and Ventilation Basics" and "Ventilation Basic." The kits may be secured by one of the following methods:

Via US Mail

EPA Kit, PO Box 37133, Washington, DC 20013-7133.
or
US Government Printing Office, Superintendent of Documents (202-512-1800)

EPA Indoor Air Quality Information via Internet. For this information, see the EPA Indoor Air Quality Home Page at:
http://www.epa.gov/iaq

Information from the NEA Health Information Network, including fact sheets covering asbestos, asthma, biological contaminants, formaldehyde, lead, pesticides, radon, sick building syndrome, and drinking water. Information may be obtained from Indoor Environments Project Coordinator at 202-822-7798 or via the Health Information Network website. http://www.neahin.org/

The NIOSH Pocket Guide to Chemical Hazards, published by the US Department of Health and Human Services in June, 1997. The document is available by contacting the Superintendent of Documents, US Government Printing Office at 202-512-1800. The CD/booklet is an excellent resource for support staff and professionals who work with chemicals. It identifies many chemicals and points out their health hazards and the protections necessary for working with and around them.

# Laboratory Design

Pennsylvania is a home rule state. The local school district and municipality maintain the authority to govern over the actions of the individual school. The Pennsylvania Department of Education places few restrictions on those operations. Department regulations include the following:

1. Laboratories must be well ventilated (separately), from the rest of the school;
2. Laboratories must be adjacent to adequate storage facilities and preparation rooms;
3. Each laboratory must be supplied with safety equipment and materials;
4. An architect must certify that all applicable laws and regulations have been met. (The municipality of the school determines which laws are applicable.)

For more information on school facilities' building requirements, contact the Division of School Facilities at 717-787-5480.

Part of the difficulty in designing new laboratories is that there are no absolutes. In choosing a local exhaust ventilation, for instance, the choice of exhaust rates for fumes varies among experts consulted.

## *The Classroom/Laboratory*

The classroom should provide a pleasant, airy and visually stimulating atmosphere in which to learn. The room should also be quiet and devoid of echoes and reverberations.

The facility should accommodate the needs of the permanently and the temporarily handicapped student. This includes aisles wide enough to accommodate wheelchairs or students on crutches.

Several publications cited in the References contain checklists or information that could easily be used by those wanting to renovate or build new technology education labs. The checklist included in the appendix is NOT an exhaustive checklist and is only intended to address the secondary (9–12) technology education laboratory.

Teachers need to be involved in all aspects of facility renovations and new construction. Recommendations based on current regulations and teaching methodology should be actively presented to the architectural firm and the school administration. Care should be taken to prevent current and future overcrowding that would result in a potentially unsafe environment. Assistance can be obtained by contacting the Technology Education advisor from the Pennsylvania Department of Education and/or the leadership from the Technology Education Association of Pennsylvania. The following student to space ratios are recommended:

Lecture Classroom 45 sq. ft. per student
Computer Laboratories 50 sq. ft. per student
Modular Laboratories 75 sq. ft. per student
Laboratories Utilizing Tools and Equipment 100 – 125 sq. ft. per student

It is recommended that a laboratory-based class never exceed a ratio of 24 students per teacher.

The room should be designed so that there are no inherent BLIND SPOTS. The teacher should be capable of supervision from any point in the room. This is especially critical when young students are involved, and when students with special needs are partaking of the Technology Education courses. If such blind spots do exist as the result of structural barriers, which would be prohibitively expensive to eliminate, teachers might explore the installation of large convex mirrors similar to those used in department stores by clerks to observe customer movement.

## *Electrical Hazards*

The teacher should be sure that all equipment in the facility is properly maintained. This includes such common items as grounded electrical receptacles and circuits rated to handle the draw of the machines attached to them. Extension cords must be heavy-duty three wire with grounding prongs. Extension cords should only be used for temporary/moveable service. Especially critical is the need to assure that extension cords are out of the mainstream of traffic or enclosed in electrical cord ducting strips to prevent tripping.

Ground fault interrupters (GFI) and electrical surge protectors should be given serious consideration for some outlets. Electrical outlets near (i.e., within arm’s length) water faucets, for instance, should have GFIs on them to prevent shock due to a faulty or

missing ground wire on the appliance being plugged in. Surge protectors are essential where sensitive electrical equipment is being used, in geographic areas where thunderstorm activity is a regular phenomenon and where other electrical spikes and drops are common. Another method of protection is the utilization of a ground fault circuit interrupter (GFCI). This device continually monitors the current leakage to ground via a path outside the circuit conductors. The GFCI circuit measures the currents in the "hot or voltage energized conductor and its associated neutral conductor. If the two currents are equal, there is no leakage current; conversely, if the two currents are not equal, there is a leakage current path. If the leakage current goes to ground, (either through the equipment grounding conductor or through a person), exceeds the trip level, (5mA + 1mA), the circuit is interrupted quickly enough to prevent electrocution.

In Pennsylvania, new construction follows the guidelines of the National Electrical Code requiring the installation of "Ground Fault Circuit Interrupters" (GFCIs) in any electrical outlet within six feet of a water source. GFCIs measure the current going out of the load and compare it with the current coming back from the load. If there is a difference of even 5 milliamps, the GFCI grounding receptacle interrupts the current within 0.17 seconds and so prevents serious shock.
For complete information concerning electrical wiring, safeguards, etc., the NFPA, National Electrical Code Handbook is strongly recommended.

### *Environmental Hazards*

Environmental hazards should be assessed and addressed immediately. Special attention should be paid to such chronic hazards as asbestos linings of ceilings and walls. It is best for teachers to contact the administration or the state department of education or environmental protection agency should they discover such problems. There are federal and state funds specifically earmarked to address such problems. In most instances the alternatives for addressing these problems are well defined and include: removal, sealing behind walls or impregnation of the friable (stringy) asbestos fibers in a sealer.
The teacher should view the classroom as the environment through which students gain their initial and lasting impressions of technology education courses and themselves as teachers. The room should complement the teaching style of the instructor and be reflective of the course, the teacher's interest in it, and his/her educational and practical experiences with such. The room should stimulate student interest without restricting creativity due to safety hazards.

## Accepted Standards and Practices

1. Aisles should be a minimum of three feet and preferably four feet wide.
2. Color Coding/ANSI – Color should be used to create a pleasant work area, reduce glare and promote safety. Light pastels are best for walls, partitions and ceiling areas. Many nationally recognized organizations offer suggested standards for color-coding machines and equipment. Most equipment color suggestions would follow the basic American National Standards Institute (ANSI) color system. The color-coding system must be standard throughout the school. New equipment should be matched to the existing color-coding system.

| ANSI Color Coding System | |
|---|---|
| Basic Machines | Gray or Green (by tradition) |
| Depicts Potential Danger | Safety Orange |
| Dangerous Parts | |
| Energized Equipment | |
| Depicts Caution | |
| Stumbling, Tripping, Striking | Safety Yellow (or black and low |
| Against or Caught between Hazards | |
| Depicts Imminent Danger | |
| Emergency Action – Stop Button | Safety Red |
| Urgent Condition (fire) | |
| Fire Extinguishing Equipment, Exit | |
| Signs, Fire Alarm Box | |
| Location of Safety Equipment/First Aid | Safety Green |
| Emergency Eye Wash Station | |
| Traffic Aisles & Stairways | Black, White (or Black & White) |

3. Types of Safety Signs – The hazards in the technology education laboratory should be identified and classified as needing one of the following types of Safety Signs:
   a. Danger – DANGER SIGNS are color-coded Safety Red on Black with a white background. They are used in imminently hazardous situations that "**will**" result in serious physical injury.
   b. Warning – WARNING SIGNS are color-coded Safety Orange and inform of potentially hazardous situations that if not avoided "**could**" result in serious physical injury.
   c. Caution – CAUTION SIGNS are color-coded Safety Yellow and inform of potentially hazardous situations that "**could**" result in minor or moderate injury.
   d. Notice – NOTICE SIGNS are color-coded Safety Blue and provide information or school policy.
   e. General Safety – GENERAL SAFETY SIGNS are color-coded Safety Green. They provide general safety instructions, safety reminders and the location of safety related equipment.

4. Lighting: Laboratory areas require 70 foot-candles of illumination while drafting areas and general classrooms require 100 foot-candles of illumination. Additional lighting is often necessary through the use of flexible or adjustable lamp attachments on specific machines or in hazardous areas.

# MATERIALS

## Latex Allergies

Latex use has increased over the past few years. Latex gloves and other products are used in our schools in increasing frequency. The number of individuals diagnosed with allergies to latex has also increased. Before using any latex-based product, be sure to determine that students with latex allergies are identified and are prevented from coming in contact with any latex-based products present in the laboratory.

## The Use and Storage of Flammable and Combustible Liquids

1. Always read the label on the container or MSDS information, before using any of these materials. MSDS information should be kept on file for easy reference if necessary.
2. Be sure exhaust fan(s) or ventilation vents are operating in the area where flammable liquids are stored.
3. Draw out only as much liquid as will be needed for each class period for a particular operation.
4. Dump waste or excess material into approved covered metal containers only. Containers should be emptied daily.
5. Use a funnel when pouring into a small container.
6. Read and follow instructions for handling and mixing catalysts with resin and finishes.
7. Never pour catalysts back into the bottle.
8. Always add catalyst to resin, **never resin to catalyst.**
9. Never apply resin, paint or other finishing material near areas used for flame cutting, welding, grinding, soldering, or other hot work.
10. Be sure that your work area is well ventilated.
11. Store thinners and solvents only in original purchase containers or approved cans.
12. Wear rubber gloves to minimize chances of skin irritation.
13. Wash hands and other exposed skin areas before leaving the laboratory.
14. Remove any article of clothing that may have become accidentally soaked with epoxy, polyester resins and other potentially dangerous substances.
15. Make sure your work area is protected with a fire extinguisher in good working order. Be certain the extinguisher contains the proper extinguishing agent for flammable and combustible liquids.
16. If a respirator is needed, consult your instructor to see what respirator should be used.
17. Always wear protective eyewear when using flammable and combustible liquids.
18. All flammable materials should be stored in closed containers when not in use.
19. Storage cabinets must be distinctly marked “FLAMMABLE--KEEP FIRE

AWAY."

Some of the more hazardous flammable liquids (listed in approximate order of hazard) that you may encounter in your laboratory activities are:

1. Starting fluid
2. Gasoline
3. Aerosol cans *
4. Catalysts ** (like MEKP)
5. Carburetor cleaner
6. Acetone
7. Lacquer and lacquer thinner
8. Adhering liquid (for screen printing process)
9. Paint thinner
10. Alcohol (Isopropal)
11. Shellac
12. Japan dryer **
13. Kerosene
14. Paint
15. Resin (polyester)
16. Stain and varnish
17. Danish oil
18. Film Cleaner (Ethyl Alcohol)

Note: This is not a complete list. Teachers should review the materials that they use for possible additions.
* The hazard could vary greatly depending upon the propellant used in the can. (Consult your instructor before use.)
** These materials could accelerate spontaneous combustion or could react violently when mixed with organic material. (Consult your instructor before use.)

## Chemical Hygiene Plan

For additional information regarding chemical hygiene plans, check the following website: http://www.ecs.csus.edu/techshop/

OSHA Occupational Exposures to Hazardous Chemicals In Laboratories Chemical Hygiene Plan, (29 CFR, 1910.1450) as of January 31, 1991, laboratories engaged in activities that are encompassed within the definition of "laboratory use" must have in place a written Chemical Hygiene Plan (CHP) outlining how the facility will comply. This OSHA standard applies to all employers engaged in the laboratory use of chemicals. The plan requires that employers, including schools, develop a comprehensive plan for identifying and dealing with chemical hazards. The plan must include all employees who could be exposed to these chemicals and it must be updated annually. Refer to page 115 in the Appendix for CHP guidelines.

The classroom and the lab must be periodically inspected for unsafe conditions. Notably,

safety equipment should be in place and operable. An out-of-stock first-aid kit is of very little help during an accident, or later in a lawsuit. An outdated fire extinguisher or one inappropriate to the type of fire expected, or uncharged, is inexcusable. Check for broken or excessively worn equipment and discard it or have it repaired. Check for mislabeled, unlabeled or outdated substances. Review the layout of the room for orderliness of its contents with an eye toward safety, traffic flow and ease of exit. KNOWINGLY ALLOWING AN UNSAFE CONDITION TO CONTINUE IS WORSE THAN NEVER DISCOVERING IT IN THE FIRST PLACE.

# TOOLS AND EQUIPMENT

## Lasers*

The laser, an acronym for Light Amplification by Stimulated Emission of Radiation, emits beams of focused radiation of a single color (wave length) and frequency. In contrast, conventional light sources (e.g., incandescent lamps, arc light) produce random, disordered light wave mixtures of various frequencies.

Just about all present-day lasers are potential eye hazards. The selection of a proper protective filtering lens for laser operators depends upon the wavelengths involved and the optical density (based upon the relative power output of the laser), needed to prevent damage to the retina of the eye. A “pump” activates the laser material. This pump is really a very high voltage power supply of a pre-determined frequency. Because of this, all lasers must be treated with respect from an electrical safety reference point. A mirror inside the laser reflects light to the partially transparent mirror and the actual laser beam is then focused into a very narrow beam by a lens. The resulting light beams have an extremely high intensity and energy. This energy could cause serious harm.
The primary hazard associated with laser operations is the laser beam. The laser beam can cause permanent eye damage and skin burns if proper safety practices and procedures are not followed. Eye damage occurs due to the refocusing of the laser beam by the eyes lens onto the retina. It is the energy transmitted to the retina via the eye and focused by the lens that causes the loss of sight. Reflective surfaces may redirect the laser beam and also pose safety hazards. Additionally, direct viewing of the laser beam (that is, looking into the laser output opening) with binoculars or telescopes may also cause retina damage due again to the refocusing of the beam of energy.

### *Basic Safety Practices*

1. Do not leave LASERS unattended during operation. Beam shutters or caps should be utilized or the LASER should be turned off.
2. Instruct users as to potential eye hazards and the importance of limiting unnecessary exposure.
3. Warning sign(s) should be posted. Such signs might read:

a. LASER BEAM IN USE.
b. DO NOT STARE AT LASER BEAM.
c. DO NOT AIM LASER BEAM AT A PERSON’S EYE.
d. DO NOT AIM LASER AT SURFACES THAT MAY REFLECT

IT.

e. DO NOT USE OPTICAL INSTRUMENTS (e.g., TELESCOPE, BINOCULARS) TO VIEW LASER BEAM.

4. Combustible materials stored in the laboratory should be protected from the laser beam.
5. Follow all electrical safety practices you would utilize for line operated and high voltage equipment.

NOTE: No one type of glass offers protection from all laser wavelengths. Consequently, many firms do not depend upon safety glasses/goggles to protect from laser burns, because goggles might give a false sense of security and tempt the wearer to be exposed to unnecessary hazards. Nevertheless, laser users do frequently use eye protection as a recommended by the manufacturer.

Lasers are grouped into four basic categories; however, it is suggested that only CLASS I and CLASS II LASERS be considered safe for technology education laboratory usage.

CLASS I: Exempt LASERS or systems: These units, under normal operating conditions cannot emit a hazardous level of optical radiation. No warning label or control measure is required.

CLASS II: Low power LASERS: Visible beams that do not have enough output power to injure a person accidentally. However, prolonged exposure (e.g., being stared at by an individual) may produce retinal injury. A caution label is required.

* This information is found in the reference manual, Fundamentals of Industrial Hygiene, Julian B., Olishifski and Editor. Published by the National Safety Council, Chicago, IL, 1979.

