CHEMICAL HYGIENE PLAN

For:

Ball State University Laboratories

Prepared by the:

Ball State University
Environmental Health and Safety Office

May, 2015 Version

LABORATORY CHEMICAL HYGIENE PLAN

LABORATORY SPECIFIC CHEMICAL HYGIENE PLAN INFORMATION

Department _____

Laboratory: Building _____ **Room #** _____

Laboratory Supervisor/Principal Investigator:

Name _____ **Phone** _____ **Email** _____

Laboratory Safety Manager (if different from the Supervisor/Principal Investigator):

Name _____**Phone** _____ **Email** _____

Ball State University
Emergency Information and Phone Numbers

[For all emergencies, contact BSU Campus Police at 5-1111 (or 911) from a campus phone or 285-1111 from other phones]

Police Emergency	(28)5-1111 or 911
Fire	(28)5-1111 or 911
Ambulance / EMT	(28)5-1111 or 911
Delaware County Emergency Management Agency	747-4888 or 911
University Health Center	(28)5-8431
BSU Environmental Health and Safety Office	(28)5-2807
Crisis Management Team Coordinator (after hours: 760-7791 or 778-0166)	(28)5-8988
Facilities Planning & Management (Work Control)	(28)5-5081

Location of *Chemical Spill Kit*: _____

Location of *First Aid Kit*: _____

Location of *Eyewash/Shower*: _____

Location of *Evacuation Route/Plan* (or attachment): _____

Location of SDSs: _____

The Emergency Information above should be included in this laboratory's CHP, SOP, or SDS Manual. Contact information, access restrictions, PPE requirements, and hazard warnings must appear on the door sign at each laboratory entrance.

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1.0 PURPOSE

The Ball State University Chemical Hygiene Plan (CHP) is intended to provide guidelines, directives, and policies for individuals working in the campus laboratory community. The laboratory supervisors, safety managers, principal investigators, or individual Departments should produce standard operating procedures to accompany this CHP or choose to customize this CHP to suit their individual needs in order to more precisely portray the hazards and controls of their individual laboratories. This CHP includes policies, procedures, equipment, personal protective equipment, and work practices that are required and capable of protecting laboratory personnel from the general health hazards in laboratories. It is intended to satisfy the requirements of the federal Occupational Safety and Health Administration (OSHA) *Laboratory Safety Standard*, also known as "*Occupational Exposure to Hazardous Chemicals in Laboratories*" (See copy in **Chapter 27**) – when supplemented or revised with laboratory-specific protocols by the various University Departments, Principal Investigators, or Laboratory Managers. The CHP will be administered by the BSU Environmental Health and Safety (EHS) Office on a University-wide basis, with the individual academic and research Departments being responsible for its implementation on a Department and research or educational laboratory-specific basis. The CHP also applies to the BSU School of Art and College of Architecture and Planning studios and workshops that meet the definition of "laboratory", or where "laboratory use" of chemicals occurs, as defined or intended by the OSHA Standard. Student employees and paid graduate students are also governed by this Plan. While not directly covered by the OSHA standards, which apply only to "employees", all BSU students are nevertheless expected to abide by the procedures, mandates, and prohibitions presented in this Plan. Faculty and instructors should include its content, as well as general laboratory and studio safety, in their curriculum as part of their student's science or arts education and toward developing a "safety culture" in these settings and for these activities.

The BSU Laboratory Safety and Security Committee, to the extent possible, are involved in the development and implementation of this Plan and related laboratory safety policies. The appointed Chemical Hygiene Officer or the BSU Environmental Health and Safety Office, however, will take the necessary actions to administer the laboratory safety program for all faculty, staff, and other employees.

In genral, this CHP is intended to safely limit laboratory workers' exposure to harmful chemicals. Laboratory workers must not be exposed to substances in excess of the permissible exposure limits (PEL) specified in OSHA rule 29 CFR 1910, Subpart Z, Toxic and Hazardous Substances. PELs for regulated substances are provided in **Chapter 23.3, Appendix III, Table 12**. PELs refer to airborne concentrations of substances and are averaged over an eight-hour day. Compounds with individual standards generally have "action limits" (usually set at half the Threshold Limit Value). Some substance specific regulations include *action levels* which are are air concentrations below the PEL which, if exceeded, require that certain actions such as medical surveillance and workplace monitoring take place. A lab worker's workplace exposure to any regulated substance must be monitored if there is reason to believe that the exposure will exceed an action level or a PEL. If exposures to any regulated substance routinely exceed an action level or permissible exposure level, there must also be laboratory personnel medical exposure

surveillance. Please refer to the individual chemical standards for details. However, this Plan and related precautions and procedures relate to biological and physical safety as well as chemical safety.

OSHA regulations require employers to evaluate their workplaces for the presence of hazardous substances, harmful physical agents, and infectious agents and to provide training to laboratory personnel concerning those substances or agents to which laboratory personnel may be exposed. Written information on agents—in particular, Material Safety Data Sheets (MSDSs) or the newer Safety Data Sheets (SDSs), or Pathogen Safety Data Sheets--must be readily accessible to laboratory personnel. Laboratory personnel have a conditional right to refuse to work if assigned to work in an unsafe or unhealthful manner with a hazardous substance, harmful physical agent, or infectious agent. Labeling requirements for containers of hazardous substances and equipment or work areas that generate harmful physical agents are also included in the OSHA Standard. The development and use of *Standard Operating Procedures* (SOPs) for laboratory work involving hazardous chemicals is another important requirement of the OSHA Standard. This CHP also addresses the identification, handling, and disposal of hazardous and other waste materials from BSU laboratory and support operations.

Other than for employee safety and OSHA compliance, the development and application of the BSU CHP also allows for limited hazardous materials and chemical storage and use in laboratories under the *Indiana Fire Code* (which has adopted the *International Fire Code*). BSU's compliance with this Plan allows for the storage and handling of hazardous chemicals (flammable, combustible, oxidizers, etc.) in other than specified "control areas" under the Fire Code. However, this exemption is subject to a number of restrictions on the nature and quantity of chemicals stored, the type of containers, fire suppression system presence, use of safety cabinets, and the physical location of the laboratory in the building (floor level).

While the expressed purpose of the OSHA *Laboratory Safety Standard* is to ensure the safety of *employees* (faculty, staff, researchers, etc.) in laboratory settings and operations; many, if not all, of the precautions and procedures established in this Plan are also relevant for the safety and training of Ball State University students and its content should be included in instructional programs. At present, this CHP only peripherally addresses radiological and biological safety, referring the reader to the Radiation and Biosafety Committees for further safety information.

2.0 SCOPE AND APPLICATION

The OSHA *Laboratory Safety Standard* applies where 'laboratory use' of hazardous chemicals occurs. Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

i. the handling or use of chemicals occurs on a 'laboratory scale', that is, the work involves containers which can easily and safely be manipulated by one person;
ii. multiple chemical procedures or chemical substances are used; and
iii. protective laboratory practices and equipment are available and in common use to minimize the potential for laboratory personnel exposure to hazardous chemicals.

At a minimum, this definition covers laboratory personnel (including student employees and interns), technicians, supervisors, and principal investigators) that use chemicals in teaching, research, and clinical laboratories at Ball State University. Certain non-traditional laboratory settings may be included under this standard at the option of individual Departments within BSU. For the purposes of this Plan, the term *Laboratory Safety Manager* is used to designate the *Principal Investigator, Laboratory Manager, Laboratory Supervisor, Laboratory Technician,* or other employee of the BSU Department who is intended or designated as the responsible party for laboratory safety in a particular lab or group of laboratory operations, under this Plan and the OSHA Laboratory Standard. The various BSU Departments operating laboratories may have different titles for the individual so designated or intended by the Department to ensure compliance with the OSHA Laboratory Standard for the laboratory or laboratories under their management or jurisdiction. The designated *Laboratory Safety Manager* may be responsible for a single laboratory, multiple laboratories, or all laboratories within a particular BSU Department, interdepartmental, or interdisciplinary laboratory research, demonstration, or educational effort.

This standard does not apply to laboratories whose function is to produce commercial quantities of material. Also, where the use of hazardous chemicals provide no potential for laboratory personnel exposure, such as in procedures using chemically impregnated test media and commercially prepared test kits, this standard will not apply. Neither does this standard apply to BSU employees engaged in other than laboratory work. Those employees are covered by **OSHAs *Hazard Communication Standard* at 29 CFR 1910.1200** and numerous other OSHA and EPA standards related to chemical management and safety. A copy of the *OSHA Laboratory Standard* is provided, as required, in **Chapter 27** to this Plan.

While students are not covered under the provisions of the OSHA Laboratory Standard, students should be made aware of chemical health and safety hazards in classroom situations, and should be provided with information to protect themselves from those hazards. Departments must provide student training at the beginning of each laboratory course in which hazardous chemicals are used. Specific safety instructions should also be provided at the beginning of each class period for the work being performed. It is desirable that safe and hygienic laboratory practices be imparted to students as part of their academic education, and awareness of this Chemical Hygiene Plan can be an important component of that training.

3.0 RESPONSIBILITIES

Implementation of the Laboratory Safety Standard at BSU is a shared responsibility. Laboratory personnel, Principal Investigators, Supervisors, Laboratory Safety Managers, Department heads, Deans, upper administrative staff, the Laboratory Safety and Security Committee, and EHS staff all have roles to play. These roles are outlined below.

3.1 UNIVERSITY WIDE

Ball State University, in conjunction with its academic and non-academic Schools or Departments, is responsible for developing and supporting a broad-based chemical hygiene program that will protect its science laboratory and art program personnel from health effects or hazards associated with hazardous chemicals. Deans, Directors, and Department Chairs are responsible for integrating laboratory and chemical safety into all of their activities, for promoting the same attitude among all levels of employment and students at the University, and for providing adequate time and recognition for all laboratory personnel that are given laboratory safety responsibilities.

3.2 COLLEGES, ACADEMIC DEPARTMENTS, AND NON-ACADEMIC DEPARTMENTS

Each academic and non-academic School or Department that engages in the laboratory use of hazardous chemicals must identify at least one *Laboratory Safety Manager* to serve as a focal point for laboratory health and safety activities within the Department and as liaison with the Ball State University Environmental Health and Safety (EHS) Office. Each academic, and non-academic Department, must modify this generic *Chemical Hygiene Plan* to incorporate location-specific information and submit a copy of the modified plan to the EHS Chemical Hygiene Officer for approval. Each unit will also identify the assigned Laboratory Safety Manager(s) within their Department or administrative entity and will transmit that information to the Chemical Hygiene Officer.

The following Departments, schools, units, or entities, at a minimum, should participate in the administration of, and compliance with, the Chemical Hygiene Plan:

Chemistry Department	Biology Department
Physics and Astronomy Department	Physiology and Health Science
Human Performance Laboratories	Geological Science
Natural Resources and Environmental Management	Applied Archeology Labs
Public Safety Department	Radiation Safety Committee
Biosafety Committee	Research Integrity
Environmental Health and Safety Office	Health Center
School of Art	College of Architecture and Planning
Medical Education	Burris School and Indiana Academy

3.3 LABORATORY SAFETY AND SECURITY COMMITTEE

The BSU Laboratory Safety and Security Committee was formed in late 2011 as an advisory and policy-making committee. The Mission Statement of the LSSC is as follows:

Ball State University is dedicated to providing a safe and secure academic research environment for all faculty, staff and students. In furtherance of this commitment, the Laboratory Safety and Security Committee (LSSC) provides general oversight and guidance to the campus through promotion of a safe and secure work environment in all research and teaching laboratories, associated scientific operations and facilities. The Committee consists of members from a broad range of departments and reflects the diversity of scientific disciplines and regulatory issues involved with laboratory safety, integrity, and security on campus.

The responsibilities of the Committee are to:

- Create an atmosphere conducive to safe, effective, and regulatory compliant laboratory-based programs in order to enhance our overall research and education efforts.
- Advise senior BSU officials on strategic issues effecting research safety and security;
- Develop, update and maintain policies and procedures in compliance with applicable Federal regulations;
- Develop BSU specific policies and procedures, best practice guidance and applicable research safety guidelines;
- Establish plans and develop training programs applicable to the health and safety of all research personnel;
- Establish strategies to ensure ongoing and adequate hazard identification, compliance, and risk evaluation of laboratory activities;
- Review findings of campus inspection, hazard surveillance, environmental compliance, and faculty, staff, and student safety programs related to laboratories;
- Work collectively with other campus research review and safety committees to ensure open lines of communications, consistency in research policies and practices and to enhance collaborative efforts;
- Encourage participation in biological, chemical, and radiological security efforts for laboratory personnel and related activities, supplies, agents, and products;
- Serve as an educational and informational resource to the BSU scientific community;

In addition to providing oversight and guidance, the Committee may recommend the modification, suspension, or termination of any laboratory activities to the Chemical Hygiene Officer that are deemed to pose an unacceptable risk to life, security, or safety.

3.4 CHEMICAL HYGIENE OFFICER

The Chemical Hygiene Officer for BSU is currently also the Environmental Specialist with the Environmental Health and Safety Office. Chemical Hygiene Officer (OSHA definition)--*An employee who is designated by the employer and is qualified, by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan (CHP) and the OSHA Laboratory Safety Standard*.

Qualifications:

Proficiency, by education and/or related experience of applicable safety, technical, and regulatory requirements, e.g., OSHA, EPA, CDC, IFC, FDA, DEA, DHS, DOT, etc., standards as they relate to practices and safety in educational and research laboratories. The attainment and maintenance of certification as

a *Chemical Hygiene Officer* by the National Registry of Certified Chemists and as a *Certified Hazardous Materials Manager* (CHMM) from the Institute for Hazardous Materials Management.