# SUMMARY

Safety is the best prevention for avoiding both accidents and resulting lawsuits. This has not changed since the beginning of recorded American case law. The message is clear. The public expects the learning environment to be safe for ITS children. To the extent that teachers or school officials do not observe commonly accepted safety practices, they may be held liable for injuries resulting from accidents. The best defense to a lawsuit arising out of an accident is to provide evidence of the safety practices that were observed. If they correspond to the generally accepted practices in Technology Education instruction, then liability can usually be avoided. The prescription for teachers and schools is simply this: stay abreast of the latest developments in the field, in safety, and use common sense!

## REFERENCES/RESOURCES

## General Information on Federal Safety Mandates

The following is a list of federal agencies and their most applicable regulations concerning safety in schools. This list is not to be considered comprehensive. Many of the regulations cited and any recent updates/changes can be found on the Internet at the agency's web address, e.g., www.osha.gov or www.epa.gov

- Asbestos Hazard Emergency Response Act (AHERA) – Environmental Protection Agency (EPA)
- Code of Federal Regulations (CFR), Appendix C, Part 20, Title 10, United States Nuclear Regulatory Commission (NRC) exempt quantities
- CFR, Part 29 (pertinent sections), Occupational Safety and Health Administration (OSHA) Standards:

1910. General Workplace Standards
1910. Subpart Z Exposure Standards
1910.133 Eyewear Standards
1910.134 Respirator Standard
1910.1028 Benzene Standard
1910.1030 Blood borne Pathogens Standards
1910.1048 Formaldehyde Standard
1910.1200 Hazardous Communication Standard
1910.1450 Occupational Exposure to Hazardous Chemicals in Laboratories
1910.20 Access to Employee Exposure and Medical Records

- Resource Conservation and Recovery Act (RCRA) – EPA
- Title III Emergency Planning and Right-to-Know Sections 301-304, 311-313 – EPA
- Title IV – Superfund Amendments and Reauthorization Act (SERA) (indoor air quality) – EPA
- Toxic Substances Control Act (indoor air quality) – EPA

Early, M. W. (1999). National Electrical Code Handbook, 7th ed. National Fire Prevention Association.

Cote, R. (1997). Life Safety Code Handbook. 7th ed. National Fire Prevention Association.

American Red Cross. (1995). First Aid Fast. Mosby Lifeline.

# ELEMENTARY SCIENCE & TECHNOLOGY EDUCATION PROGRAMS

# INTRODUCTION

Hands-on science and technology activities afford children the opportunity to master concepts and acquire problem-solving skills through inquiry-based learning. Since these are laboratory-oriented activities, adequate training in the safety aspects of science and technology classes is imperative for elementary teachers. It is the responsibility of the administration and the teacher to provide a safe environment for the students and staff. A sample parent permission letter is available on page 116 of the appendix and may prove useful for communications with the parents. A significant amount of information is available in the general Safety section. It is strongly recommended that the reader review the General section for important related information.

# PENNSYLVANIA LAWS AND REGULATIONS

Legislation in Pennsylvania exists and is applicable to school safety and health. This includes the Eye Safety Act, Act 116 of 1965, the Worker and Community Right-to-Know Act, Act No. 159 of 1984, and the General Safety Law, Act No. 174, which has been in effect since 1937. The Right-to-Know Act is briefly covered in this guide under the section "Hazardous Substance."

## Act 116 - Pennsylvania Eye Safety

Providing for the use of eye protective devices by persons engaged in hazardous activities or exposed to known dangers in schools, colleges and universities. The General Assembly of the Commonwealth of Pennsylvania hereby enacts as follows:

*Section 1*

Every teacher, student, visitor, spectator and every other person in any shop or laboratory in public or private schools, colleges and universities who is engaged in or is within the area of known danger created by:

1. the use of hot liquids, solids or gases, or caustic or explosive materials,
2. the milling, sawing, turning, shaping, cutting, grinding or stamping of solid materials,
3. the tempering, heat treatment or kiln firing of metals and other materials,
4. gas or electric welding,
5. the repairing or servicing of vehicles shall wear industrial quality eye protective devices at all times while engaged in such activities or exposed to such known dangers.

*Section 2*

Schools, colleges and universities shall have the power to receive Federal, State and local

moneys and to expend the same to provide such devices and shall furnish such devices to all visitors and spectators and all other persons required under the provisions of this act to wear them.

*Section 3*

Enforcement of this act shall be in accordance with standards, rules and regulations promulgated by the State Board of Education.

*Section 4*

For the purposes of this act, "industrial quality eye protective devices" mean devices meeting the standards of the American Standard Safety Code for Head, Eye and Respiratory Protection, Z2.1-1959, promulgated by the American Standards Association, Incorporated.

*Section 5*

This act shall take effect immediately.

## *Regulations Governing the Use and Care of Protective Eye Devices in the Schools of Pennsylvania*

Enforcement of Act 116 of 1965

I. An Act

To provide for the use of eye protective devices by persons engaged in hazardous activities or exposed to known dangers in schools, colleges, and universities.

II. To Whom And Where Does It Apply

To all pupils, teachers, visitors, spectators, and every other person upon entering and/or engaging in Vocational Education, Technology Education, Science, and all other areas where known dangers exist, such as shops or laboratories in public or private schools, colleges and universities where the activities enumerated in the Law are in progress, shall be required to wear industrial quality eye protective devices.

Known dangers are the use of hot liquids, solids or gases; caustic or explosive materials; the tempering, heat treatment or kiln firing of metals and other materials; gas or electric welding; or the repairing or servicing of vehicles. Persons exposed to these dangers shall wear industrial quality eye protective devices suitable for the specific hazards at all times while engaged in such activities or exposed to such known dangers.
Enforcement of this Act shall include custodial, service, food preparation, and other areas of school operation where eye hazards exist.

For the purpose of implementing this act, “industrial quality eye protective devices” means devices meeting the standards of the American Standard Safety Code for Head, Eye, and Respiratory Protection, Z2.1 – 1959, promulgated by the American Standards Association, Incorporated.

III. Who Is Responsible

Local boards of school directors, boards of education, college boards of trustees, and governing bodies of private schools shall adopt such rules and regulations as may be necessary for the provision, maintenance, and use of eye protective devices as required to meet the provisions of the law.

IV. For Non-Compliance

In cases of non-compliance, the Superintendent of Public Instruction may take whatever action is deemed necessary. In simple terms, this law states that any time that a risk of eye injury exists, all persons in the same room or other enclosed area (lab/lecture combination room) must wear "industrial quality eye protective devices."

# Civil Rights Mandate

The Rehabilitation Act of 1973, Section 504, was initially enacted into law to protect the civil rights of all Americans with handicaps. The implementation regulations and enforcement provision did not become law until June 1977. Now, however, it provides greater opportunities for physically or mentally handicapped individuals.

The basic requirements of the law are summed up in the following section:

## *GENERAL PROVISION AGAINST DISCRIMINATION*
## *Section 84.4*

Any program or activity which receives federal financial assistance 1) may not exclude qualified handicapped persons from aids, benefits or services; 2) must provide equal opportunity to participate or benefit; 3) must provide services as effective as those provided to the non-handicapped, and 4) may not provide different or separate services except when necessary to provide equally effective benefits.
Services need not be identical to those provided to the non-handicapped, but must be the equivalent to them and must afford an equal opportunity to achieve results in the most integrated setting appropriate to the person’s “needs”.

Mainstreaming is the result generally associated with section 504. It puts students in a “least restrictive environment,” usually a regular classroom or lab situation. When one or two special needs students are mainstreamed into a regular class, the teacher must take extra safety precautions. Such situations will have to be adapted to the person’s “needs”.

# Liability

The connection between safety and the law is founded in reasonableness. The law only requires that a person be reasonable, that is, exercise good common sense. Good safety consists mainly in behaving reasonably and exercising good common sense. A teacher does not need to worry about adopting unfamiliar habits in order to conform to what the law expects to avoid being sued. Rather, a good teacher can avoid being sued by merely being reasonable and promoting a safe learning environment. In the cases cited at the end of this chapter, it should be obvious that the outcome accords with common sense. Teachers do not need to fear being held to a ridiculous standard of perfection as long as they act reasonably. The law expects reasonable people to acquire and practice safety habits, which are no more than reasonable precautions.

## *The Law Defined*

**Pennsylvania Negligence Definitions**
The teacher, district science specialists, and administrators are legally responsible for the safety of the student in the science classroom. The legal principles involved are part of tort law. A tort is a wrongful act causing damages, which may rise to a civil suit. If a person is injured; they are often called personal injury cases. Concern arises when the torts are based on an allegation of negligence. Negligence is defined in *Black's Law Dictionary* as 'the omission to do something, which a reasonable person, guided by those ordinary considerations, which ordinarily regulate human affairs, would do, or the doing of something, which a reasonable and prudent person would not do.' The Dictionary states that "one is not 'negligent' unless he/she fails to exercise the degree that would be exercised by a person of ordinary prudence under all the existing circumstances in view of probable danger of injury." The law basically requires teachers to be reasonable and use good common sense. Teachers are required to exercise the skill and training that would ordinarily be expected from someone in their profession. In the classroom, this requires an understanding of the substances and materials the teacher and the students will be using, whether it is a chemical or combination of chemicals, animals, plants, or lab equipment. This manual cannot list all possible problems, but may serve as a starting place for inquiry. Teachers must gather the information needed to reasonably assess the risk versus the benefit of any activity. As professionals, teachers are obligated to provide a healthy and safe environment in the classroom.

**According to 42 Pa.C.S.A. §8332**
(a) Any person who renders emergency care, first aid or rescue at the scene of an emergency, shall not be liable to such person for any civil damages as a result of any acts or omissions in rendering the emergency care, first aid or rescue, except any acts or omissions intentionally designed to harm or any grossly negligent acts or omissions which result in harm to the person receiving the emergency care?

## *Legal Responsibilities as An Elementary Teacher Relating To Negligence*

The LEGAL DEFINITION of "negligence" is important for every teacher to know. Negligence, as defined by the courts today, as conduct that falls below a standard of care established by law or profession to protect others from an unreasonable risk of harm, or the failure to exercise due care. It should be noted that in the absence of specific laws or local policies, the profession sets the standard of care expected.

The technology education teacher has three basic duties relating to the modern concept of negligence:

- Duty of instruction
- Duty of supervision
- Duty to properly maintain facilities and equipment

Failure to perform any duty may result in a finding that a teacher and/or administrator within a school system is/are liable for damages and a judgment awarded against him/them.

DUTY OF INSTRUCTION includes adequate instruction before a laboratory activity (preferably in writing) that:

- is accurate; is appropriate to the situation, setting and maturity of the audience; and addresses reasonably foreseeable dangers.
- identifies and clarifies any specific risk involved, explains proper procedures/techniques to be used and presents comments concerning appropriate/inappropriate conduct in the lab. Instruction must follow professional and district guidelines. A teacher who sets a bad example by not following proper laboratory procedures may be sued if injury results from students following the teacher's bad example.

DUTY OF SUPERVISION includes adequate supervision as defined by professional, legal and district guidelines to ensure students behave properly. Points to remember:

- Misbehavior of any type must not be tolerated.
- Failure to act or improper action is grounds for liability.
- The greater the degree of danger, the higher the level of supervision should be.
- The younger the age of students or the greater the degree of inclusion of special population students, the greater the level of supervision should be.
- Students must never be left unattended, except in an emergency where the potential harm is greater than the perceived risk to students. Even then, risk should be minimized or responsibility transferred to another authorized person if the situation allows.

DUTY OF MAINTENANCE includes ensuring a safe environment for students and teachers.

- Never use defective equipment for any reason.
- File written reports for maintenance/correction of hazardous conditions or

defective equipment with the appropriate administrators.

- Establish regular inspection schedules and procedures for checking safety and first aid equipment.
- Follow all safety guidelines concerning proper labeling, storage and disposal of chemicals.

**By keeping files of all hazard notifications and maintenance inspections, teacher liability in the event of an accident is minimized in cases where no corrective actions were subsequently made.**

# GENERAL SAFETY CONSIDERATIONS

Students must be at the proper developmental level and possess adequate motor skills for individual use of laboratory materials and tools as well as be able to follow the safety rules. Lab safety rules should be clear, simply written, and posted in the classroom.

- Wear eye protection, aprons, and gloves when necessary.
- No playing or running in lab areas.
- No throwing of objects of any kind.
- Clean up all work areas and dispose of materials properly.
- Keep work areas neat and organized.
- Never use a hand tool when others are standing within your safety zone.
- Don't wear loose or baggy clothing or jewelry when using tools.
- Tie back dangling, long hair when using tools.
- Wash hands with soap after using lab materials.
- Never touch a spinning or rotating tool.
- **Never taste any substance or object without permission from your teacher**.

## Definitions

**Acids/Bases** – chemicals that release hydrogen or hydroxide ions when mixed with water, becoming corrosive. May be strong (e.g., hydrochloric acid, sodium hydroxide, lye) or weak (e.g., acetic acid, vinegar, baking soda).

**Body fluids** – any liquid produced by the body of humans or other animals; includes saliva, blood and urine.

**Chemicals** – materials that may produce reactions leading to corrosion, noxious fumes, or other negative effects when used inappropriately in the classroom.

**Combustibles** – any material that burns easily.

**Hand tools** – non-motorized implements used to do work in the laboratory.

**Hazardous waste** – materials that become toxic or could possibly endanger species and the quality of the environment when released.

**Metals** – shiny, dense, malleable elements that can be toxic if ingested, inhaled in powder or vapor form, or taken in through the skin (e.g., mercury).

**MSDS (Materials Safety and Data Sheet) Sheet** – contains information about chemicals purchased from a science supply vendor; lists all of the properties and possible hazards of the chemical. If an MSDS is not available, request one from the manufacturer or obtain one online at http://www.msdsonline.com

**Organic compounds** – chemical compounds containing carbon, hydrogen and often times oxygen bonded together (e.g., turpentine, fats and oils, sugars, starches, some fertilizers).

**Safe environment** – teaching and learning conditions that promote and allow attitudes and procedures that avoid accidents and injury within the school community.

**Solvents** – materials that dissolve other chemicals (e.g., water, fat, organic)

**Toxins** - materials that are or may become harmful if taken into the body or released into the environment.

# FACILITY DESIGN

## Classroom Management

Safe conditions in the science and technology classroom depend upon how the teacher manages materials, workstations and student behavior. Advance preparation and organization of materials are vital to a successful hands-on program. In addition, students should be instructed in behavior that promotes safety for themselves and their classmates in the learning environment.

- Safety rules must be clearly written, discussed with students, and posted in the classroom.
- A safety contract should be required for appropriate age levels.
- Students should be taught safe use and transport of tools and materials. This information should be appropriately assessed.
- Stations where students pick up and return tools and materials should be clearly marked and kept as neat as possible.
- Safety precautions should be reviewed with students when presenting a new lesson.

- The teacher should make every effort to become aware of possible hazards as a part of preparation for any activity. Frequently, safety measures are found in written teacher guides.
- Administration and parents should be notified if any student behaves in a manner that puts him/her or other students at risk.

## Laboratory – Physical Setting

Safe teaching and learning conditions begin with organized classroom facilities. This means that proper attention must be paid to adequate space, appropriate furnishings, properly installed electrical outlets, sinks, lighting, ventilation and storage.

- Furniture, workstations and mobile lab carts should be appropriately sized and adequately spaced. Forty- five to 60 square feet (4.2-5.6 square meters) of working space per student should be provided. Class size should not exceed 24 students.
- The American Disabilities Act (ADA) requires that handicapped and disabled students be provided an additional 20 square feet (1.9 square meters) of work space per student.
- Furniture and lab equipment should be in good condition.
- There should be designated and appropriate storage areas for materials which do not block walkways and exits. These areas should be secure to prevent student access.
- Adequate and properly grounded electrical outlets should be spread out around the room.
- The room and lab stations should be well-lit.
- Fire extinguisher(s) should be fully charged and readily available, and staff should be trained to use them. Fire blankets should be within easy reach.
- Fire doors and exits should meet current building codes.
- A working telephone and/or intercom should be available in each room for emergencies.
- Ventilation should provide for regular air exchange within the room.
- Lab safety rules clearly written and posted.
- Classes should include no more than 24 students per teacher. If three or more students are identified as “special needs,” a paraprofessional or other responsible adult should be provided for additional supervision.
- The teacher should have a clear view of all work areas.
- Protective clothing and eye protection should be available as needed.
- The classroom teacher should be involved in any plans for room/building renovations to insure proper facilities, storage and utilities.
- **Students should be supervised by an adult at all times.**

## Storage

The following recommendations will provide for safe and adequate storage:

- Storage should be kept neat and clean.
- Storage areas should not block walkways and work spaces.
- Shelves must be adequate to support loads.
- Heavier items should be stored on secure lower shelves.
- Stored tools and lab materials should be inaccessible to students.
- Storage of chemicals requires special guidelines:
  - All chemicals must be clearly labeled (contents, strength, date purchased, precautions) and stored in original containers.
  - Chemicals should not be stored past the manufacturer's suggested shelf life.
  - MSDS sheets for purchased lab-grade chemicals must be filed within easy reach of chemical containers.
  - Flammables and corrosives should be stored separately in a fire-proof storage area.

# MATERIALS

## Materials To Avoid in an Elementary Program

- Aerosols with organic propellants
- Alcohol burners
- Bacterial cultures
- Body fluids
- Certain glues (e.g., "instant," epoxy, airplane)
- Common allergens (e.g., pollens, animal furs, peanut products, mold)
- Flammable liquids (e.g., methyl alcohol, carbon disulfide, ether)
- Formaldehyde-preserved animal specimens
- Mercury thermometers (replace with alcohol-filled thermometers)
- Nail polish remover
- Oil-based paint thinners and turpentine
- Organic-based craft dyes• Organic paint strippers
- Plant parts other than tuber, holly berries
- Poisonous plants (e.g., poison ivy, mistletoe, poinsettia, azalea, tulip bulb, potato)
- Poisonous animals (e.g., spiders, stinging insects, centipedes, millipedes, some snakes and lizards)
- White-out type solutions
- Strong acids (e.g., undiluted hydrochloric, nitric, sulfuric; boric acid powder)
- Strong bases (e.g., undiluted ammonia, sodium hydroxide (lye), chlorine bleach)
- Anything harmful if ingested, if age appropriate

## Disposal of Materials

Many materials used in an elementary lab program can be disposed of in classroom trashcans and sinks. However, special procedures should be followed for some materials. The Environmental Protection Agency (EPA) and the American Chemical Society (ACS) list the following disposal methods:

- Provide a separate, labeled container for broken glass and other sharp objects.
- Regulations governing what materials will be accepted at sanitary landfills and your local sewer system vary. Call your local codes enforcement office for this information.
- Hazardous wastes require special handling. Contact EPA or call your local codes enforcement office for this information.
- Recycling or reuse of materials should be promoted whenever possible.
- Sink disposal of solid materials (e.g., soil, clay, plaster) should be avoided.
- All liquid chemicals that is safe for classroom sink disposal should be diluted before being poured into drains. Consult the appropriate MSDS sheet whenever possible.

**If you are not sure if a waste is hazardous, contact a local/state hazardous waste management agency or your state or regional EPA office, fire marshal's office, or Pennsylvania Department of Education.**

# TOOLS AND EQUIPMENT

Hands-on, inquiry-based science and technology instruction requires the use of lab materials and tools by students, individually and in groups. Proper planning that includes choices of appropriate materials and instruction for students in their use promotes safety in the classroom.

- Students must be at the proper developmental level and possess adequate motor skills for individual use of tools and lab materials. Instruction and supervision must be provided by a qualified instructor.
- Tools should be the proper size for the age and size of the students.
- Wherever possible a jig or vise should be used to hold materials, allowing students to have both hands free.
- Each hand tool and piece of lab equipment should be introduced by the teacher, including its proper use and safety precautions.
- Students should demonstrate safe tool and equipment use to the instructor before working independently.
- Lab equipment and tools must be kept in good working order (e.g., saws kept sharp, hammers with intact handles and secured heads, glassware without cracks or sharp edges).
- A teacher who is uncertain about the safe use of a particular tool or material with students should first consult with someone having the appropriate science or

technology expertise.
- See the Appendix for a suggested list of hand tools may be safely used at the elementary level.

Refer to the "Suggested List of Appropriate Hand Tools for Elementary School Use" located on page 117 in the Appendix.

## Safety Equipment

All students and teachers are required to wear eye protection whenever using materials that can damage the eyes. Goggles should meet the standards of the American National Standards Institute (ANSI), including chemical splash goggles to be worn whenever potentially harmful chemicals are a part of the lesson. If students in different classes will share goggles, they must be sterilized between uses by dipping in a disinfectant solution or treatment in a sterilizing ultraviolet light cabinet.

Protective aprons and disposable gloves should be provided and worn by teachers and students whenever appropriate.

# Resources


- DeLuca and Haynie, Safety System Design for Technology Education, ITEA, Revised July, 2000.

- Standards for Technological Literacy: Content for the Study of Technology, ITEA, 2000.

- Technology Education: Welcome to Our Safety Lesson, Marshall Middle School, North Allegheny Schools.

- North Allegheny Schools Technology Education Safety Test Booklet

- Pennsylvania Industrial Arts/Technology Education Safety Guide, Third Edition, TEAP.
- Science and Safety, Making the Connection, Council of State Science Supervisors.
- Safety is Elementary, The Laboratory Safety Institute, Natick, MA, 2000

# BIOTECHNOLOGY

# INTRODUCTION

A significant amount of information is available in the General Safety section. It is strongly recommended that the reader review the General Safety section for important related information.

The word biotechnology itself is quite simple to understand. Bio represents biology, which is the science of all living things? Technology represents the tools and techniques used to apply our knowledge so that living organisms respond as we want them to respond. The interpretation of what biotechnology is can be very broad; for example, a wooden chair is an example of biotechnology since it originated as a living organism. The interpretation could be very narrow, only those things that are living can be thought of as biotechnology. In Pennsylvania, "Biotechnology is anything that directly effects or alters a living organism." The following Units have been established to help organize the study of Biotechnology:

**Agriculture** – a dynamic human activity that produces food and fiber from development through growth to the table and beyond

**Bio-materials** – end products that are produced or altered by living organisms to enhance food and fiber production systems.

**Genetic Engineering** – deliberate manipulation of DNA to make or modify products; often applied as part of a traditional breeding program.

**Medical Technology** – application of health wellness principles and theories to develop methods and tools that enhance the safe production of food and fiber and promote good health.

**Regulation and Safety** – method to ensure the safe production of food and fiber production, addressing protocols of public concern and safety.

**Resource Recovery** – practices that maintain a quality of living, a quality environment, adequate food and fiber production utilizing limited renewable and nonrenewable resources while protecting air, water, and soil resources.

It is the purpose of this safety guide to provide educators with the understanding, foresight and attitude to enable them to meet their responsibilities. This increased safety consciousness should, in turn, make these informed educators more confident, less susceptible to accidents and liability suits and better equipped to experience biotechnology with their students.

Teachers must choose safe laboratories that cover important concepts. Thought must be given to the chemicals purchased by schools. Which chemicals are the safest for the proposed laboratories, how much is needed, where will the chemicals be stored and in what arrangement? Are the storage areas locked and well ventilated?

Schools needing to dispose of unwanted or unknown (no label) chemicals should contact their state technology education supervisor, state ecology agency or regional EPA office. Teachers or school officials should be prepared to give the name or description of the chemical, amount, type of container, nearest landfill and local sewage system.

Contact your local office of the Pennsylvania Department of Environmental Protection for local or statewide school chemical clean-up programs. Where this cannot be done, local schools should band together to engage in regional chemical clean-ups to conserve costs.

# GENERAL SAFETY CONSIDERATIONS

1. Always perform an activity or demonstration prior to allowing students to replicate the activity. Look for possible hazards. Alert students to potential dangers.
2. Safety instructions should be given orally and be posted each time an activity is begun.
3. Constant surveillance and supervision of student activities are essential.
4. Never eat or drink in the laboratory or from laboratory equipment. Keep personal items off the lab tables.
5. Never use mouth suction in filling pipettes with chemical reagents. Use a suction bulb.
6. Never force glass tubing into rubber stoppers.
7. A bucket of 90% sand and 10% vermiculite, or kitty litter (dried bentonite particles) should be kept in all rooms in which chemicals are either handled or stored. The bucket must be properly labeled and have a lid that prevents other debris from contaminating the contents.
8. Smoke, carbon monoxide, and heat detectors are recommended in every laboratory. Units should be placed in the laboratory and related areas (storerooms, preparation rooms, closets, and offices).
9. Use heat-safety items such as safety tongs, mittens, aprons, and rubber gloves for both cryogenic and very hot materials.
10. Students should not fear doing activities, using equipment, but should respect them for potential hazards. Students should read the lab materials in advance noting all cautions (written and oral). A positive student attitude toward safety is imperative.
11. Rough play or mischief should not be permitted in biotechnology classrooms or labs.
12. Never assume that any activity is free from safety hazards.
13. Closed-toed shoes are required for labs involving liquids, heated or heavy items that may injure the feet.

14. Students should be aware of the four (4) routes of chemical entry into the body:
    A. Ingestion B. Injection C. Absorption D. Inhalation
15. Never conduct activities in the laboratory alone or perform unauthorized activities.
16. Use safety shields or screens whenever there is potential danger that an explosion or implosion of an apparatus might occur.
17. All persons engaged in supervising, or observing biotechnology activities involving the potential hazard of chemical splattering/splashing to the eye must wear proper eye protection devices.
18. Make certain all hot plates and burners are turned off when leaving the laboratory.
19. MSDS sheets must be maintained on all school chemicals. Schools should maintain an inventory of all biotechnology equipment.
20. Protective (rubber or latex) gloves should be provided when students dissect laboratory specimens.
21. Students should properly report any suspicious odors or fumes.
22. Biotechnology laboratories should be equipped with local exhaust ventilation. Local exhaust ventilation should be available for activities involving flammable and/or toxic substances.
23. Some chemical authorities believe that contact lenses do not pose additional hazards to the wearer and that contact lenses are allowed when appropriate eye and face protection are used. The wearing of contact lenses in the biotechnology laboratory has been a concern because of possibility of chemicals becoming trapped between the lenses and the eye in the event of a chemical splash. Check with your state technology education supervisor for your state's recommendation.
24. Students should understand that many plants, both domestic and wild, have poisonous parts and should be handled with care.

Refer to the Biotechnology Facility Check list, page 112 located in the Appendix.

## Release of Body Fluids, Pathogenic Bacteria, or DNA Samples:

For cleanup of body fluids, pathogenic bacteria, or spilled DNA samples, it is imperative that gloves be worn during the cleanup. A diluted disinfectant, such as 5% Lysol, Zephiran, Wescodyne, or similar disinfectant or 10% Clorox bleach solution should be poured on the spill and worked toward the center with paper towels. The paper towels should be disposed of in biohazard bags. Contaminated glassware should be sterilized in an autoclave for at least 30 minutes at 15 psi. and temperatures above 248ºF (120ºC).

## Communicable Blood borne Diseases

This guide strongly recommends the use of simulation labs in place of any activity requiring the use of human blood.

## Mercury

The use of mercury in any form is not recommended.

# FACILITY DESIGN

The room should have doors that are lockable to prevent unwarranted student or staff entry during certain labs. Screens are placed on all windows to prevent the entrance of insects that could contaminate experiments. Laboratories must be designed so that they can be easily cleaned. This is facilitated by good spacing between equipment and the use of materials that are impervious to moderate heat, acids, alkalis, and solvents. Sinks are conveniently located so as to facilitate hand washing before and after the lab. Regularly spaced and ground faulted electrical outlets are conveniently available for such equipment as gel electrophoresis gel boxes, wire loop sterilizing tubes, etc. Unnecessary drafts are reduced to prevent dust formation, spread, and resulting contamination of experiments. No goggles are shared. Each student has his/her own set to help prevent transmission of bacteria, etc. among classmates. Sterilizing equipment is provided for hardware or adequate storage for disposable items.
Storage areas should, ideally, be separate from the classroom/lab. The NSTA recommends that such storage should encompass the equivalent of 15% of the laboratory space minimally. Storage for lab coats should be provided. Students will need these to help prevent personal clothing contamination. These should be washed in bleach regularly or be of the disposable type. Additional storage is provided for equipment items such as: pipettes, culture agar, glassware, petri plates, biologic waste containers. Proper, controlled, and secured storage areas will need to be provided for liquids such as organic solvents, bleach, Lysol, Roccal, Wescodyne and possibly liquid nitrogen (for frozen cultures). A refrigerator is available for the storage of antibiotics, etc.

# MATERIALS

## Chemicals

### *How Should I Label And Store Chemicals?*

A Material Safety Data Sheet (MSDS) should be kept on file and be easily accessible for ALL chemicals. MSDS sheets should be referenced for proper storage and for appropriate personal protective equipment (PPE). Refer to your school district and state policies for local storage requirements and mandates.

Labeling Chemicals

Include the following minimum essential information on chemical labels:

- Chemical manufacturer or supplier (including address and telephone number)
- Chemical name and/or trade name of the product (same as MSDS when

applicable)
- Date received or date placed in the container
- Strength of the chemical
- Precautions to be observed in handling or mixing the chemical
- Appropriate hazard symbol.

Chemical Storage

Store chemicals according to the following minimum storage requirements:

- Separate storage area from the classroom area. Use appropriate warning symbols to mark storage areas.
- Make certain that storage area is properly ventilated.
- Make certain that the chemical storage area meets all local, state and federal building codes.
- Provide appropriate fire extinguisher(s) or extinguishing systems.
- Make certain that storage shelves are securely attached to wall (each shelf with a front one-inch or 2.5 centimeters lip to pre-vent bottles from sliding off shelves).
- Separate inorganic chemicals from organic chemicals.
- Use a reputable guide, e.g., National Institute for Occupational Safety and Health/Occupational Safety and Health Administration (NIOSH/OSHA), to help you properly separate incompatible chemical families.
- Do not store chemicals past the manufacturer's suggested shelf life.
- Make certain that chemicals are labeled and stored in approved containers.
- Store flammables and corrosives separately in approved cabinets.

## *Purchase of New Chemicals And Disposal of Old Chemicals*

A purchasing policy should be developed by the school/district. Before purchasing a new chemical, review the Materials Safety Data Sheet (MSDS) that will provide important information on physical properties, toxicology, storage, and handling for the chemical. Consider these factors BEFORE purchasing:

- Will amounts be used within 1–2 years?
- Can the chemical be stored properly?
- Is the facility properly designed to use the material safely?
- Can the chemical be easily disposed of and will it be disposed of as a hazardous waste?
- Does the facility have proper personal protective equipment (PPE)?
- Are facility personnel aware of any hazards associated with this product?
- Are facility personnel properly trained in the use and handling of the material?
- Does the budget allow for disposal of the chemical or by-products?
- Can the chemical/material be safely stored in the facility?

Disposal

The Environmental Protection Agency (EPA) and the American Chemical Society (ACS) list the following possible disposal methods:

- Sanitary landfills
- Hazardous waste landfills
- Sewer system (regulations differ for different locations)
- Thermal treatment (incineration)
- Recycling or reuse
- Chemical, physical, or biological treatments, including neutralization, oxidation, precipitation and solidification

For safe disposal of materials, consult the appropriate MSDS sheet. If an MSDS is not available, request one from the manufacturer or obtain one online at http://.www.msdsonline.com Disposing of wastes in landfills is not environmentally recommended; reducing wastes, recycling, and destruction is preferable.