Responsibilities: The *Chemical Hygiene Officer* for BSU is responsible for:

- Preparing, revising as necessary, and updating, on an annual basis, BSU's *Chemical Hygiene Plan* (CHP);
- Consultation and advocacy for laboratory, chemical, and biological safety with administrative entities, other committees, and the general university population;
- Implementing and documenting laboratory safety and regulatory compliance programs for the university;
- Performing or overseeing exposure monitoring of employees when required or advisable;
- Overseeing programs for the routine inspection, presence, and operability of fume hoods, glove boxes, biosafety cabinets, laboratory pressure differentials and ventilation, autoclaves, eyewashes/emergency showers, fire extinguishers, medical and spill response kits and other safety equipment and appurtenances;
- Conducting or overseeing audits and inspections of the laboratory spaces, preparation rooms, and chemical and biological storage facilities for conformance with the CHP, BSU policies, and other rules and standards related to safety and hygiene;
- Interacting with the Occupational Safety and Health Agency (OSHA), Environmental Protection Agency, Department of Homeland Security, their state counterparts, and state and local fire, water, and wastewater jurisdictions regarding our occupational and safety programs for laboratory work;
- Assisting the laboratory departments or other units in tailoring and implementing the CHP for their particular needs or laboratories;
- Ensuring that Standard Operating Procedures (SOPs) for laboratories are developed and implemented where needed;
- Acting as liaison with BSU Facilities Planning and Management regarding building design and HVAC concerns;
- Developing, implementing, and ensuring safe and compliant plans and procedures for the storage, handling, transport, and use of chemical and biological materials.
- Overseeing solid and hazardous waste and chemical and biological waste management and disposal for the various departments;
- Training departmental staff regarding their responsibilities for safety and compliance with regulations and BSU standards that apply to laboratory and other safety and environmental measures, and assisting in the safety training of graduate assistants and students when requested;
- Ensuring that an annual chemical inventory is conducted for each department, laboratory, and related workspaces or stockrooms for both compliance and internal university purposes.
- Monitoring the progress of the various departments' toward achieving and maintaining compliance with this Plan and OSHA and other regulations and standards;
- Investigating laboratory-related accidents and chemical exposures within the various departments.
- Providing or assisting with response to any chemical, biological, or radiological spills or releases and the resulting cleanup and assessment; and,
- Identifying, reporting and assisting in correcting unsafe conditions or practices.

3.5 LABORATORY SAFETY MANAGER (REPRESENTATIVE OR OFFICER)

The *Laboratory Safety Manager is* the title, for the purposes of this Plan, intended to identify the individual delegated or assigned to perform the following roles:

- Interacting with the Chemical Hygiene Officer to ensure a safe and healthful laboratory environment;
- Assuring that potential hazards of specific projects have been identified and addressed before work is started;
- Ensuring that they, other laboratory workers, and students have received general laboratory safety training and laboratory-specific safety indoctrination.
- Develop and implement a specific Chemical Hygiene Plan for the laboratory including necessary Standard Operating Procedures (SOPs) for attachment or reference to this generic CHP;
- Ensuring there are written, laboratory-specific standard operating procedures for the protocols carried out in the laboratory that incorporate directions about how to mitigate the hazards of the procedures;
- Informing and training laboratory personnel and students regarding the specific hazards in their area and in the work they will be doing;
- Instructing laboratory workers in the safe and adequate response to spills or releases of hazardous chemicals or biological agents;
- Providing for any necessary personal protection equipment (PPE) to laboratory personnel;
- Scheduling time for laboratory personnel to participate in training outlined in **Chapter 14**;
- Documenting and maintaining records of safety training per **Chapter 14** including certification that all lab personnel have read and understand the Chemical Hygiene Plan;
- Enforcing BSU safety policies and safe work practices;
- Conducting periodic audits of the laboratory or research space under their control;
- Ensuring that all laboratory safety equipment is available and in good repair;
- Reporting hazardous conditions, or employee monitoring or PPE needs, to the Chemical Hygiene Officer and/or Facilities Management; and
- Investigation of laboratory accidents, documenting the investigation, and sending copies of the report with recommendations to the Chemical Hygiene Officer for review.

If a *Laboratory Safety Manager* is not delegated or otherwise identified by the BSU Department, the immediate supervisor of the laboratory (Laboratory Supervisor, Manager, or Technician), Principal Investigator, or Department Chair is then responsible for assuming the role of Laboratory Safety Manager under this Plan and the OSHA Laboratory Standard and to perform or oversee the above functions for each laboratory under their control.

3.6 FACULTY, STAFF, AND LABORATORY PERSONNEL

Faculty, staff, and laboratory personnel who have significant responsibility for directing their own laboratory work, or those of students, are responsible for assuring that general laboratory safety and the potential hazards of specific projects or lessons have been identified and addressed before work is started. All laboratory personnel are responsible for:

- Following the policies, procedures, and precautions in this Chemical Hygiene Plan and the requirements of the OSHA Laboratory Standard;
- Attending required laboratory safety training sessions;
- Following and enforcing safety guidelines applicable to the laboratory, the chemicals being handled, and the specific procedures being carried out;
- Assuring that required safety precautions are in place before work is started;
- Cooperating with the Chemical Hygiene Officer and any Departmental Laboratory Safety Manager(s), and
- Reporting hazardous conditions or exposures as they are discovered or occur.

4.0 DEFINITIONS

Note: *Many of the definitions below are from the OSHA Hazard Communication Standard found at 29 CFR 1910.1200 or from the OSHA Laboratory Standard (29 CFR 1910. and included in its entirety at* ***Chapter 27*** *in this Plan. Only those definitions from those standards that are cited elsewhere in this Chemical Hygiene Plan appear below.*

Action Level -- A concentration designated in 29 CFR part 1910.1450 for a specific substance, calculated as an 8-hour time weighted average (TWA), that initiates certain required activities. The Action Level is generally considered to be one half of the Permissible Exposure Limit (PEL).

Acute --An adverse effect with symptoms of high severity coming quickly to a crisis.

Bloodborne Pathogen -- Pathogenic micro-organisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, Hepatitis B Virus (HBV) and Human Immune Deficiency Virus (HIV).

CARCINOGEN -- A substance capable of causing cancer (also see ***Select Carcinogen***).

Chemical Hygiene Officer -- An employee who is qualified, by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan (CHP). At BSU, this role is currently fulfilled by the Environmental Specialist in the Environmental Health and Safety Office.

Chemical Hygiene Plan-- A written program developed and implemented that sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in the laboratory. This plan shall be reviewed and updated at least annually by the University Laboratory Safety Committee or the designated Chemical Hygiene Officer.

Chronic -- An adverse effect with symptoms that develop slowly over a long period of time or that frequently recur.

Combustible -- A material that has a Flash Point at or above 140^0 F.

Compressed gas means:

(i) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(ii) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(iii) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as

determined by ASTM D-323-72.

Control Area (International Fire Code)—Spaces within a building where quantities of hazardous materials (flammable, reactive, or toxic chemicals) not exceeding the maximum allowable quantities per control area are stored, dispensed, used or handled.

Designated Area -- An area that may be used for work with select carcinogens, reproductive toxins, or substances that have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a single device such as a laboratory hood, biosafety cabinet, or glovebox.

Explosive -- A chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable Liquid-- A material that has a flash point below 140^0 F and a vapor pressure not exceeding 40 pounds per square inch, absolute (psia) at 100^0 F.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(i) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z1 1.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(ii) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z1 1.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(iii) Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Globally Harmonized System is the *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*. The GHS is a system for standardizing and harmonizing the classification and labelling of chemicals. It is a logical and comprehensive approach to: (1) defining health, physical and environmental hazards of chemicals; (2) creating classification processes that use available data on chemicals for comparison with the defined hazard criteria; and (3) communicating hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS). Refer to **Chapter 7, Section 7.1,** and **Chapter 39** for more information on the GHS.

Hazard category under the GHS system of chemical hazard classification means the division of criteria within each hazard class, e.g., oral acute toxicity and flammable liquids include four hazard categories. These categories compare hazard severity within a hazard class and should not be taken as a comparison of hazard categories more generally.