If you are not sure if a waste is hazardous, contact a local/state hazardous waste management agency or your state or regional EPA office, fire marshal's office, or Pennsylvania Department of Education.

# Chemical Hygiene Plan

Refer to the chemical hygiene section of the general safety section and the CHP checklist included in the Appendix on page 115.

# Cleaning Materials

Any swabs, needles, toothpicks or sty lets must be discarded immediately after use into a container that is of a material strong enough to withstand puncture. The items used in the unit involving blood materials should not be laid on the desk or table but always placed in the discard container immediately. This container should be placed in a plastic bag, tied, and discarded at the close of the class period.

Students and staff should wash their hands under running water with soap after working with any body fluid.

Lab tables should be washed with Clorox solution (one part Clorox to ten parts water) after the activity is completed. Clorox solutions should always be made fresh daily. Students must always work with their own blood exclusively to avoid contamination by any transmissible agents that might be present in someone else's blood. If bleeding persists after the finger is punctured, student must apply a sterile bandage using moderate pressure.

Provide in a readily accessible location appropriate materials and procedures for clean-up of hazardous spills and accidents, e.g., 10% Clorox bleach solution or 5% Lysol solution for body fluids, and appropriate procedures for disposal of chemo- and bio-hazardous materials.

# PROCESSES

## Animals:

Whenever animals are to be used in biotechnology activities with students, it is imperative that care be exercised to both protect the animals and the students. It is obvious that animals stimulate learning. They can, however, present some unique hazards to students. Teachers should anticipate such hazards as much as possible so that neither students nor animals are injured. Before using animals, teachers should establish guidelines to avoid any intentional or unintentional abuse, mistreatment, or neglect of animals and to promote humane care and proper animal husbandry practices. If animals are to be kept for any time in the room in cages, be certain that adequately sized and clean cages are provided to all animals. Keep cages locked and in safe, comfortable settings. Animals can stimulate and enhance learning and should be used safely in the laboratory/class-room. Because increased activity and sudden movements can make animals feel threatened; ALL student contact with animals should be highly organized and supervised. Teachers should keep the following precautions in mind to ensure an enjoyable and comfortable experience for their students. The following recommendations should be followed:

- Inquire beforehand about student allergies associated with animals.
- Allow students to handle/touch animals only after proper directions and demonstrations have been given.
- Have students use gloves while handling vertebrates and appropriate invertebrates and wash hands afterward. This will help prevent students from inadvertently transmitting germs.
- Report to the principal and school nurse immediately any animal bites or scratches.
- Do not allow dead animals in the room, as the exact cause of death may not be determinable. Many warm-blooded animals carry and transmit diseases to humans through ticks, mites, and fleas. Have a veterinarian evaluate all animals that die unexpectedly. Provide proof of purchase and if applicable, the shot/vaccination records. This is cheap insurance in helping prevent disease complications.
- Never dispose of fecal matter in sinks or with commonly used equipment.
- Never use wild animals. Obtain classroom animals from reputable pet suppliers.
- Never use poisonous animals in the classroom.
- Never allow animals to be handled when they are eating.
- Never allow students to tease animals or touch animals to their mouths.

For additional information regarding the responsible use of animals in the classroom, check this websites:

http://www.nsta.org/handbook/animals.html
http://www.ehs.ucdavis.edu.sftynet/bio/sn-7html
http://www.etsu_tn.edu/ospa/exosubf.html

Since most supply houses are required to quarantine animals and check them for disease before sale, it would be wise to obtain study animals only from these dealers. If any are purchased locally, check for general health of all animals before purchase.

## Plants:

While plants produce the oxygen necessary for animal life, provide us with food, and beautify our surroundings, some produce very toxic substances. Plants should be kept in areas where they can thrive be readily viewed, and protected. Students should be cautioned not to pick unfamiliar plants as they may present hazards. In addition, many plants are protected by law from picking, or damage, - leave them alone! Teachers should familiarize themselves thoroughly with any plants they plan to use in the classroom.

- Inquire beforehand about student allergies associated with plants.
- Never use plants that present hazards from oils (poison ivy, poison oak, poison sumac, poinsettia, and other local plants); hazards if eaten (some fungi - mushrooms, belladonna, herbane, pokeweed, foxglove, jimson weed, azalea, castor bean, holly, milkweed, mistletoe, nightshade, and other local plants); or hazards from saps (oleander, stinging nettle, and other local plants).
- Never burn plants that might contain allergy-causing oils, e.g., poison ivy.
- Make a clear distinction between edible and non-edible plants.
- Never allow plants to be tasted without clear direction from the teacher.
- Have students use gloves while handling plants and wash hands afterward.

## Microbiology

It has become increasingly clear that, with proper guidance and a well-trained teacher, that research with certain microorganisms and host organisms rDNA (Recombinant Deoxyribonucleic Acid) is appropriate for students in high schools. Experiments with Escherichia coli (E. coli K-12) for example, was exempted from the National Institutes of Health (NIH) guidelines in 1986. This indicates that DNA from a safe compound can now be generated in E. coli K-12 using a vector that is compatible with E. coli K-12. NABT endorses this decision. As an added degree of safety, it is strongly recommended that teachers limit any work with students to BIOSAFETY LEVEL 1 as defined by the Center for Disease Control, National Institutes of Health in CDC-NIH Biosafety in Microbiological and Biomedical Laboratories, 2nd Ed., May, 1988. These activities are defined as being suitable for work involving organisms of no known or minimal potential

hazard to laboratory personnel and the environment. Biological laboratory rooms are classified as 1 through 4 in accordance with increasing hazard severity. Table 1 summarizes the factors that determine the classifications. For additional information consult the CDC/NIH publication Primary Containment for Biohazards: Selection Installation and Use of Biological Safety Cabinets.

Table 1. Laboratory Classification/Biosafety Level

| Level | 1 | 2 |
|---|---|---|
| Potential Hazard | None to minimal | Low to moderate(recommended for use with body fluids) |
| Protection Provided | None | Very good |
| Method of Protection | None | Recirculate HEPA filtered exhaust air |
| Allowable Toxic Chemicals or Radionuclides Present or in Use | None | Minute quantities only |
| Biosafety Cabinet Normally Req. | None | Class II, Type A or B3 |
| Minimum Required Cabinet Ave. | 75ft/min (0.4m/sec) | 75-100ft/min (0.4-0.5 m/sec) Face Velocity |
| Makeup Air Req. | 100% of face opening input | 30-100% of face opening input |
| Cabinet Exhaust Arrangement | HEPA filtered may be returned to room or discharged outdoors via hard duct | HEPA filtered 70% recirculate to the cabinet, 30% returned to room or discharged outdoors via canopy connection |
| Exhaust Air | None | 30% maximum (HEPA allowed to filtering req.) |

Table 1. Laboratory Classification/Biosafety Level

| Level | 3 | 4 |
|---|---|---|
| Potential Hazard | Moderate to high (e.g., HIV) | Moderate to very high (e.g., HIV, TB, extremely toxic and lethal substances) |
| Protection Provided | Very good | Very high to total |
| Method of Protection | Recirculate HEPA filtered exhaust air | Non-circulated HEPA filtered air and environmentally conditioned interior |
| Allowable Toxic Chemicals or Radionuclides Present or in Use | Minute quantities | Minute quantities only as needed |
| Biosafety Cabinet Normally Req. | Class II, B1, B2 | Class III |
| Minimum Required Cabinet Ave. | 100 ft./min. (0.5m/sec) | Not applicable (fully enclosed cabinet) |
| Makeup Air Req. | 100% of face opening input | Depends on unit size and characteristics |
| Cabinet Exhaust Arrangement | HEPA filtered required hard-duct connection with total exhaust to the outdoors | HEPA filtered required hard-duct connection with exhaust outdoors |
| Exhaust Air Allowed to Recirculate to Lab Room | None | None |

Only Biosafety Level 1 work, as defined by the Center for Disease Control- National Institutes of Health publication Biosafety in Microbiological and Biomedical Laboratories, 2nd Ed., May 1988, is conducted.

## Additional Considerations

Special attention will need to be paid to insect and rodent control. These organisms may be attracted by some of the activities and culture materials and may lead to their contamination and spread throughout the building.

Laboratory activities are governed by approximately 100 publications generated by the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA) with more specific interpretations rendered on these same publications in some states. Most EPA regulations appear in Title 40 Code of Federal Regulations while OSHA's regulations appear in Title 29 Code of Federal Regulations.

# SUMMARY

The learning environment should be comfortable, stimulating, dynamic, and safe. In addition to making efforts to keep the room changing and interesting, the teacher should periodically make safety tours through the classroom, laboratories, storerooms, office areas and other cognate areas attempting to recognize obvious hazards and take steps to correct them.

As long as teachers view biotechnology as an action verb describing a process for constructive, creative investigation, they will be in the proper state of mind to address safety concerns in their teaching environment. They will also more readily recognize when the hazard level of an activity outweighs its educational merit.

Refer to the Technology Education Safety Inspection Checklist located on page 94 in the Appendix.

# REFERENCES / RESOURCES

## Glossary of Terms

**Absorbent**: A substance that takes in other material

.

**Absorption:** The penetration of a substance onto the body of another.

**Acid**: A compound consisting of hydrogen plus one or more other elements and which, in the presence of certain solvents or water, reacts with the production of hydrogen ions. An acid reacts with an alkali to form a salt and water, turning litmus paper red.

**Alkali (base)**: A compound that has the ability to neutralize an acid and form a salt, and will turn litmus paper blue.

**Ampere:** The standard unit for measuring the strength of an electrical circuit.

**Anemometer**: A device used to measure air velocity.

**Antiseptic**: A substance that prevents or inhibits the growth of microorganisms on animate surfaces such as skin.

**Autoclave:** An apparatus using pressurized steam for sterilization.

**Bacteria**: Microscopic plants living in soil, water, organic matter, or the bodies of plants and animals.

**Base**: A compound that reacts with an acid to form a salt; another term for alkali, which turns litmus paper blue?

**Biodegradable**: Capable of being broken down into inoculate products by the action of living things.

**Blood borne Pathogen:** A disease-causing agent, such as a bacterium that lives in and is transported in the blood

**Capture Velocity**: Air velocity at any point in front of the exhaust hood necessary to overcome opposing air currents and to capture the contaminated air by causing it to flow into the exhaust hood.

**Carbon Monoxide**: A colorless, odorless toxic gas produced by any process that involves the incomplete combustion of carbon-containing substances.

**CAS Number**: Identification of a particular chemical by the Chemical Abstract Service, a service of the American Chemical Society that indexes and compiles abstracts of worldwide chemical literature called “Chemical Abstracts”.

**Combustible Liquids**: Liquids that have a flash point at or above 140 degrees Fahrenheit (60 degrees Celsius), which are known as Class III liquids. Class IIIA liquids include those having flash points at or above 140 F (60 C), but below 200 degrees Fahrenheit. Please note that the NFPA code does not extend ‘to liquids having flash points above 200 F, but this should not be construed as indicating that all liquids with high flash points are noncombustible.

**Disinfectant:** An agent that frees from infection by killing the vegetative cells of microorganisms.

**Exhaust Ventilation:** The removal of air usually by mechanical means from any space. The flow of air between points is due to the occurrence of a pressure difference between the two points.

**Fire Point**: The lowest temperature at which a material can evolve vapors to support continuous combustion.

**Flash Point**: The lowest temperature at which a liquid gives off enough vapor to form an ignitable mixture with air and produce a flame when a source of ignition is present, using two tests-open cup and closed cup.

**Foot Candle:** A unit of illumination. The illumination at a point on a surface which is one foot from, and perpendicular to, a uniform point source of one candle.

**Fume**: Airborne dispersion consisting of minute solid particles arising from the heating of a solid body such as lead, in distinction to a gas or vapor.

**Gas:** A state of matter in which the material has very low density and viscosity; can expand and contract greatly in response to changes in temperature and pressure; easily diffuses into other gases; readily and uniformly distributes itself throughout any container.

**GFI:** A device that measures the amount of current flowing to and from an electrical source. When a difference is sensed, indicating a leakage of current that could cause injury, the device very quickly breaks the circuit.

**Hazard**: An unsafe condition that, if left uncontrolled, may contribute to an accident.

**Infection**: Entrance into the body or its tissues of disease-causing organisms and the causation of damage to the body as a whole or to tissues or organs.

**Irritant**: A substance that produces an adverse effect when it contacts skin, eyes, nose or respiratory system.

**Liability**: The state of being bound or obliged by law to do, pay, or make good something. As to the law of torts, usually based on the law of negligence.

**Liquid**: A state of matter in which the substance is a formless fluid that flows in accord with the law of gravity.

**Local exhaust Ventilation**: A ventilation system that captures and removes contaminants at the point they are being produced before they escape into workroom air.

**MSDS**: A material safety data sheet; a document prepared by a chemical manufacturer that describes the properties and hazards of the chemical.

**Negligence:** The lack of reasonable conduct or care, characterized by “accidental” or “thoughtlessness” that a prudent person would ordinarily exhibit.

**Orifice**: The opening that serves as an entrance and/or outlet of a body cavity, organ, or some types of equipment; especially the opening of a canal or a passage.

**PPE**: Personal Protective Equipment includes devices worn by the worker to protect against hazards in the environment such as gloves, respirators and hearing protection.

**Physical Hazard**: A chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyro chloric, unstable (reactive) or water reactive.

**Pinch Point**: Any point at which it is possible to be caught between moving stationary parts or the material being processed.

**PPM**: Parts per million - part of air by volume of vapor or gas or other contaminant.

**Route of entry**: The path by which chemicals can enter the body, primarily, inhalation, ingestion and skin absorption.

**Solvent**: A substance most commonly water but often an organic compound that dissolves another substance.

**Sanitize:** To reduce the microbial flora in or on articles, such as eating utensils, to levels judged safe by public health authorities.

**Ultraviolet Light:** Form of light falling in the wave spectrum just beyond violet light and before x-rays (4,000 – 40 angstroms). Ultraviolet lamps can be useful in destroying some forms of bacteria that may be present on equipment and safety glasses.

**Ventilation**: Circulating fresh air to replace contaminated air. Dilution- airflow designed to dilute contaminants to acceptable levels. Mechanical- air movement caused by a fan or other air-moving device. Natural- air movement caused by wind temperature difference, or other non-mechanical factors.

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The following is a list of general references. It should be obvious that it is not exhaustive. The references provided are for those interested in obtaining additional information from primary sources. No implication of endorsement or lack of endorsement should be read into inclusion or omission of any referenced material within this document.

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# INFORMATION TECHNOLOGY

# INTRODUCTION

Information and Communications Technology includes graphic communications, design, technical drawing, CADD, photography, and video, multimedia and web-based applications. A significant amount of information is available in the General Safety section. It is strongly recommended that the reader review the General Safety section for important related information.

# GENERAL SAFETY CONSIDERATIONS

## Computer and Student Safety

***Theft and vandalism*** – Students should be denied access to the inside of computers, printers and other peripheral devices through the use of locks or appropriate furniture. All laboratory entrances should be tightly secured. Many problems can be avoided if students are denied access to the operating and control systems of computers. Individual student passwords are recommended for network security.

***Internet Security*** – School district policies on Internet use should be strictly followed for the physical and legal protection of students and teachers. Under no circumstances should students provide any personal information to websites using school computers?

# FACILITY DESIGN

## General Laboratory Layout Considerations

General considerations in Communications laboratories include items such as traffic flow, physical space per student, lighting, utilities (electrical and plumbing) and separation of areas based on factors such as noise, light and dust. Refer to the General Safety section for more information on these subjects.

### *Isolated Spaces*

Concern for safety in isolated spaces should be a priority in any Information and Communications Laboratory. Diverse laboratory settings and emerging technologies dictate the need to have isolated areas within existing laboratories. Some equipment needs to be housed in a clean environment, which increases the need for isolated areas. Teachers should be aware of protecting as well as being able to monitor students who are working in areas separate from the majority of the class.