Hazard class means the nature of the physical or health hazards, e.g., flammable solid, carcinogen, oral acute toxicity.

Hazard not otherwise classified (HNOC) means an adverse physical or health effect identified through evaluation of scientific evidence during the classification process that does not meet the specified criteria for the physical and health hazard classes addressed in this section. This does not extend coverage to adverse physical and health effects for which there is a hazard class addressed in this section, but the effect either falls below the cut-off value/concentration limit of the hazard class or is under a GHS hazard category that has not been adopted by OSHA (e.g., acute toxicity Category 5).

Hazard statement means a statement assigned to a hazard class and category that describes the nature of the hazard(s) of a chemical, including, where appropriate, the degree of hazard.

Hazardous Chemical--means any chemical which is classified as a physical hazard or a health hazard, a simple asphyxiant, combustible dust, pyrophoric gas, or hazard not otherwise classified.

Health hazard (GHS)-- means a chemical which is classified as posing one of the following hazardous effects: acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenicity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); or aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in Appendix A to §1910.1200—Health Hazard Criteria.

High Degree of Acute Toxicity (Substances)-- Acutely toxic agents include certain corrosive compounds, irritants, sensitizers (allergens), hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes (see **Chapter 18**). Substances which have a high degree of acute toxicity are interpreted by OSHA as being substances defined as "toxic" and “highly toxic” agents in 29 CFR 1910.1200, and substances which “may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration. See Chapter 18. These substances fall into the category of *Particularly Hazardous Substances*, many of which are listed on **Table 10 in Chapter 23.3, Appendix III**.

Laboratory -- A workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory Scale -- Work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. Also may be called *Bench Scale*.

Laboratory Standard -- The procedures and standards encompassed by 29 Code of Federal Regulations (CFR) 1910.1450; also known as the *Occupational Exposure to Hazardous Chemicals in the Laboratory-- Chemical Hygiene Plan*.

Laboratory Use of Hazardous Chemicals -- Handling or use of such chemicals in which all of the following conditions are met.

1. Chemical manipulations are carried out on a laboratory scale.
2. Multiple chemical procedures or chemicals are used.
3. The procedures involved are not part of a production process nor in any way simulate a production process.
4. Protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Laboratory Employee -- An individual paid by the Department or a Principal Investigator who is a laboratory worker, this may include faculty, staff, post-doctoral students, graduate students, and student employees.

Laboratory Safety Manager – The individual designated or assuming the role of "safety supervisor" for a laboratory or laboratories under the OSHA Laboratory Standard. This role may be assigned to a *Laboratory Supervisor*, *Principal Investigator*, *Laboratory Manager*, *Laboratory Technician, Faculty member, Department Chair*, or any other qualified person, but the intent is to identify the individual delegated or assigned to implement the provisions of this Chemical Hygiene Plan in one or more laboratory operations. The Laboratory Safety manager should also be accorded the authority to stop operations in a laboratory should unsafe conditions arise or be observed.

Laboratory Worker-- An individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Medical Consultation -- A consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Mutagen means a chemical that may cause mutations in the germ cells of humans that can be transmitted to the progeny. A mutation is defined as a permanent change in the amount or structure of the genetic material in a cell.

Nanoparticles are a sub-classification of ultrafine particle with lengths in two or three

dimensions greater than 0.001 micrometer (1 nanometer) and smaller than about 0.1 micrometer (100 nanometers) and which may or may not exhibit a size-related intensive property. Engineered nanoscale materials or nanomaterials are materials that have been purposefully manufactured, synthesized, or manipulated to have a size with at least one dimension in the range of approximately 1 to 100 nanometers and that exhibit unique properties determined by their size.

Oxidizer means a chemical other than a blasting agent or explosive as defined in §1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases. A list of strong oxidizers appears in **Chapter 23.3, Appendix III, Table 7,** to this CHP.

Particularly Hazardous Substances (PHSs) - Substances that pose such significant threats to human health that the OSHA Laboratory Standard requires special provisions be established to prevent harmful exposure of researchers. Three categories of *Particularly Hazardous Substances* are defined in the OSHA Lab Standard: *Select Carcinogens*, *Reproductive Toxins*, and *Compounds with a High Degree of Acute Toxicity*. Refer to Chapter 18 of this CHP. Many of these are listed in **Table 10 of Chapter 23.3, Appendix III**.

Permissible Exposure Limit (PEL) – For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR 1910, Subpart Z (**Appendix III, Table 16** of this CHP).

Physical Hazard (GHS) -- means a chemical that is classified as posing one of the following hazardous effects: explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid or gas); self-reactive; pyrophoric (liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; or in contact with water emits flammable gas. See Appendix B to §1910.1200—Physical Hazard Criteria.

Pictogram means a composition that may include a symbol plus other graphic elements, such as a border, background pattern, or color, that is intended to convey specific information about the hazards of a chemical. Eight pictograms are designated under this standard for application to a hazard category.

Precautionary statement means a phrase that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous chemical, or improper storage or handling.

Principal Investigator / Laboratory Supervisor -- The Principal Investigator (PI) /Laboratory Supervisor (LS) hasresponsibility for the health and safety of laboratory personnel doing work in his/her laboratory. The PI/LS may delegate the safety duties for which he/she is responsible, but must make sure that any delegated safety duties are clearly defined, are carried out, and are documented**.**

Product Identifier means the name or number used for a hazardous chemical on a label or in the SDS. It provides a unique means by which the user can identify the chemical. The product identifier used shall permit cross-references to be made among the list of hazardous chemicals required in the written hazard communication program, the label and the SDS.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Recommended Exposure Limits (REL) – Employee exposure limits recommended by the National Institute for Occupational Safety and Health (NIOSH)

Regulated Laboratory--A facility where the laboratory use of hazardous chemicals occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a teaching, research, practicum, or non-production basis.

Reproductive toxins mean chemicals that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard (§1910.1200) shall be considered reproductive toxins. These are also considered to be *Particularly Hazardous Substances*--**See Chapter 18** and **Appendix III, Table 10 of this CHP.**

Safety Data Sheet (SDS) means written or printed material concerning a hazardous chemical that is prepared in accordance with paragraph (g) of this section. This may also refer to, or include, **Material Safety Data Sheets (MSDSs)**

Select Carcinogen -- Any substance that meets one of the following criteria:

1. It is regulated by OSHA as a carcinogen; or

2. It is listed under the category, known to be carcinogens, in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

3. It is listed under Group 1 (carcinogenic to humans) by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

4. It is listed in either Group 2A or 2B by IARC or under the category, reasonably anticipated to be carcinogens by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime, to dosages of less then 10 mg/m^3.
b. After repeated skin application of less than 300 mg/kg of body weight per week; or
c. After oral dosages of less that 50 mg/kg of body weight per day.

Carcinogens are also considered to be *Particularly Hazardous Substances*—**See Chapter 18** and **Appendix III, Table 10 of this CHP.**

Signal word means a word used to indicate the relative level of severity of hazard and alert the reader to a potential hazard on the label. The signal words used in this section are "danger" and "warning." "Danger" is used for the more severe hazards, while "warning" is used for the less severe.

Simple asphyxiant means a substance or mixture that displaces oxygen in the ambient atmosphere, and can thus cause oxygen deprivation in those who are exposed, leading to unconsciousness and death.

Specific chemical identity means the chemical name, Chemical Abstracts Service (CAS) Registry Number, or any other information that reveals the precise chemical designation of the substance.

Substance means chemical elements and their compounds in the natural state or obtained by any production process, including any additive necessary to preserve the stability of the product and any impurities deriving from the process used, but excluding any solvent which may be separated without affecting the stability of the substance or changing its composition.

Teratogens --A substance that causes a deformity in newborns if a significant exposure exists during pregnancy.

Threshold Limit Value (TLV) – The exposure limit for employees recommended by the American Conference of Governmental Industrial Hygienists (ACGIH)

Toxic--Harmfulto living organisms.

Unstable (Reactive)--A chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive-- A chemical that reacts with water to release a gas that is either flammable or presents a health hazard. A list of some of these chemicals is provided in **Chapter 23, Appendix III** to this CHP.

Common Acronyms/Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
BSU	Ball State University
CHO	Chemical Hygiene Officer
CHP	Chemical Hygiene Plan
CFR	Code of Federal Regulations
DOT	Department of Transportation
EC	Environmental Control (Facilities Planning and Management)
EHS	BSU Environmental Health and Safety Office
EPA	Environmental Protection Agency
FPM	BSU Facilities Planning and Maintenance Department
GHS	Globally Harmonized System
IARC	International Agency for Research on Cancer
IDEM	Indiana Department of Environmental Management
IFC	Indiana (or International) Fire Code
IUPAC	International Union of Pure and Applied Chemistry
LD_{50}	Lethal Dose for 50% Mortality
MSDS	Material Safety Data Sheets
NFPA	National Fire Protection Association
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit (OSHA)
PHS	Particularly Hazardous Substance
PPE	Personal Protective Equipment (PPE)
REL	Recommended Exposure Limit (NIOSH)
SOP	Standard Operating Procedure
TLV	Threshold Limit Value (ACGIH)

5.0 GENERAL LABORATORY PROCEDURES AND PROHIBITIONS

NOTE: THESE PRECAUTIONS, PROHIBITIONS, AND PROCEDURES SHOULD BE FOLLOWED BY STUDENTS AT BALL STATE UNIVERSITY--AS WELL AS EMPLOYEES.

CHAPTER 42.0 OF THIS PLAN INCLUDES A TRI-FOLD BROCHURE ENTITLED, *SAFETY IN BSU UNIVERSITY LABORATORIES* THAT SUMMARIZES THE FOLLOWING PROCEDURES AND PROHIBITIONS, AS WELL AS A *LABORATORY SAFETY AGREEMENT AND CERTIFICATION FORM* TO BE PROVIDED TO ALL NEW LABORATORY EMPLOYEES AND ENTERING STUDENTS.

5.1 BEHAVIOR IN THE LABORATORY

1. Appropriate personal protective equipment shall be worn at all times in the laboratory. Refer to the BSU PPE Policy (**See Chapter 10**)
2. Employees should act in a professional manner at all times.
3. Horseplay and practical jokes are expressly forbidden.
4. Employees should not work alone with hazardous chemicals using potentially dangerous procedures.
5. Any visitor to the laboratory is to be escorted by an employee and is the responsibility of that employee. Appropriate safety rules and PPE requirements must be observed.
6. While running unattended operations, employees shall leave lights on, place appropriate information (experimenter's name and phone number, supervisor's name, chemical reagents and products and quantities) on door signs, and provide for containment of hazardous substances in the event of a catastrophic (such as electric or HVAC) failure.
7. Employees shall be aware of the location and proper operation of laboratory safety equipment.
8. Employees shall seek to correct or stop unsafe practices when observed by other employees or students and/or report the same to the Laboratory Safety Manager and/or Chemical Hygiene Officer.

5.2 AVOIDANCE OF ROUTINE EXPOSURES

1. Avoid direct contact with any chemical. Keep chemicals off hands, face, and clothing, including shoes. Minimize exposure to chemicals at all times.
2. Do not smell or taste chemicals.
3. Use a vacuum or pipette bulb - do not pipette by mouth.

4. Vent any experiment that may discharge toxic or noxious chemicals into a local exhaust device, (i.e., a chemical fume hood, slot or snorkel vent, paint booth).

5. Flammable, corrosive, or toxic volatile materials must be trapped when they are evaporated, for example with rotary evaporators or similar devices.

6. Use only those chemicals or biologic agentsfor which the protective and air movement quality of the available ventilation system(s) is appropriate.

7. Never underestimate the risk. Chemicals involving two or more substances may form reaction products that are significantly more toxic than the starting reactions. Assume that all substances of unknown toxicity are toxic.

8. Do not use an open flame to heat a flammable liquid or to carry out a distillation under reduced pressure.

9. When transferring flammable liquids in metal or conductive plastics equipment, use bonding and ground straps to avoid static-generated sparks.

10. Ventilation should be utilized to prevent the formation of flammable atmospheres.

11. Chemicals should only be used if their identity, characteristics, incompatibilities and potential reaction byproducts are known to the user and an SDS is available and has been reviewed.

5.3 PERSONAL HABITS AND CONDUCT IN THE LABORATORY

1. Eating, drinking, gum or tobacco chewing, and cosmetic application are not permitted in the laboratory.

2. Gloves shall be doffed and hands washed thoroughly after laboratory chemical handling. Hand to mouth and face contact should be consciously minimized.

3. Smoking is not allowed in any laboratory or building on the BSU Campus.

4. Food may not be stored in a refrigerator that has been or is being used to store chemicals. Refrigerators storing chemicals should be so labeled.

5. Ice produced by ice machines for laboratory use shall not be used for beverages, food, or food storage.

6. No glassware or utensils that are used for laboratory operations shall be used for storage, handling, or consumption of food or beverages.

7. Hands should be washed before and after using the restrooms and before eating or smoking. Areas of exposed skin, i.e. forearms, should be washed frequently if there is potential of contact with chemicals.

8. Long hair, jewelry, and loose clothing should be confined or restrained.

9. Closed shoes, long sleeves, and long pants are the normal attire for laboratory work.

10. Keep work area clean and uncluttered, with chemicals and equipment being properly labeled and stored.

11. Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the laboratory and this Chemical Hygiene Plan.

12. Access to exits, emergency equipment (fire extinguishers, eye washes), and utility controls (emergency gas shut-offs) shall never be blocked.

13. Ensure that all chemical containers bear the original manufacturers label and safety information and do not remove, damage, or deface that information. If damaged or removed, the original information must be reproduced and affixed to the container;

14. Working containers to which transfers of chemicals from a labeled container occur must be labeled with the product or solution common name, concentration, and the associated hazard warnings (pictograms, NFPA or HMIS labels).

15. Laboratory workers shall be alert to unsafe conditions and shall see that they are corrected when detected.

16. Any spills or accumulations of chemicals on work surfaces shall be removed as soon as possible using techniques that minimize residual surface contamination.

17. Fume hoods and biosafety cabinets must be used properly by ensuring working order. Fume hood sashes must be at proper height, and face remaining outside of the sash plane with work at least 6 inches within the hood sash plane. Do not use the hood for storage of chemicals or appurtenances. Verify the hood is working before use.

18. Be aware of the location and operation of all emergency equipment and protocols including eye washes, emergency showers, first aid and spill control kits, fire extinguishers, alarms, and emergency exit routes.