### *Electrical Hazards*

Electrical hazards exist in all communications facilities. Careful planning and consideration of items such as, quartz lights, electrical outlets and surge protection can reduce potential hazards. If new construction or renovation occurs, all efforts should be made to minimize electrical hazards. Care should be taken to insure that the correct electrical needs are met. Refer to the General Safety section for additional considerations.

## Darkrooms

In a darkroom facility, these safety items should be addressed:

- appropriate laboratory layout
- luminous tape to designate the work zones of equipment
- equipment layout reflecting the order of operation (print to process)
- equipment placed so that it does not protrude into aisle space
- appropriate disposal of photographic chemistry (silver recovery units, proper chemical disposal, proper chemical separation of used chemistry) and
- adequate project and supply storage that is directly accessible.

***Ventilation***: Floor ventilation is recommended because photographic chemistry vapors are heavier than air and will collect at the floor level. Dangerous gases should be removed using a comprehensive dedicated exhaust system.

***Plumbing:*** Adequate water flow and temperature control must be functional at all times. A wastewater purification system to control potentially toxic discharges is also recommended.

***Electric: G***round fault outlets should be used throughout because of the proximity of water and chemicals to enlargers and electrical timing devices.

***Lighting***: Even though most darkrooms are bathed in red or amber light, the lumens per square foot need to be bright enough to allow students to work safely. Sufficient white light per square foot is necessary for set-up work and maintenance.

***Eye Protection:*** Protective eyewear should be worn in the darkroom at all times.

***Chemical Safety***: Refer to the “Chemical Recommendations” section in the General Safety section, pages 29 - 31 and the “Chemicals” section in the Biotechnology section, pages 52 – 55.

## Computer Facilities

### *Laboratory Layout*

- Adequate power outlets should be placed so that the use of extension cords and the overloading of circuits are eliminated.
- Tables and monitors should be placed so that students remain at least 18" distance from the monitor screen.
- Consideration should be given to traffic patterns and the movement of students through the facility. Accessibility to scanners, printers and other shared resources should be addressed when planning the facility.
- It is recommended that every student have his or her own computer work station. If this is not possible, it is recommended that two students per computer workstation be considered the maximum.
- Dimensions for computer workstations should follow standard ergonomic guidelines indicated by ANSI/HFS 100-1988, February 1988.

### *Operational factors*

- Ventilation – Computers generate a significant amount of heat. Air conditioning and uniform airflow is essential to prevent unsafe conditions and computer failures. Fresh air at the appropriate temperature should be used to replace all contaminated air.
- Electrical – Power cords, mouse cords, printer cables, etc. should be properly secured. This can be achieved by the use of custom furniture.
- Lighting – Efficient use of natural light is essential to create an environment free of shadows and glare. The glare off of monitor screens is unacceptable and should be avoided. Consideration should be given to the light reflecting properties of ceiling materials to maximize lighting while minimizing glare.

# MATERIALS

## Eye Hazards

Lasers (see the "Laser" section, page 31 in the General Safety section), exposure units, studio lighting, and similar devices emit powerful amounts of light that may be harmful to the eye. Precautions should be taken to prevent eye damage when using light emitting devices. Such precautions should include placement of warning signs, instruction of proper use, student safety testing and the appropriate placement of on-off switches.

## Toxic Chemicals

Equipment and technical processes in the Graphic Communications area often involve the use of hazardous materials and chemicals. Consider finding non-toxic substitutes when purchasing products needed for use in the Graphic Communications facilities.
Precautions should be taken to insure the proper use and disposal of all chemicals (Refer to the "Chemical Recommendations" section in the General Safety section, pages 29 - 31

and the “Chemicals” section in the Biotechnology Safety section, pages 52 - 55). Such precautions should include ventilation systems, student instruction, and testing, proper storage of chemicals and careful work planning to ensure a safe working environment. Students should be expressly warned that it is improper to dispose of hazardous chemicals through sink drains, trash cans, and other inappropriate methods.

## Latex Allergies

Latex use has increased over the past few years. Latex gloves and other products are used in our schools in increasing frequency. The number of individuals diagnosed with allergies to latex has also increased. Before using any latex based product be sure to determine that students with latex allergies are identified and are prevented from coming in contact with any latex based products present in the laboratory.

# TOOLS & EQUIPMENT

## Injury from Moving and Mechanical Parts

Printing presses, paper cutters (manual or hydraulic), folding machines, paper drills, screen printing presses, ink curing heaters and similar devices can cause serious injury if used improperly and unsafely. Such precautions should include safety instruction and testing, proper use of machine guards and safety devices, marked caution zones for safe work areas, emergency shut-off power buttons, and planning to insure that there is only one operator for each piece of equipment.

# PHYSICAL TECHNOLOGY

# INTRODUCTION

Effective safety education leads to attitudes and conscience that result in safe work practices and prevent accidents within the technology education laboratory. A significant amount of information is available in the general Safety section. It is strongly recommended that the reader review the General Safety section for important related information.

# FACILITY DESIGN

When designing, equipping or remodeling a technology education facility, there are a great many situations and details that should be anticipated as the planning proceeds. Consider the moral, financial and legal aspects of a sound safety program. It is prudent to give safety a dominant and controlling role in the planning process.

The placement of machines and equipment in a given work area is critical and should allow for the normal flow of machines through the operational process. There should be a minimum of cross traffic of both material and/or students.

The planner or the specification writer normally considers the following factors

1. flow of materials
2. flow of students
3. tool and equipment arrangement
4. electrical and other utilities
5. dust collection
6. Color
7. lighting
8. storage
9. costs
10. ventilation
11. noise and
12. tool and equipment specifications.

## Aisle and Machine Placement

All machines and equipment must comply with existing state and federal regulations. Although Pennsylvania is a non – OSHA compliant state, it is strongly recommended that schools consider adopting these requirements. Where hazards exist around a machine, the machine should be placed so students in the area are not in the line of danger. Machines such as table saws, jointers and planers are capable of violent kickback of the stock. They should be arranged so that the stock will not be accidentally thrown into areas where other students will be working. Painted lines on the floor should also

designate the hazard areas. The aisles should provide adequate travel space between benches and machines; they should also provide adequate space areas in front of tool panels and storage lockers and other areas where students may either congregate or are working. Special consideration should be given to those areas that present potentially dangerous operations.

## Noise

Physical technology laboratories produce a higher level of noise than other types of laboratories. The level, in conjunction with the time of exposure, must be kept below permissible exposure levels. This may be accomplished through the use of sharp tooling, proper maintenance and correct alignment of machinery, the use of energy and noise absorbing materials, or the substitution of quieter procedures and equipment. Personal ear protection is necessary when noise levels and the time of exposure exceed OSHA standards. If a normal speaking voice cannot be understood from two feet away, the noise level is probably excessive.

## Dust Collection

Control or collection of dust is necessary, particularly in the materials areas. This may be accomplished by the installation of a dust collection system or by individual (localized) dust collectors attached to specific machines or incorporated into the design of portable power tools. General cleanliness in the laboratory may contribute greatly to dirt and dust control. If the laboratory is to be air conditioned, a central dust collection system is imperative. Additional protection could be offered by supplying every student with a disposable dust mask.

## Ventilation

Mechanical exhaust ventilation is, in most cases, the first choice for control of air contaminants, which are potential health and/or fire hazards. A properly designed and maintained localized exhaust or general dilution ventilation system will either remove air contaminates which may be present or lower the concentration of fumes, vapors, dusts, mists or other contaminates generated in the working environment.

Local exhaust ventilation removes the hazardous materials at or near their point of origin and prohibits them from being drawn through the breathing zone of the worker. Local exhaust ventilation is the preferred type, as it usually performs most efficiently and prevents air contaminates from circulating through the entire laboratory area or school building. There are three basic types of localized exhaust systems: a) down draft, b) lateral flow and c) suspended canopy. The suspended canopy is the least desirable type of localized ventilation because the hazardous material contaminates are drawn through the person’s breathing zone.

Local exhaust ventilation systems should be installed whenever a large volume of air contaminant is generated or where a particularly hazardous substance is used. Some operations requiring the use of local exhaust ventilation are welding, spray painting, woodworking and processes involving the use of resins, solvents and flammable liquids. Processes involving the use of asbestos, lead, mercury, chromium and zinc should not be preformed in technology education laboratories.

General dilution ventilation depends upon a sufficient volume of air passing through the laboratory area to dilute the contamination to a recommended non-hazardous level. Dilution ventilation works best with low toxicity contaminates and requires a greater volume of air movement for efficient operation. General dilution ventilation may be an effective control for areas generating low concentrations of relatively non-hazardous substances.

The design of ventilation systems is somewhat detailed, involving determination of the volume of air, which needs to be moved, the type of fan, which will adequately exhaust the air volume, the placement of the exhausts, make-up air and the positioning of the system. A mechanical engineer or industrial hygienist should be consulted to assist in providing an effective environmental control through the use of a ventilation system. In addition, filters need to be cleaned and changed regularly, and qualified personnel should check all ventilation systems at the beginning of each school year in order to confirm continued effectiveness. As a word of caution, it is recommended that teachers do not modify existing systems as this may create an environment with negative health results.

## General Production/Fabrication Area Recommendations

1. The production / fabrication area should be adjacent to the classroom seating area with interior vision panels to allow for supervision.
2. The production / fabrication area should provide convenient, but controlled access to the rest of the school for use by teachers needing access to tools.
3. The production / fabrication area should be isolated from the classroom and research areas to minimize distractions.
4. Noisy dust control and ventilation units should be located in auxiliary rooms or outside the building.
5. The laboratory should have provisions for the storage of safety equipment.
6. The production / fabrication area should be provided with a hardened, sealed concrete, non-slip floor. Designated machine operator zones should be identified on the floor with slip resistant floor materials.
7. Wall, ceiling and trim should be finished with durable, easily cleaned materials.
8. Large assembly areas should be available in the construction and manufacturing laboratories. An alternative would be to design the furniture and equipment type and location to allow the room to easily be reconfigured to meet the needs of instruction.
9. A suspended acoustic tile ceiling is acceptable if a 12 foot ceiling height is maintained.

10. A sink should be provided for water access with appropriate traps for waste line oil, paint, clay, ink and Plaster of Paris.
11. A finishing area should be provided with a separate adjacent room, preferably with an interior window to production/fabrication area for supervision. This area should have the following provisions:
    a. storage for small quantities of paint, stains, brushes, cloths, sponges and sprays
    b. floors that can withstand high traffic and resist damage from water, dirt or dust
    c. drying racks
    d. flammable liquid cabinets
    e. exhaust system for paint fumes & to minimize dust
    f. uniform glare free lighting overall with 50-100 foot candle illumination
    g. scrub sink with hot and cold water and
    h. disposal of waste material from the finishing process.

# MATERIALS

## Introduction

Materials are a necessary component part of the physical technology laboratory. They have evolved from the traditional product areas of metal and wood to encompass areas such as plastics, ceramics and polymers with an ever-increasing array of sizes and shapes available. Consequently storage and handling of material in the physical technology laboratory becomes an increasingly complex issue.

The material storage area should be convenient for unloading delivery trucks and adjacent to production/fabrication areas with easy access for the teacher using cutting tools and machines for cutting materials into smaller sizes for student use. The placement of machines and equipment in a given work area is critical and should allow for the normal flow of materials through the operational process. There should be a minimum of cross traffic of both material and/or students. Project storage areas should be laid out to minimize congestion at the start and end of class and provide lockers, open cubicles, shelves, bins and racks to accommodate a variety of sizes and project types.

## Storage of Inflexible Three-Dimensional Materials

Examples of this category of materials include: angle iron, square tubing, bar stock, lumber, conduit, and plastic bar stocks. The storage configuration may be either in the horizontal or vertical position. In the horizontal position, weight of the material needs to be considered. The heaviest materials should be stored on lower levels and the lighter materials stored at higher levels. Vertical storage of materials should lean towards the wall, with the height limited to eight to ten feet, allowing a person to grasp the material above the midpoint.

## Storage of Flexible and Sheet Stock Materials

This category of materials includes materials that are generally rolled onto coiled spools. If possible a spooling rack should be devised to dispense these types of materials. Materials such as sheet metal, which need to remain flat, are best stored either horizontally on wide shelving or vertically between full width dividers.

## Compressed Gas Cylinder Storage

Bulk storage of oxygen cylinders and fuel gas cylinders must be protected by a fire resistive barrier or stored a distance of twenty feet apart.

# PROCESSES

Processes may be classified in various ways. This safety manual will use the contemporary approach. Safety considerations concerning six widely accepted secondary processes will be discussed here:

1. Separating
2. Assembly
3. Conditioning
4. Casting and Molding
5. Forming
6. Finishing

## Separating

Separating involves converting material size and shape through the extraction of excess material. It is through these processes that the material is cut or sheared. These processes include an expansive family of operations such as sawing, planning, grinding, sanding, glass cutting, slicing, etching, chip removal, drilling, boring, turning, machining and even electro-chemical machining processes. This is by far the largest family of most frequently used hazardous processes found in technology education laboratories. Eye protection is crucial in all of these processes. Other hazards that are shared by many of these processes involve:

1. moving parts and blades
2. potential of the work piece to become lodged in, or pulled into the machine at higher than desired rates, as in climb milling or crosscutting on the radial arm saw,
3. the potential of the work piece to be thrown out of the machine toward the operator as in a kickback from the table saw,
4. hands or limbs positioned near moving blades,
5. blades, drills or abrasive wheels shattering from excessive impact or poor

condition,
6. tools or accessories being thrown by centrifugal force such as chuck keys from drill presses and lathe tools,
7. improperly set-up or attended CNC machines or automated equipment, causing collisions between parts and work pieces,
8. improperly clamped work pieces being grabbed by machines (spinning on drill presses, etc.),
9. inappropriate uses of portable power tools,
10. dust and chips being ejected from machines,
11. attempting to cut large pieces of material without adequate support or aid and
12. equipment failure due to poor maintenance, which results in injury.

Aside from proper instruction, the most important duty of the teacher is to insure that the equipment is in good working order. If it has the appropriate guards and shields in place and is functioning properly, specific hazards can always be avoided. Students should be monitored very closely when they perform operations on these pieces of equipment. Manufacturer's operating instructions should be consulted directly and followed closely. Generic instructions for operation of these types of equipment may be found in textbooks and technical manuals on the processes and materials involved, but manufacturers instructions are the only source of information on conditions unique to a specific brand or model of machine. Students should be cautioned extensively about the potential hazards of operations in the separating processes studied.

## Assembly

Assembly is the process of temporarily or permanently holding two or more materials together. This large family of operations includes welding, brazing, soldering, gluing, nailing, clamping, bolting, stapling, jointing, taping, binding and a host of other assembly techniques. Eye protection and reasonable care is needed for operations that are low in hazard potential, but others are quite hazardous and demand many special provisions for safe operation. Heat-shielding apparel and specialized eye protection is required, especially in the welding, brazing and foundry areas. Machinery with moving parts, and hammering operations used in sewing, stapling, pressing and other processes require special attention in the protection of the hands and limbs. Another safety concern involves the chemicals often involved in gluing operations. Further safety precautions for each of these operations can be found in textbooks and technical manuals. All assembly processes should be cautiously presented to students and each unique hazard should be visibly identified. By monitoring students carefully, this will ensure that they will wear the appropriate clothing and eye protection while performing dangerous operations.

## Conditioning

Conditioning involves the use of heat, mechanical force or chemical reaction to alter the internal properties of a material. Some examples of conditioning include curing

thermosetting plastic with heat, forging steel, annealing copper, curing epoxy with a catalyst and many others. As in most operations, eye protection is required. The most common hazards occurring within these processes include:

1. hazards associated with heating equipment and/or handling of hot materials,
2. dangers associated with spilling or splattering of chemicals and,
3. mishaps involving hammering or compressing, such as forging.