5.4 GLASSWARE

1. Inspect all glassware before use. Do not use broken, cracked, or badly scratched glassware.

2. Exercise great care in removing frozen glass connections such as stopcocks and ground glass stoppers.

3. When cutting or breaking glass tubing, protect your hands with a thick cloth or gloves. The break point should be well etched and scored. Make the break away from your body. Fire or grit polish the ends to remove sharp edges.

4. When inserting glass tubing into a rubber stopper, lubricate the surface of the glass tubing before insertion using water, glycerine, or stopcock grease.

5.5 ELECTRICALLY POWERED LABORATORY APPARATUS

1. Laboratory workers should know the basic procedures for removing a person from contact with a live electrical conductor.

2. Laboratories should be maintained so that all 110-Volt AC outlet receptacles accept a three-prong grounding plug.

3. Ground fault circuit interrupters (GFCIs) are recommended on selected indoor electric receptacles.

4. Outlets for ventilation hoods should be located outside of the hood to prevent any possible electrical sparks inside of the hood.

5. Electrical cords that provide power to the hood should not be in a path that the cord could accidentally become unplugged.

6. Annual inspections of all electrical cords are strongly recommended.

7. Overload protection should be provided on equipment that is likely to be left on and unattended for long periods of time.

8. Non-sparking induction motors and intrinsically safe equipment should be used in laboratories where volatile flammable materials may be present.

9. Any exposed moving parts (i.e., belts, pulleys) must be equipped with proper machine guards.

5.6 PRESSURIZED AND VACUUM OPERATIONS/COMPRESSED GAS

1. Never use a gas cylinder that does not have a clearly marked label as to its contents. Color-coding is not a reliable means of identification due to the colors from different suppliers.

2. All gas lines leading from a compressed gas supply should be clearly labeled stating: the identity of the gas, the laboratory served, and relevant emergency telephone numbers.

3. Compressed gas cylinders should be firmly secured at all times and placed so that the cylinder valve is easily accessible. Preferably two (2) straps or clamps should be used located at the 1/3 and 2/3 height of the cylinder.

4. Never bleed a cylinder completely empty. Leave a slight pressure to keep contaminants out of the cylinder.

5. Keep a minimal number of cylinders on hand. Always store empty cylinders as though they are full – with caps on. Identify full and empty cylinders as such.

6. Prevent sparks, flames electrical apparatus, or circuits from coming into contact with cylinders.

7. Store flammable and oxidizing gases either twenty feet apart or separated by a half-hour fire wall, five feet high.

8. Use appropriate gauges, fittings, and materials compatible with the particular gas being handled.

9. No more than two (2) cylinders should be restrained by the same strap or chain.

5.7 HOUSEKEEPING

1. Lab areas are to be kept clean and uncluttered. This will help prevent spillage, breakage, personal injuries and unnecessary contact with chemicals.

2. Contaminated glassware should be cleaned daily.

3. Spills shall be cleaned up immediately from work areas and floors.

4. Doorways and walkways within the lab shall not be blocked or used for storage.

5. Access to exits, hallways, emergency equipment, and utility controls shall never be blocked.

6. Chemical containers shall be properly emptied and cleaned prior to disposal. Glass bottles will be uncapped, washed out with an appropriate solvent, triple rinsed with water and placed in a container for disposal.

7. Equipment and instrumentation shall be cleaned to remove spillage and contamination before repair or calibration service is requested, and service personnel will be informed of any hazardous contamination prior to servicing.

8. Laboratory fume hoods are provided for the safety of workers during laboratory exercises and research. These are not to be used for storage of chemicals and appurtenances and such obstacles should be minimized to prevent the disruption of air flow through the fume hood.

9. Chemicals and biologicals are not to be stored or placed on the floor unless in DOT approved packaging or safety containers.

10. If biological agents are being used, the area, surfaces, equipment, and devices must be decontaminated following established cleaning and decontamination procedures. Spills or releases must be cleaned up and the area promptly disinfected.

5.8 EMPLOYEE RESPONSIBILITIES

Laboratory employees are responsible for obtaining approval from the Laboratory Supervisor if any of the following operations will occur:

1. Laboratory operations that will be left unattended.

2. Modification of any established laboratory procedure.

3. Modification to laboratory chemical inventory.

4. Continuation of any laboratory procedure if unexpected results occur.

5. Use of particularly hazardous materials in locations where no engineering controls (e.g., fume hood) are to be used.

6. Any operation for which employees are not aware of the hazards nor are confident in their ability to be adequately protected.

5.9 LABORATORY CONDITIONS AND EQUIPMENT

1. All laboratories and associated rooms or areas must be maintained in a safe condition at all times and be provided with adequate supplies and functioning equipment. Notify the Department, BSU Work Control, or the CHO if any problems or concerns exist.

2. All laboratories must be provided with the following equipment, notices, or materials:

    a. A sign at or on the entry door(s) providing information as to the nature of the hazards therein, the contact person(s), required PPE, and level of admissable entry. Refer to **Chapter 41** of this Plan.
    b. Adequate general and local ventilation for the type of work being performed and the chemicals/biologicals in use. This includes chemical fume hoods and biological safety cabinets as necessary.
    c. Fire extinguisher(s) if any flammable chemicals are stored or handled.
    d. Eye wash / emergency shower(s) if corrosives, or other chemicals or activities make such necessary – this will be the case in nearly all laboratory and art studio/workshop operations.
    e. Chemical and biological spill response kit(s). Special neutralizers may be necessary for some chemicals – aldehydes, hydrofluoric acid, etc. Refer to **Section 11.11 and Chapter 34, Section 7.**
    f. Adequate containers for all chemical substances and wastes that are compatible with the chemicals contained therein and properly labeled;
    g. Safety Data Sheets (SDSs) for all chemical substances stored or used in the laboratory or associated area;
    h. Biological or Pathogen Safety Data Sheets or similar biological information on any potentially infectious agents;
    i. Standard Operating Procedures (SOPs) or lesson plans with similar information for the research or educational activities performed in the laboratory;
    j. A copy (or readily available electronic version) of the BSU Chemical Hygiene Plan;
    k. Laboratory safety training records;
    l. An accurate written or electronic inventory of the chemicals and maximum quantities in the laboratory, studio, or storeroom;
    m. A supply of chemical waste containers and LAB WASTE labels, and,

n. As necessary, broken glass box(es), autoclave containers, biohazard waste bags or boxes, and sharps containers.

3. All exterior windows and interior doors to the laboratory should be kept closed at all times. The general ventilation to laboratories, studios, and stockrooms is maintained under negative pressure to prevent the escape of contaminants or particulates. Similarly, the exhaust velocity of fume hoods and other local exhaust is measured and set with the doors and windows closed.

4. If windows are provided in the laboratory doors, those should not be covered to obscure vision into and out of the room. If necessary for tests or other short periods of time, the windows may be covered for that limited duration.