To prevent injury from one of the above-mentioned hazards, protective clothing should be worn, including gloves and aprons made of leather for high temperature protection. Plastic or rubber protection is to be worn for work involving chemicals. For added protection, full-face shields are recommended.

## Casting and Molding

The process of casting and molding involves the pouring or forcing of liquids or semisolid materials into a prepared mold. The material is given time to become solid and is then detached from the mold. The main hazards involved in casting and molding are linked to the methods used to make the material into a liquid or plastic state. Special care is needed while managing liquid materials. Potential hazards for casting and molding include:

1. hand or limb injuries resulting from the ramming of molds, water, chemical, or gas leaks,
2. ruptures in a crucible of molten metal,
3. spilling liquid plastics or metals onto skin or clothing,
4. splashing of molten materials during pre-pouring conditioning,
5. opening molds before proper curing and cooling is completed and
6. handling freshly cast products while still hot.

For high temperature protection, full-face shields are a necessity. Gloves, aprons, leggings and sleeves of leather are a necessary safety measure. For chemical protection, the appropriate rubber or plastic gloves should be used when needed. Education about these processes must mention all the above precautions, as well as other safety hazards and how to avoid them. Further specific safety information and instructions may be found in textbooks, technical manuals and on the container labels of products used as well as from product manufacturers.

## Forming

The art of forming involves the use of direct force to cause a material to lastingly take a shape. A die, mold or roll is most commonly used to shape the material, but there is no change in the volume of the material. Some examples of forming processes include metal spinning, thermoforming plastic, bending band iron by hand and steam bending wood. Forming hazards depend mostly on the forces used and the manner in which they are applied. Depending upon the materials and the type of processes used, heat, pressure,

rotating machines, chemicals, pneumatic or hydraulic action, mechanically amplified forces and heavy equipment are all involved. The hands at times are very near the application point of the force (as in metal spinning).
Forming hazards include:

1. smashing, pinching or crushing hands and limbs,
2. dangers connected with heating sources,
3. entanglement with rotating and powered equipment,
4. the possibilities of fragments breaking away from the product and becoming airborne as the dies and molds close,
5. handling hot products too soon after processing and
6. equipment or product breakage due to the application of excessive force.

Instruction on forming processes must mention all of these as well as other possible hazards. Instructions on how to avoid them are also needed. The most accurate and authoritative source of additional safety information on forming processes may be found in the instruction manuals for the individual equipment's used. Textbooks and technical manuals on these materials and processes may also be helpful.

## Finishing

The act of finishing involves the protection and/or beauty restoration to the surface of a material. The finishing process depends upon the material to be finished and it's projected use. For example, wood demands different finishing techniques than metal, but wooden picnic tables require different processes than wooden floors. In spite of these variations, many finishing processes involve paints or other chemicals. Before these are used they must be mixed. When applied, they are brushed, spread, poured and sprayed. The solvents used in these products and for their clean up can prove to be hazardous to the health due to their fumes and their effects on unprotected skin. Goggles are a must for all finishing operations to protect the eyes from splashes. Plastic or rubber gloves, depending upon the chemicals used, are often required. Adequate ventilation and sometimes respirators of special types are necessary to provide additional safety protection. Concentrated fumes can become explosive from heat sources as small as the arcing inside an electrical switch. Finishing has many latent dangers, which will not be easily seen or immediately diagnosed. While a cut finger needs immediate attention, lung diseases from breathing paint vapors are not so easily detected. It is important to make students aware of these hidden dangers and to explain just how debilitating some repercussions of not following proper safety guidelines can be. Due to the unfortunate popularity of "huffing" as a method of drug abuse, it is important that teachers carefully monitor students while they use finishing materials. It is the educator's job to warn students of the dangerous health hazards associated with "huffing".

For many students, finishing operations may be their first experience with compressed air power. They must be warned about the great potential for danger that is involved. Inappropriate use of compressed air hoses may result in blindness, air or foreign objects injected into the skin or bloodstream, internal damage to organs or even death.

# TOOLS AND EQUIPMENT

Because of the widespread use and abuse of hand and power tools and the severity of many tool injuries, it is important that the elimination of tool accidents be made a part of every safety program. Technology educators realize the importance of using hand tools properly, but typically, students treat these tools with little respect. Teachers must be a role model, exemplifying the proper use of hand tools.

## Hand Tool Safety

Many of the injuries in technology education are attributed to the improper use of tools and equipment. Proper training and supervision is essential for safely handling and operating tools and equipment. The following general tool safety rules should be followed at all times.

1. Always wear safety glasses to protect eyes.
2. Select the right tool for the job.
3. Keep tools in good condition.
4. Use tools correctly.
5. Keep tools in a safe place.
6. Machine safeguarding is a must.

All too often, students fail to use hand tools for their intended use. It is this misuse that results in many preventable injuries. Technology educators realize the importance of proper tool usage, and it is their proper instruction and supervision that is essential to the student's safety. There are four classes of hand tools, with each presenting a unique set of hazards.

1. Cutting Tools
2. Torsion Tools
3. Shock Tools
4. Thermal Processing Tools

### *Cutting Tools*

Cutting tools include saws, chisels, planes, files, knives, taps and dies, snips and abrasive materials. Concentration and control are essential for safe operation of all tools, cutting tools being no exception. It is very important that cutting tools are kept sharp and in good working order. The sharpness of a tool is essential for safety. Dull blades have the potential to reduce control and cause greater physical harm. Given the material the tools are designed to cut, the cutting edge should be sharpened to the proper angle. Teachers should ensure that students are instructed in the proper selection process of each cutting tool for a variety of materials and operations. Selecting the proper size and type of tool allows students to learn and follow through with each correct procedure. Many injuries are a result of burrs and chips created while cutting? Care should always be used in chip removal – never brushing the material with their hands. Gloves may protect students'

hands from these injuries. Injuries to the eyes are also a hazard while using tools; therefore, safety glasses must be used during any cutting operations.

## *Torsion Tools*

Torsion tools include wrenches, pliers, allen wrenches, and screwdrivers. These tools are found to be the most abused and misused set of tools. The availability of screwdrivers leads to unnecessary abuse and subsequently becomes a source of frequent injury. Several unnecessary abuses of screwdrivers, which may be prevented, include being used as punches, wedges and pry bars. The tips of screwdrivers should always be kept clean and ground to their original shape, when possible, to ensure the proper fit into a screw slot. To reduce the misuse of screwdrivers, an adequate selection of drivers should be readily available.

To safely use any wrench, the user is required to always be alert and prepared for the possibility that the wrench may slip off the fastener and cause injury. Wrenches are made in many different sizes; therefore, it is essential the proper size wrench be used. Generally, socket wrenches are the safest to use and offer the most flexibility, while box wrenches offer greater safety over an open-ended wrench. Adjustable wrenches are recommended for light-duty jobs and should have limited applications.

It is imperative for students to learn the proper tool choice for each type of job. Torsion tools proving to be too large or too small will require extra force. Proper fit, coupled with the degree and direction of force, ensures safer procedures. The insulation of tool handles is necessary when working with electricity.

## *Impact Tools*

Impact tools, or shock tools, are best exemplified by hammers in various types and sizes with varying degrees of hardness. Different configurations are used for specific purposes. They should be selected and used for their intended purposes only. Discard any hammer if it is dented, chipped, mushroomed, has a loose head, split handle or shows excessive wear. As with any impact tool, discarded debris may fly readily, and every student within the work area should always wear safety glasses.

## *Thermal Processing Tools*

One way to condition and assemble materials is through a process of heat energy known as thermal processing. Some commonly used thermal tools include hot glue guns, hot wire cutters, soldering irons, heat guns, strip heaters, torches, welders, lasers, kilns, furnaces and ovens. Any heat-producing tool carries with them the potential to severely burn the user and are sources of ignition. In order to minimize impending hazards, protective safety equipment should be worn and the work area should be kept clear of all flammable materials. Natural gas, acetylene and other energy sources are very dangerous. This increases the need to inspect equipment often and keep it in good

working order.

These tools have the ability to produce visible and non-visible radiation and may cause severe burns and eye damage. Wearing eye protection provides the appropriate shielding to contain radiation needed when using tools such as lasers and electric arc welders. Lasers emitting visible light at a low level are the safest to use when working with students.

## Power and Mechanics

Power tools and hand tools perform very similar operations. The difference however, is found in how the external power source is used to perform operations. Power tools are most commonly divided into four groups: electric, pneumatic, internal combustion and explosive. Electrical and pneumatic tools find their commonplace within a laboratory. When air or electric sources are not readily available, internal combustion engines come in to play. These three power sources require emergency shutdown switches to be located in the most accessible location. Explosive tools are generally inappropriate for student use due to their high hazard potential.

The use of power tools involves great risks; therefore safety precautions should be strictly followed. Factors that increase the danger associated with these tools include the velocity of functional machine parts, the force applied and the mobility potential. As velocity increases, the student's reaction time becomes more critical, and the safety zone increases due to kickback potential. As applied force increases, the likelihood of severe injury increases. It is when a machine is portable, or is composed of moveable parts, (ex: blade of radial arm saw), that guarding becomes more difficult, and the zone of safety increases. To increase the safety within a classroom, rechargeable battery-powered tools add mobility, without the need of an extension cord and provide the greatest protection against electric shock.

## Automated Equipment and Robots

Robots and Automated equipment are powered mechanical equipment and should follow the same safety precautions observed when operating any computer-controlled machine. Automated equipment may be safer than standard equipment due to the fact that the user is generally removed from the point of processing. On the other hand, automated equipment may be more dangerous. Since users are less involved, distraction and lack of concentration may result.

When using automated equipment, the user should follow four general recommendations.

1. Be aware of tool limitations. Special caution must be taken to ensure safety operations since the operator does not directly control the machine. A common safeguard comes in the form of guards with emergency shut-off switches that trip when opened.
2. Cables must be kept neat and connections must be inspected periodically. Poor connections or overlapping wires may cause interruptions in data flow between

the controller and the machine inducing erratic movements in the machine.

3. When programming computer-controlled machines, machine movements must be checked with the “step” option on the controller. This option allows the individual to check each program line, thus avoiding hazardous situations.

4. Two emergency shut-off systems, a mechanical power-off switch, and a soft switch are found in CNC and robotic equipment. These immediately stop program execution and, coupled with the user’s quick reaction, will prevent both injury and machine damage.

## Equipment Safety

The following is a generic list of safe operations for most power tools. Categorized by ergonomic factors, power tools should be demonstrated along with the specific safety rules for each machine. The ultimate safety practices for each specific piece of equipment, however, must agree with the safety practices prescribed by the machine manufacturers. All manufacturer recommendations should be on file and posted on each machine.

In preparation, the user must remember the following:

1. Wear safety glasses for all operations.
2. Secure loose clothing, jewelry, and any other item that may get caught in the machine.
3. Clear area of scraps.
4. Position guards correctly.
5. Set the machine for a specific operation.
6. Position stock for the machine operation.
7. Consider physical demands and use a helper when deemed appropriate.
8. Check with instructor before performing any operation.

When preparation has been completed, it is time to focus on the task performance. The following steps are imperative:

1. Mentally review operating procedures and machine safety rules.
2. Direct full attention to machine operation.
3. Never leave the machine while performing a specific task
4. Stop machine at a safe point if a problem is encountered.
5. Only make machine adjustments when the machine has stopped.

Termination, the user must remember the following:

1. make sure the machine is turned off and all motion is stopped,
2. remove scrap materials that accumulate during the operation and
3. return the machine to its customary set-up.

## *Safety Zone*

What exactly constitutes a safety zone? A safety zone is the area where the user can stand without being harmed. The distance of hands and other body parts from the source of a hazard is directly related to the hazard potential. Keep in mind: *the greater the distance, generally the less the hazard;* therefore, zones can be established to highlight vital areas of concern. These zones have been divided into three areas of concern: **danger zones, critical zones, and safety parameters.**

Danger zones consist of mechanical, electrical, heat or radiation hazards at the point of material processing. In this zone, machine parts require guarding or other fail-safe systems. Critical zones are areas involving work surfaces and machine components that play key roles in the processing procedure. These zones must be free of scraps and tools that may interfere with operation. Take precautions in case of machine failure. Three feet from the machine plus anywhere material may be thrown from the machine makes up the safety parameter. No one is to be inside this zone except the operator, unless a helper is needed. The operator and helper are responsible for maintaining a safe work environment. The instructor must reinforce the location of all safety zones during any machine demonstrations.

## *Machine Guarding*

Machine guarding is one of the most important safety considerations in a laboratory. Proper guarding will allow the worker to work safely as well as perform tasks effectively. Safeguarding systems for machines come in a variety of forms. Fixed and moveable machine guards prevent fingers from entering the machine's danger zone. Enclosures prevent access to mechanisms that may cause injury. In order to eliminate shock hazards, protective devices or systems are enacted, and fail-safe systems can automatically limit the potential for injuries. There are six basic types of safeguarding systems:

1. Fixed enclosures are non-movable devices generally used to prevent access to pulleys, gears, belts and other moveable parts. These enclosures can be used at the processing point if designed to allow stock entrance, but prohibit hands and fingers from being admitted.

2. Adjustable enclosures are normally used at the point of processing (danger zone) and allow a variety of stock sizes. These enclosures may have kickback devices, chip removal accessories and other built-in safety features. Hands will not be stopped from entering the danger zone with this enclosure so rigid safety precautions are to be followed.

3. Enclosures with electrical or mechanical interlock turn off or disengage power when a guard is open. Computer controlled machines and robots exemplify these types of enclosures.

4. Automatic or semi-automatic feed systems reduce machine hazard by eliminating the need for the operator to work near the danger zone. This may lead to other potential hazards and require careful attention by the operator.

5. Two-hand trips are activated by electrical control-mechanisms, which are activated simultaneously with both hands, preventing them from entering the danger zone.

6. Hand clearing devices in the form of fixed bars, straps and other devices prevent hands from reaching the danger zone. They may be stationary or fall into place just before impact or cutting.

Most machines for educational purposes have fixed or adjustable enclosures installed by the manufacturer. When designing machine set-ups, information should be incorporated in the content and made part of the machine set-up design criterion. Safety guidelines and guarding accessories should be incorporated whenever possible.

## *Occupational Safety and Health Administration (OSHA) Requirements*

OSHA does not presently cover Pennsylvania public schools because no state plan has been developed. Listed below are some of the more common OSHA guarding requirements that are recommended for the school laboratory. For additional requirements or more specific information, refer to the appropriate sections of the OSHA regulations.

1. The guard must be affixed to the machine, if possible.
2. Fans less than seven feet above the floor or working level must be guarded with mesh openings not more than one-half inch.
3. Machines designed for a fixed location must be securely anchored.
4. All V-belts and chain drives must be completely enclosed.
5. Machines must not start automatically when power is restored after a power failure.
6. Shield the feed rolls or other moveable parts of feeder attachments to protect the operator.
7. Table saws must have a hood (guard) that completely covers the saw blade at all times.
8. Except for grooving, dadoing or rabbeting, a spreader and non-kickback fingers or dogs must be provided on a table saw.
9. Radial arm saws must have an upper hood enclosing the top portion of the blade. The sides and the lower portion of the blade are guarded to the full diameter with a device that automatically adjusts to the thickness of the stock.
10. Anti-kickback fingers are also required on a radial arm saw.
11. Direction of saw blade rotation must be clearly marked.
12. Band saws must be completely enclosed except for the portion from the bottom of the guide rolls to the table.
13. Jointers may not have a knife projecting more than 1/8 inch beyond the cylinder head.