6.0 CHEMICAL PROCUREMENT, DISTRIBUTION AND STORAGE

6.1 PROCUREMENT

1. Before purchasing any new chemical the following information is to be considered by the Laboratory Supervisor or Safety Officer (and the Department):

    a. Regulatory status of the chemical;
    b. Proper storage, labeling, and handling procedures;
    c. Waste characteristics and proper disposal procedures;
    d. Presence of adequate facilities to handle and store the material safely;
    e. Adequate training for personnel handling the material;
    f. Compatibility and reactivity of the chemical; and,
    g. Whether chemicals of lesser toxicity, reactivity, or flammability may be substituted;

2. The decision to procure a chemical shall be a commitment to handle and use the chemical properly from initial receipt to ultimate disposal;

3. All Material or Safety Data Sheets (MSDSs or SDSs) that are received with shipments to the lab shall be maintained on file at a convenient location as required under this CHP. An MSDS should be requested and kept on file for all hazardous chemicals that are present or used in the lab;

4. No chemical container should be accepted without an adequate identifying label. The label should include, at a minimum, the chemical name and an appropriate hazard warning and target organ effects. The appropriate SDS should be provided by the vendor and included with each substance received unless an SDS for that chemical has already been provided by the vendor and is maintained by the BSU Department or laboratory. If an SDS cannot be located for a particular chemical, one should be requested from the manufacturer or supplier;

5. All chemicals on the Ball State University **Particularly Hazardous Substances List (Chapter 23.3, Appendix III, Table 10)** must have the approval of the Department Chairperson prior to purchase. Prior to purchasing approval, the following must be considered:

    a. Proper storage and handling procedures (SOPs);
    b. Whether facilities are adequate to safely handle the material; and,
    c. Is there a designated area for the PHS use in the laboratory?

6. Avoid purchase of non-recyclable “lecture” size compressed gas bottles whenever possible due to the associated disposal costs for these non-recyclable containers;

7. Pyrophoric chemicals are not allowed to be stored or used in structures or laboratories that are not equipped with an automatic fire suppression system.

8. The Chemical Hygiene Officer will review all hazardous material purchases through SciQuest to ensure that they are appropriate in quantity, destination, and use;

9. Be aware that many chemical substances and biological materials or agents are classified as *Hazardous Materials* under the U.S. Department of Transporation regulations at 49 CFR 171, et.seq. As such they must be classified, packaged, and labeled in accordance with those shipping regulations. Hazardous materials may not be shipped or received by persons who have not had the required DOT Hazardous Material Shipping training which must be repeated every 3 years.

6.2 HAZARDOUS CHEMICAL INVENTORY

Each laboratory will, at least annually, conduct and document a **Hazardous Chemical Inventory**. Preferably, the inventory will be accurately maintained at all times. The inventory shall be in compliance with the *BSU Hazard Communication Program*. An example of the form is provided in **Chapter 25 as Form 6** (or on the BSU **Facilities Planning and Management website in a fillable pdf format**) that may be used or revised for this purpose. This inventory should be kept with this CHP (in **Chapter 29**), or its location referenced there in the laboratory-specific CHP, with a copy of the Inventory to the EHS Office. The inventory must include, at minimum: the chemical/product name, quantity, and the building name and room number. Unused or unwanted chemicals should be identified and properly stored pending disposal.

1. Each department must provide the yearly inventory of their laboratories to the Environmental Health and Safety Office by February 1 for the preceding calendar year.

2. All chemical inventories should be completed on the Ball State University Chemical Inventory Form (**Chapter 25, Form 6**) which may be submitted electronically or as a hard copy. However, The use of the BSU ChemTracker web-based inventory system is preferred.

3. The annual inventory process for chemicals stored in each laboratory, storage room, or waste management area shall ensure container integrity, label maintenance, chemical expiration dates, and provide for the proper segregation of incompatibles and for the disposal of spent, expired, unneeded, or unwanted chemicals, as well as those chemicals that may have become reactive.

Preferably, all laboratories, studios, and workshops will utilize the ChemTracker system, as described in the following Section, for maintaining chemical inventory. If that is

done, the necessary chemical inventory records can be accessed directly by the EHS Office for required reports and the above steps would not be required.

6.3 CHEMTRACKER INVENTORY SYSTEM

BSU is a member of the ChemTracker consortium. Developed and hosted by Stanford University, ChemTracker is a web-based application that can:

1. Maintain accurate inventory of chemicals and other materials;
2. Produce local, state and federal regulatory reports and increase compliance with fire, building safety, and other codes;
3. Enhance safety by quickly providing health, safety, and hazard information to lab personnel, emergency responders, risk managers, and EHS personnel;
4. Numerous search features by single or multiple critera – hazard type, regulations, storage code, building/room location, department, etc.

BSU facility, department, building, and room information have already been entred into the system and all that remains is for any department, shop, or other entity to complete a "People" spreadsheet specifying access to the inventory and a "Chemical Inventory" listing the name, quantity, and location of the individual chemicals or materials. The EHS Office can provide training on the system to interested users.

6.4 DISTRIBUTION OF CHEMICALS AND BIOLOGICS

1. Chemicals to be hand-carried should be placed in a compatible outside container, a bottle carrier, flammable, combustible, or corrosive safety cans, or a corrosive-carrying bucket to protect against breakage, or spillage.

2. When a cart is used to transport chemicals, the cart should be stable under the load and easily manipulated. The chemicals should be secured on the cart in smaller containers or by other means as necessary. Secondary containment for liquids should be provided. Carts with integral secondary containment are preferred, but that can be otherwise provided using plastic tubs.

3. Use freight elevators whenever possible in order to avoid possible exposure to persons on passenger elevators. Do not use a passenger elevator if it is occupied by other persons at the time of transporting the chemical.

4. Verify that the material identity and known hazard information is indicated on the label when a hazardous chemical is transported.

5. The transportation of hazardous chemicals and wastes, by BSU employees in the performance of their University duties, is not normally regulated by the U.S. Department of Transportation, Hazardous Material Regulations. However, the shipping of hazardous materials to off-site locations by commercial carriers is regulated

– including for the shipper. Contact the EHS Office for assistance by a DOT trained individual to ensure proper packaging, labeling, and use of shipping papers for hazardous materials.

6. Hazardous materials may not be transported by employees by motor vehicle unless the following apply (students are not allowed to transport hazardous materials by vehicle):
    a. It is part of a department approved field or research project;
    b. The transportation is done in a state-owned vehicle;
    c. The material is packaged and labeled in accordance with DOT standards for transport;
    d. The employee is trained and knowledgeable about the hazards of the material and how to respond to a release or other incident.

Additional precautions will be required for the transport of any compressed gases – including securing the cylinder and venting of the vehicle interior if carried in the cab.

6.5 STORAGE

1. Stored and working amounts of hazardous chemicals shall be kept to the minimum quantity necessary. Determine the quantity that should be stored in the laboratory by considering the capability of the laboratory workers, the extent of the safety features available, the location of the laboratory, the nature of the chemical operations, and the accessibility of the stockroom or storage room.

2. All primary containers should bear the original manufacturers label. All secondary chemical containers must have a legible and firmly attached label with, at a minimum, the name of the compound and appropriate hazard information. If the container is too small, the name of the compound is sufficient with some other means of identifying the associated hazards (sign, tag, secondary container, placard, etc.).

3. Chemicals shall always be stored in closed containers with which they are chemically compatible.

4. Containers must always be tightly closed except when adding or removing the chemical from the container.

5. Flammable substances must be stored in a safety cabinet or refrigerator designed for flammable liquid storage when required by the Indiana Fire Code (IFC) and International Fire Code (IFC) requirements or recommendations (**Chapter 23.3, Appendix III, Table 2**).

6. Compressed gas cylinders must be properly secured at all times. Cylinder caps should be in place on cylinders when not in use. Use straps, chains, or stands to support the cylinders. Label empty containers as such, replace the cylinder caps, and secure the containers as though they were fully charged. Remember that

"empty" cylinders are designed to maintain some residual pressure and contents.