14. Jointer guards must automatically adjust themselves to cover all sections of the head on the working side of the fence and remain in contact with the work at all times. The section of the cutter head behind the fence must also be guarded.
15. Cutting heads on wood shapers must be enclosed with a cage or adjustable guard at least as wide as the diameter of the cutter.
16. Feed rolls on a planer must be guarded by a hood or suitable guard to prevent the operator's hands from coming in contact with the in-running rolls.
17. The blade of a portable circular saw must be guarded above and below the base plate or shoe.
18. When the portable circular saw is withdrawn from the work, the lower guard must automatically and instantly return to a covering position.
19. Disc sanders require an enclosed disc except for the portion of the disc above the table.
20. Belt sanders require guards at each nip point (where the sanding belt runs onto a pulley). The unused portion of the sanding belt must be guarded against accidental contact.

21. Wood lathes used for turning long pieces of stock held only between the two centers must have long curved guards, extending over the top of the lathe to prevent the work pieces from being thrown out of the lathe in the event they become loosened.
22. The tops and sides of the router must be covered.
23. Wheel safety guards must cover the spindles end, nut, and flange of a grinder.
24. The exposed end of a grinding wheel should not exceed more than one-fourth of the area of the entire grinding wheel.
25. Hand-held electric power tools must be equipped with "dead man" or "quick release" control so that the power can be shut off when the operator releases the control.
26. All hand-held portable electric equipment must have its frame grounded or be double insulated and identified as such.
27. Each employer shall be responsible for the safe conditions of tools and equipment used by employees.

## SUMMARY

The processes used in technology education courses vary greatly from one course to another and from one school to another, but they all emulate industrial practices in some way. Each process has unique hazards and potential dangers, which must be understood by the teacher, taught to the students, and have definite steps taken to avoid the potential for injury.

General guidelines and procedures are published in textbooks and technical manuals, but in almost all cases, the best source of specific safety information on equipment, materials and products is the original manufacturer. Providing a safe environment, keeping

equipment in good repair and well-guarded, finding accurate product information, teaching the correct and safe techniques and careful monitoring are the most important duties of the teacher with regard to safety while teaching about processes.

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INTERNET SITES
Occupational Safety & Health Admin - Washington DC
http://www.osha.gov

US Centers for Disease Control
http://www/cdc.gov

US Dept. of Health and Human Services
http://www.os.dhhs.gov

US Environmental Protection Agency
http://www.epa.gov

US Federal Emergency Management Administration
http://www.fema.gov

US National Institutes of Health
http://www.nih.gov/

US National Library of Medicine
http://www.nim.nih.gov/

# APPENDIX

# Appendix

1. Sample District Safety Policy
2. Hazardous Conditions Report
3. Technology Education Safety Inspection Check List
4. General Student Safety Contract
5. Parent/Guardian Safety Acknowledgement Form
6. Accident Report Form
7. Biotechnology Facility Check List
8. Microbiology and DNA Student Safety Contract
9. Chemical Hygiene Checklist For Biotechnology Laboratories
10. Elementary Safety Parent Permission Letter
11. Elementary Hand Tool Safety Rules
12. Elementary Suggested List of Appropriate Tools
13. Individual Equipment Safety Recommendation Sheets
    a. Circular saw (table)
14. Blank Equipment Safety Recommendation Sheet

Note: Additional Equipment Safety Recommendation Sheets are available by visiting the Technology Education Association of Pennsylvania's web site at www.teap-online.org

# District Safety Policy Statement

Policy Statement On Safety

A suggested safety education policy statement is provided below:

It is the policy of the_____ school board that an effective technology education program be conducted throughout the school system, one of its prime objectives being accident prevention in the school, at work and at home. In further support of this policy, the school board adopts the provisions of the Pennsylvania Technology Education Safety Guide for instruction at all levels.

The implementation of this policy will help make young people and adults more aware of the dangers that exist about them in today's industrial technological world and of the need for attitudes and habits that will ensure safe living and conservation of human resources.

The superintendent shall be responsible for implementation of this policy and shall make necessary appointments and delegate authority to see that effective safety training and procedures are carried out at all levels within the school district. The superintendent shall see that the safety laws, codes, administrative regulations and suggested practices of the Commonwealth of Pennsylvania be followed and funded as they relate to the educational system. The staff should make extensive use of the appropriate safety guides, manuals and statues that have been instituted and distributed by the Pennsylvania Department of Education.

## HAZARDOUS CONDITIONS REPORT

This form is a suggested method for reporting a hazard and directing action to see that the hazard is corrected or removed. If a hazard exists, the operation should be "blue tagged" and shut down until the hazard is corrected. (Note: This form can be used to report a student who is a hazard as well as a hazardous condition in the laboratory.)

HAZARDOUS CONDITIONS REPORT

Date: _____

To: _____

(Building Administrator) (Position) (School)

Description and location of health or safety hazard:

_____

_____

_____

_____

Suggested solution:

_____

_____

_____

_____

Teacher: _____

Signature

Distribution: Original - Building Administrator
1st copy - Department Chairperson
2nd copy - Teacher reporting hazard
3rd copy - District Safety Officer

Action taken:

_____

_____

_____

By Whom:

_____

Signature

# TECHNOLOGY EDUCATION SAFETY INSPECTION CHECKLIST

School Building _____ Laboratory _____

## 1. School Administration

**S = Satisfactory U = Unacceptable NA = Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | The school principal and school safety officer visit all laboratories to check for hazardous conditions and to make provisions for corrections. |
| S | U | NA | The school principal requires that standardized written reports of hazardous conditions be submitted and distributed to the proper individuals to assure corrective action. |
| S | U | NA | A written procedure has been established for reporting defective equipment immediately to assure prompt repair. |
| S | U | NA | The school principal keeps records of all inspections and these records are readily available for reference. |
| S | U | NA | The school district has defined "an accident" and has available employee and student accident reporting forms which fulfill the state statistical requirements. |
| S | U | NA | All accidents are promptly reported and analyzed. Immediate steps are undertaken to correct causes of accidents, and copies of all reports are kept in a school file until it is determined they are no longer necessary. |
| S | U | NA | The school has readily available all necessary information in order to reach parents or guardians in case of emergency. |
| S | U | NA | The school has an effective standardized district safety policy. |
| S | U | NA | The school has an effective policy and procedure to follow in case of an accident. |
| S | U | NA | The school has a policy and procedure for the administration of first aid. |
| S | U | NA | The instructor is notified of all student disabilities. |

| | | | |
|---|---|---|---|
| S | U | NA | The instructor has direct communication with the school nurse. |
| S | U | NA | First aid personnel or a nurse is available at all times. |
| S | U | NA | The school principal accepts the responsibility for keeping class size appropriate for activities, student age, facility size and the number of workstations available. |
| S | U | NA | The school principal is aware of his/her responsibility and liability in regard to students' protection. |
| S | U | NA | The school principal requires that the technology education areas be maintained and cleaned and provided with the same custodial services available to other general education programs. |
| S | U | NA | The school principal will make sure that a technology education certified instructor is in attendance when student work takes place. |
| S | U | NA | The school district has a policy for dealing with the removal of students who consistently violate safety regulations. |

## 2. Teacher

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | Teacher supervision is provided at all times when classes are in session. |
| S | U | NA | The teacher continuously inspects the facility to discover needed repairs and corrections. |
| S | U | NA | The teacher utilizes an inspection checklist when making formal inspections and maintains file copies. |
| S | U | NA | The teacher reports all hazardous conditions to the proper administrator. |

| | | | |
|---|---|---|---|
| S | U | NA | The teacher keeps records of all inspections and has copies of inspection reports readily available for reference. |
| S | U | NA | The teacher keeps records of all maintenance problems and the disposition of requests for corrections. |
| S | U | NA | The teacher keeps records of all accidents and analyzes them immediately for corrective measures. |
| S | U | NA | The teacher keeps records of all safety instruction and evaluation. |
| S | U | NA | The teacher selects student activities, keeping in mind the maturation level and ability of the students involved. |
| S | U | NA | Tools owned by the teacher are not used by students unless a district policy has been established to cover their use. The school principal has been informed. |
| S | U | NA | The teacher makes sure that students wear protective equipment when needed. |
| S | U | NA | The teacher is responsible to see that personal protective equipment has been sterilized. |
| S | U | NA | Instruction is reinforced by continuous proper example through deeds and actions of the teacher, such as wearing protective equipment in all situations deemed necessary. |
| S | U | NA | The teacher is knowledgeable in the use of the various fire extinguishers in the facility. |
| S | U | NA | When the classes are not in session, the teacher makes sure that all main power switches are in the "off" position. |
| S | U | NA | The teacher makes sure that all machines are locked-out when they are being repaired, cleaned or adjusted. |
| S | U | NA | A system for handling hot materials has been established. |
| S | U | NA | Routine preventative maintenance is practiced to assure against breakdown of equipment and safety protection devices. |

## 3. Instruction

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | The student's sense of responsibility is promoted, developed and periodically evaluated. |
| S | U | NA | Students receive instruction in the use of all tools and equipment they are expected to operate. |
| S | U | NA | Students are tested and permission is granted before machines are operated. |
| S | U | NA | General rules are established and enforced for safe, efficient laboratory operation. |
| S | U | NA | Students are instructed and alerted to possible hazardous operations and are monitored in these activities. |
| S | U | NA | "Horseplay" and practical jokes are dangerous and are not tolerated. |
| S | U | NA | Proper instruction and warning are given in the use and handling of toxic, caustic and volatile materials. |
| S | U | NA | In order to provide continuous safety instruction, questions on safety are included in all phases of instructional program. |
| S | U | NA | Students are instructed in the proper methods of handling and lifting materials. |
| S | U | NA | Students are given the responsibility to see that they and other students are clear of machines when turning them on; they never to leave a machine in a running position or stop one with their hands or a piece of material. |
| S | U | NA | Students are instructed to stay clear of others operating machines and, if necessary to approach an operator, to do so in such a manner not to annoy or alarm him/her. |
| S | U | NA | All work undertaken is approved through an established method before proceeding. |
| S | U | NA | Materials being worked are secured when the operation being conducted demands it. |

| | | | |
|---|---|---|---|
| S | U | NA | A class personnel organization is used including a student safety engineer. |
| S | U | NA | Safety bulletin boards, posters and student reports are part of the total safety program. |
| S | U | NA | Students are instructed in the proper methods of handling and lifting materials. |
| S | U | NA | Students are given the responsibility to see that they and other students are clear of machines when turning them on; they never to leave a machine in a running position or stop one with their hands or a piece of material. |
| S | U | NA | Students are instructed to stay clear of others operating machines and, if necessary to<br>approach an operator, to do so in such a manner not to annoy or alarm him/her. |
| S | U | NA | All work undertaken is approved through an established method before proceeding. |
| S | U | NA | Materials being worked are secured when the operation being conducted demands it. |
| S | U | NA | A class personnel organization is used including a student safety engineer. |
| S | U | NA | Safety bulletin boards, posters and student reports are part of the total safety program. |
| S | U | NA | Students are instructed in the procedure in how to report hazards and fires. |

## 4. Personnel Protection

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | In compliance with Pennsylvania law eye protection devices will be worn and appropriate signs posted. |
| S | U | NA | Emergency showers and eye wash stations are available and tested regularly when material safety data sheets (MSDSs) specify them. |
| S | U | NA | After use, eye-protection devices are cleaned and returned to properly designed storage racks. |
| S | U | NA | In all areas needing special body-protective clothing, such clothing is provided and used (e.g., aprons, shoes, gloves). |
| S | U | NA | In all areas needing respiration devices and noise suppression devices, such devices are provided and used. |
| S | U | NA | Students are cautioned on the danger of loose clothing, jewelry, ties, long hair etc. |
| S | U | NA | All injuries are reported to the instructor for immediate attention. |
| S | U | NA | Appropriate materials and procedures for clean-up of hazardous spills and accidents are available. Examples would be vermiculite and baking soda for acids and 10% Clorox bleach solution or 5% Lysol solution for body fluids. |

## 5. General Safety

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | Lecture Classroom 45 sq. ft. per student<br>Computer Laboratories 50 sq. ft. per student<br>Modular Laboratories 75 sq. ft. per student<br>Laboratories Utilizing Tools and Equipment 100 – 125 sq. ft. per student |
| S | U | NA | There is at least 6 linear feet (1.8 meters) of workspace per student in the classroom/laboratory. |
| S | U | NA | In order to meet the Americans with Disabilities Act (ADA) requirements for handicapped and disabled students, there is at least an additional 20 square feet (1.9meters) of working space for each disabled student. |
| S | U | NA | One instructor has the overall responsibility for each major laboratory facility. |
| S | U | NA | Each major laboratory facility can be locked separately. |
| S | U | NA | Provision has been made for keeping inappropriate garments and other materials out of activity areas. |
| S | U | NA | Good housekeeping standards are observed. |
| S | U | NA | The student educational cleanup program is backed up daily with complete custodial services. |
| S | U | NA | Waste (e.g., shavings, sawdust, paint, oil rags) is collected daily and disposed of by the custodian. |
| S | U | NA | Floors are maintained in a condition conducive to safe practices with nonskid surfaces provided around machines. Tile floors are covered with a nonskid wax. |
| S | U | NA | Designated safety zones areas are provided around all dangerous areas of work. |
| S | U | NA | Aisle width should be 4-5 feet or 1.2 – 1.5 meters wide to accommodate handicapped students and equipment needs. |

| | | | |
|---|---|---|---|
| S | U | NA | Aisles are clear of protruding materials. |
| S | U | NA | The room does not have any blind spots where students cannot be observed. |
| S | U | NA | Room furniture and equipment are arranged for optimum safety. |
| S | U | NA | Non-glare lighting is provided for all work areas according to State Board of Health regulations. |
| S | U | NA | General light levels should conform to the recommendations made on page 29 in the General Safety section, Accepted Standards and Practices. |
| S | U | NA | Stairways within existing laboratories have safe treads and rise with unobstructed access with approved railings. |
| S | U | NA | Railings and treads are color-coded. |
| S | U | NA | Two widely marked exits are available from each major laboratory area. Both should open outward and at least 5 feet wide (1.5 meters) to accommodate handicapped students. Doors should have reinforced glass viewing windows or peepholes. |
| S | U | NA | Facilities are light, pleasant, clean and conducive to good instruction. |
| S | U | NA | Machine operation regulations and safety procedures are posted conspicuously near areas of operation. |
| S | U | NA | Parts of machines and equipment needing special attention or caution are painted brightly with correct color-coding. |
| S | U | NA | Machine and workstations are located in relationship to the amount of supervision required. |
| S | U | NA | Machine location has been determined by needed operator space requirements and process capability. |
| S | U | NA | The exhaust ventilation system should meet the American National Standards Institute (ANSI) 29.5 standard. |
| S | U | NA | Student medical and allergy problems are identified. |

| | | | |
|---|---|---|---|
| S | U | NA | A telephone or intercom is available for notifying the office or others in the event of an emergency. |
| S | U | NA | Health hazards were considered in laboratory design to minimize injuries from excess heat, noise, fire and fume conditions. |
| S | U | NA | Emergency master shut-off controls for water, gas and electricity should be in a securable location near the teacher's station. |

## 6. Storage

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | Storage racks and shelves are designed and constructed to meet storage requirements. |
| S | U | NA | Materials are stored in a safe manner. |
| S | U | NA | Students and instructors are protected from protruding materials and sharp edges. |
| S | U | NA | All flammable and combustible liquids, toxic materials and caustics are stored securely in proper containers, identified by name and degree of hazard. |
| S | U | NA | Fire-approved storage cabinets are provided for all flammable and combustible liquids. |
| S | U | NA | Provision has been made for a fire-approved bulk storage area. (Refer to local Fire Marshall.) |
| S | U | NA | Lockable storage is available. |

## 7. Electric

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | All switches are enclosed per National Electric Code |
| S | U | NA | All circuits are identified on circuit breaker box. |
| S | U | NA | All power cords are of proper length as determined by gauge and load. |
| S | U | NA | All outlets located near sinks and water sources are protected by Ground –Fault Interrupters (GFIs). |
| S | U | NA | All electric circuits are provided with overload protection. |
| S | U | NA | All machines and equipment are equipped with lockout devices. |
| S | U | NA | All electrical outlets and machines are grounded. |
| S | U | NA | All extension cords are three-wire with proper connections. |
| S | U | NA | All portable power tools are provided with three-prong plugs, except those that are double insulated. |
| S | U | NA | Readily accessible individual "off" and "on" controls are installed on all machines as well as the electrical control panel. |
| S | U | NA | On machines where injury might result if motors were to restart after a major power shut-off, provision is made to prevent such restarting (magnetic switches). |
| S | U | NA | A master-control "Panic Stop System" is available and conveniently located in each laboratory to shut off power. |
| S | U | NA | Each laboratory area has its own master-control switch and power panel located for easy access. |
| S | U | NA | Laboratory power panels have clearly identified individual power switches for each machine. |
| S | U | NA | Extension cords are not used for permanent installation. |
| S | U | NA | Regulator stands and pilot lights are provided for all electrical soldering irons. |
| S | U | NA | All electrical apparatus in areas of concentrated vapors are vapor proof. |
| S | U | NA | The school district has a policy for dealing with the removal of students who consistently violate safety regulations. |

## 8. Equipment

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | Safety instructions for the use of each machine are posted. |
| S | U | NA | Machines are in safe operating condition at all times. |
| S | U | NA | Lockout tags are secured to machines not in working order and power is locked-out from use. |
| S | U | NA | All machines are securely fastened in place according to good industrial practice. |
| S | U | NA | Machines and equipment are provided with guards meeting industrial standards and guards are in proper position for safe machine operation. |
| S | U | NA | Equipment control switches are readily accessible to the operator while he/she is in a normal operating position. |
| S | U | NA | Proper tools and material are available for machine cleaning. |
| S | U | NA | Hand tool equipment is stored with sharp cutting edges protected. |
| S | U | NA | Hand tools are properly maintained and kept sharp. |
| S | U | NA | Bench tops are in keeping with the activities planned. |

## 9. Fire

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | Only UL or FM approved fire protection equipment should be used. |
| S | U | NA | A sufficient number of proper fire extinguishers are periodically inspected, dated, and recharged. |
| S | U | NA | A wool fire blanket is available for a clothing fire. (Special caution should be taken with polyester clothing.) |
| S | U | NA | All portable fire extinguishers are properly mounted and readily accessible for all activity areas. |
| S | U | NA | Adequate exit doors and open aisles are available for prompt evacuation. |
| S | U | NA | UL or FM approved containers are provided for storage and waste containers. |
| S | U | NA | Parts (solvent) wash tanks are equipped with fire-fused closing lids. |
| S | U | NA | Finish and spray room doors swing out. |
| S | U | NA | Filters in spray booths are replaced regularly. |

| | | | |
|---|---|---|---|
| S | U | NA | Separate disposal containers are provided for flammables. |

## 10. Welding

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | Proper protective clothing is worn when needed. |
| S | U | NA | Goggles with the proper lenses are used when torch welding. |
| S | U | NA | An arc-welding helmet with corrective lenses is used when doing electric welding (i.e., Minimum Shade #12 for MIG & TIG and Minimum Shade#10 for STD arc). |
| S | U | NA | Observers use acceptable protection. |
| S | U | NA | Welding is done only in areas free of combustible materials. |
| S | U | NA | Cylinders are secured up-right, clear of passageways and stored in ventilated areas. |
| S | U | NA | Extra cylinders are properly stored, meeting regulations of the Pennsylvania Department of Labor and Industry. |
| S | U | NA | Persons knowledgeable with code requirements check pipelines each year. |
| S | U | NA | Torches and regulators are clean, well maintained and in good operating condition. |
| S | U | NA | Hoses are in good condition and routinely inspected. |
| S | U | NA | Only spark lighters are used to light torches. |
| S | U | NA | Anti-flashback valves are installed where required in all hoses and lines. |
| S | U | NA | Arc welding is done in dry areas only. |
| S | U | NA | The electrode holder is maintained and stored in good condition to eliminate possible accidental arcs. |
| S | U | NA | Proper ventilation is provided. |

## 11.Gas

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | Gas-operated equipment is ignited from an automatic ignition system or pilot light. |
| S | U | NA | The main supply cutoff valve is identified, is readily accessible and is located outside possible heat or fire areas. |
| S | U | NA | Gas equipment is provided with a shutoff valve and a safety system. |
| S | U | NA | Only nonflammable insulating materials have been installed adjacent to gas appliances. |
| S | U | NA | Warning signs are posted when hot metals are poured. |
| S | U | NA | Properly designed and constructed equipment is used for handling molten metal when casting. |

## General Student Safety Contract

This is to certify that I, _____, have been instructed in, and understand the following safety components of this technology education class.

## Safety Rules:

Use lab only when directed by the teacher. _____

Never work with chemicals without checking labels carefully and only when directed by the teacher. _____

Place broken glass and disposables in appropriate designated containers. _____

Report any accident, incident, or unsafe situation to the teacher. _____

Never taste substances without teacher direction. _____

Confine long hair and confine loose clothing whenever working with equipment, flame, or chemicals. _____

Wash hands before leaving the lab. _____

## Location and proper use of the following safety equipment:

Fire extinguisher _____

Fire blanket _____

Eye protective devices (goggles, face shields) _____

Eyewash _____

Deluge/drench shower _____

Chemical dispensing containers _____

Material Safety Data Sheets (MSDS) _____

Master shut-off for gas, electricity and water _____

Heat sources (Bunsen burner, alcohol lamp, microwave oven, etc.) _____

First-aid kit _____

Electrical equipment _____

Emergency telephone listing & location _____

## Safety procedures for the following situations:

Fire _____

Chemical splash to the body _____

Eye emergency _____

Chemical spill _____

**Other concerns**

Wearing vision corrective contact lenses (yes ____, no ____)

**Response to Student Violations of Rules**

| | |
|---|---|
| First Offense | Verbal warning from teacher; record kept of the infraction |
| Second Offense | Review of rule involved; parents/guardian and student sign agreement that the rule is understood and will be followed |
| Third Offense | Suspension from class for one week pending successful conference with parents/guardian, teacher and principal |
| Fourth Offense | Class suspension for the remainder of the year |

To the Parent/Guardian:

Your son/daughter will be working in the laboratory during this course. In order to ensure his/her personal safety; it is important that the above rules are followed. Failure to do so may result in the student's removal from the laboratory. I understand these rules and agree that my son/daughter will abide by these and all other written and verbal instructions given in class.

Date: _____Teacher: _____

Date: _____Parent(s)/Guardian: _____

Date: _____ Student: _____

## THE STUDENT AND SAFETY IN TECHNOLOGY EDUCATION

_____School District
_____School
_____Technology Education Teacher

To the parent or guardian of_____

Your son/daughter is enrolled on our technology education program and will have the opportunity to use various tools and equipment. Appropriate instruction in their safe operation is given and close supervision is maintained at all times. Although every precaution is taken to prevent accidents, a certain risk is involved due to the nature of the experience, the age of the student, and the learning environment. We are asking you to impress upon your child the importance of being careful. We believe this will support the instruction that is given in school. You are invited to visit our school and the technology education program. These visits can be arranged by calling _____

Thank you very much for your help and assistance in providing your son/daughter with the "real world" experience of technology in a safe working environment.

I have read the attached communication and I understand the type of program that _____is enrolled in. I will stress the safety aspects of this program to my child. I will encourage my child to participate fully in his/her technology education program.

_____
Parent or guardian date

_____
home phone work phone

Please identify any health problems that may have a bearing on your child's participation in this class.

I agree to observe all safety rules and procedures for safe operation and conduct in the school Technology Education laboratory and will wear approved eye protection at all times while in the laboratory in accordance with state law.

_____ _____
Student signature date

# ACCIDENT REPORT FORM

TECHNOLOGY EDUCATION DEPARTMENT

Student Accident Report
(To be Completed by Instructor)

Name of student: _____ Grade: _____

Location of accident: _____ Time: _____
(Laboratory area)

Date of accident: _____

Description of injury: _____

_____

_____

Location of instructor when accident occurred: _____

Description of how the accident happened: _____

Indicate equipment, machinery, or tools involved:
_____

Describe unsafe practices, if any, contributing to accident:
_____

Suggestions for prevention of similar accident: _____

_____

_____

_____

Witness to accident:

1._____
2._____
3._____

Instructor's signature: _____ Date:
_____

Student's signature: _____ Date:_____

Note: File the original copy with the school nurse. File copies with department chairperson, district safety officer and reporting teacher.

# Biotechnology Facility Check List

School Building _____ Laboratory _____

**S=Satisfactory U=Unacceptable NA=Not Applicable**

| | | | |
|---|---|---|---|
| S | U | NA | The room should not be overcrowded, providing 60 – 80 square feet per student. It should be designed for no more than 24 students/teacher. |
| S | U | NA | There should be no less than 6 linear feet (1.8 meters) of workspace per student in the classroom/laboratory. |
| S | U | NA | During labs, air in the room should be regularly recycled and mixed with outside air at a rate of 4–12 complete laboratory air changes per hour, depending on the chemicals used. |
| S | U | NA | For high school labs where chemicals of low to moderate toxicity are used, at least one functioning local exhaust hood (portable or permanent) that meets American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) 110 testing standard, with a face velocity of approximately 80–120 linear feet/minute (24.4–36.6 meters/minute), should be provided. Exhaust should be vented to the outside through the roof or outside wall. A common through-the-wall hood may serve the laboratory and preparation room. Exhaust hood(s) should be located away (10 feet or 3.1 meters) from entrances/exits, windows, intake ducts and high traffic areas. |
| S | U | NA | Goose-necked faucets should be used on sinks to allow attachment of portable eyewashes and shower hoses. |
| S | U | NA | Aisle width should be adequate (4–5 feet or 1.2–1.5 meters) to accommodate handicapped students and equipment needs. |
| S | U | NA | Lab surfaces should be made of material unaffected by acids, alkalis, solvents, and temperate heat. |

## Microbiology and DNA Student Safety Contract

This is to certify that I, _____, have been instructed in, and understand, the following safety components of this technology education class:

Hands are washed with antibacterial soap before and following the activity. _____

Hands are kept away from face and mouth. _____

The location and proper use of safety equipment (e.g., eyewash, fire extinguisher, drench shower) are known. _____

Long hair and loose clothing are confined. _____

Paper, alcohol and plastics are kept away from Bunsen burners and electrical sterilizers. _____

All study containers containing microbiology or DNA study organisms are closed when not in use. _____

Laboratory doors are kept closed when a microbiology or DNA labs are in progress. _____

Eating and drinking are never done in the lab. _____

Mouth pipetting is never done. _____

No aerosols are produced because of poor techniques (i.e., forcing the last liquid drop from a pipette with air). _____

Latex gloves are worn whenever working in the lab when cuts are present on hands. _____

Protective lab coats are worn to help prevent contamination of personal clothing. _____

The work area is sterilized before and after the lab. _____

All proper techniques are followed as outlined by the teacher and only under the teacher's direct supervision. _____

All microbiology and DNA is handled as if it they were infectious. _____

Personal items such as pens and pencils that were used in the lab are kept away from face and mouth. _____

Only Biosafety Level 1 work as defined by the National Institutes of Health CDC-NIH Biosafety in Microbiological and Biomedical Laboratories, 2nd ed., May, 1988 is performed ("suitable for work involving organisms of no known or minimal potential hazard to laboratory personnel and the environment").

To the Parent/Guardian:

Your son/daughter will be working in the laboratory during this course. In order to assure his/her personal safety, it is important that the above rules are followed. Failure to do so may result in your son or daughter being removed from the laboratory.

I understand these rules and agree that my son/daughter will abide by these and all other written and verbal instructions given in class.

Date: _____Teacher: _____

Date: _____ Parent: _____

Date: _____ Student: _____

# Chemical Hygiene Guidelines For School Biotechnology Laboratories

Pennsylvania (see Act 174 under the Regulations section) and the Occupational Safety and Hazard Administration (OSHA) require work environments, including schools, to have a safety plan that reduces risks and ensures a safe work-place for employees (OSHA Laboratory Standard—29 CFR 1910.1450). This is referred to as the Chemical Hygiene Plan (CHP) and includes policies, procedures, and responsibilities designed to develop an awareness of potentially harmful chemicals in the workplace. It is important that laboratory chemicals be used only with knowledge of possible risks involved and within acceptable limits of exposure. The CHP must stress that everyone in the school has the right to know what hazards he or she will be exposed to and is responsible for implementing safety procedures and policies. Immediate supervisors have the responsibility to provide continuing education on safety guidelines and procedures to those under their direction. The CHP should be reviewed at least annually and revised as needed. The technology education department chairperson or the technology education teacher is usually responsible for developing the CHP for the school and may share

this task with the facility supervisor. Since care and supervision of the technology education laboratory is the primary responsibility of the classroom teacher, the CHP should serve as a guide to safe technology education instruction.

Development of a statement that includes clearly defined responsibilities of the superintendent, principals, department chairs, classroom teachers, students, and parents/guardian _____

Inclusion of a laboratory safety program as part of the curriculum and instruction _____

Regular training for all staff on safety policies, record keeping and other procedures _____

Evaluation of laboratory facilities and procurement of equipment needed _____

Development and enforcement of a plan for monitoring safety equipment and storage areas _____

Preparation and storage of safety records (i.e., inventories, Material Safety Data Sheets (MSDS), accident/incident reports, hazard notification reports) _____

Identification of hazardous chemicals and minimizing exposure to students and teachers (e.g., computerized/written inventory) _____

Development of safety policies and procedures for procurement, distribution, storage, and disposal of chemicals (e.g., using MSDS file) _____

Development of a written emergency plans and practiced procedures for spills or accidents involving chemicals _____

Implementation of a plan for posting signs and labels _____

# Elementary Safety Parent Permission Letter

## PARENT PERMISSION LETTER

School District _____

School/Grade_____

Classroom/Science Teacher_____

Date_____

To the parent or guardian of _____

Your child will be participating in a hands-on science and technology program this year. He/she will have opportunities to use various tools and lab equipment. We want to assure you that appropriate instruction in their safe use and operation will be given and close supervision will be maintained at all times. Although every precaution will be taken to prevent accidents, a certain risk is involved due to the nature of the experience, the age of the child, and the learning environment. We are asking you to help us by impressing upon your child the importance of following all safety rules and using care in the classroom at all times. We believe this will support the instruction that is given in school.

You are invited to visit our school in order to see our program in action and view our instructional materials. Thank you for your help in this matter.

I have read the attached information and I understand the nature of the program that my child will be experiencing. I will stress the safety aspects of this program to my child.

_____

Parent or Guardian Date

_____

Home phone Work phone

Please identify any health problems, including allergies, that may have a bearing on your child's participation in this program.

## General Hand Tool Safety Rules for Elementary Students

- Use the proper tool for the job.
- Use and carry tools safely and properly.
- Never run with a tool in your hand.
- Never carry tools in your pocket.
- When finished with a tool, clean it and put it back where it belongs.
- If a tool is broken, bring it to the teacher.
- Wear eye protection when using a tool.
- Beware of others near your workspace.

## Suggested List of Appropriate Hand Tools for Elementary School Use

- C-Clamp
- Vise
- Saw
- Hand Drill
- Claw Hammer
- Wire Cutters
- Tri Square
- Slip Joint Pliers
- Needle Nose Pliers
- Wrench
- Regular Screw Driver
- Phillips Screw Driver
- File
- Glue Gun
- Knives (grade 4 and above)