7. Incompatible chemicals must be segregated. At a minimum, acids, bases, flammables, and oxidizers should be segregated within the laboratory. Nitric acid should be stored separately from organics including solvents and organic acids such as acetic acid. Water reactive materials must be separated from all other chemicals. It is suggested to separate hazardous chemicals in storage following the *Stanford University Compatible Storage Group Classification System* provided in **Table 1** in **Appendix III (Chapter 23.3)**. This is a relatively simple, yet protective, system that is also easily integrated with the ChemTracker chemical inventory information.

8. Food and drink shall not be stored in refrigerators with chemicals, biological agents, or other material.

9. Refrigerators shall be appropriately labeled with respect to any chemical materials stored inside.

10. Highly toxic materials should be stored in a secure manner.

11. Glass or other breakable chemical containers must not be stored on the floor and the storage of any chemicals on the floor is discouraged unless in a secure and protected location away from foot traffic.

6.6 PRIOR APPROVALS REQUIRED

The Laboratory Safety Manager, or the Principal Investigator/Laboratory Supervisor (LS/PI), is responsible for providing institutional notifications and approvals as defined below:

1. Any purchase, possession or use of **Explosive Materials** (as defined by the US Department of Alcohol, Tobacco, Firearms and Explosives) must be approved by the EHS Office, University Public Safety Department, and local Fire Department. Pursuant to 18 U.S.C. 841(d) and 27 CFR 555.23, the Department must publish and revise at least annually in the **Federal Register** a list of explosives determined to be within the coverage of 18 U.S.C. 841 *et seq.* The list covers not only explosives, but also blasting agents and detonators, all of which are defined as explosive materials in that statute. The most recent List of Explosive Materials may be found through the ATFE website at *http://www.atf.gov/publications/explosives-arson/*.

2. Any modification to a chemical fume hood or other laboratory local or general exhaust system must be reviewed and approved Facilities Planning and Management (285-5082) and/or the Environmental Health and Safety Office (285-2807) before it may be used as a means to control exposure to hazardous materials.

3. Any use of hazardous chemicals that may present a hazardous condition due to inadequate ventilation must be reviewed and approved by the Chemical Hygiene Officer prior to initiation of the operation.

4. Any research involving animals must be reviewed and approved by the BSU *Institutional Animal Care and Use Committee (IACUC).*

5. Any possession or use of radioactive materials or radiation-producing devices must be reviewed and approved by the Radiation Safety Officer. Additional information may be obtained by calling 285-8066.

6. Any possession or use in research of Controlled Substances listed as Scheduled drugs by the Drug Enforcement Agency (DEA) requires registration and licensing by the Indiana Board of Pharmacy and the DEA. Additional recordkeeping, background checks, and security will also be required. Contact the EHS Office at 285-2807 in this regard. The purchase or possession of any DEA List 1 or 2 chemicals (precursors) must be reported to the BSU EHS Office and the same record-keeping and disposal procedures followed as required for Scheduled Controlled Substances, though ISBP or DEA licensing or registration is not required for these chemicals.

7. The use of any X-Ray equipment (XRF) or devices (TEM/SEM) must be registered with the Indiana State Department of Health. Training, record-keeping, and dosimetry will be required in some instances for the use of this equipment. Contact the EHS Office at 285-2807 in this regard.

8. Class 3B and Class 4 Laser systems are regulated by OSHA through an ANSI standard. A number of training and safety precautions are required. Contact the EHS Office at 285-2807 in this regard.

9. Any research work involving human subjects must be reviewed and approved by the *Institutional Review Board (IRB)*.

10. Any purchase, possession or use of infectious agents or recombinant DNA molecules must be reviewed and approved by the BSU *Institutional Biosafety Committee*.

11. Treatment (e.g., neutralization, deactivation) or drain disposal of any waste must be reviewed and approved by the Environmental Specialist in the EHS Office. Additional information may be obtained by calling (28)5-2807. The Muncie Sanitary District Ordinance prohibits the discharge of many chemicals to the sewerage system.

12. Any use of respirators must be reviewed and approved by the BSU Respiratory Protection Program Administrator. Additional information may be obtained by calling the BSU Industrial Hygienist in the EHS Office at (28)5-2832.

13. The use of extremely toxic gases must be reviewed and approved by the Department Chair, Laboratory Safety Officer, and the Chemical Hygiene Officer prior to initiation of work. These gases include, but are not limited to:

Arsine and gaseous derivatives	Chloropicrin in gas mixtures
Cyanogen chloride	Cyanogen
Diborane	Germane
Hexaethyltetraphosphate	Hydrogen cyanide
Hydrogen selenide	Nitric oxide
Nitrogen dioxide	Nitrogen Tetroxide
Phosgene	Phosphine

7.0 HAZARD IDENTIFICATION AND LABELING

The consistent and legible identification of chemical hazards and labeling of chemical containers is a major requirement of the OSHA *Laboratory Standard* and necessary for the safe hazard identification, transportation, handling, storage, use and disposal of chemicals in the laboratory.

In laboratories the primary means of ensuring general hazard identification and recognition of specific chemical hazards is through the availability and review of Safety Data Sheets (SDSs) and sound container labeling practices. It is very important to implement consistent labeling standards that all affected employees understand. To achieve this goal, container labeling shall follow the rules below:

7.1 GLOBALLY HARMONIZED SYSTEM

The UN *Globally Harmonized System of Hazard Classification and Labelling (GHS)* was adopted by the U.S. OSHA, having been adopted earlier by the U.S. Department of Transportation (U.S. DOT) and many other countries as an international system. This system will replace the former Material Safety Data Sheets (MSDSs) with a new, more standardized, Safety Data Sheet (SDS). The SDSs must have 16 Sections in a defined order with information found in each section to be consistent between the SDSs for different products and between different manufacturers and distributors regardless of country of origin. A brief summary of this new system is provided in **Chapter 38** with specific information relative to SDSs and labeling provided or referenced in the following Sections of this Chapter.

7.2 SAFETY DATA SHEETS (SDSs)

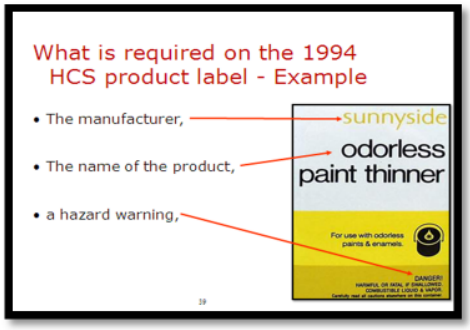
SDSs for all chemical substances in the laboratory must be made readily available at all times for all laboratory personnel and students in the laboratory. All BSU staff, faculty, researchers, and students must also receive training in how to read and interpret the SDSs and the accordant labelling practices for chemical containers.

Information on the new GHS required SDS format and content is provided in **Chapter 39.**

7.3 ORIGINAL (PRIMARY) CONTAINER LABELS

Hazard Communication Standard: Original (primary) containers of chemicals as purchased from the supplier or manufacturer must contain, at a minimum, the following labeling information, and these procedures must be followed:

1. Chemical identity or product name.
2. Appropriate hazard warnings (e.g., pictograms, symbols, statements, NFPA or HMIS label providing health, flammability, reactivity hazards, *etc.*).
3. Name and address of chemical manufacturer or responsible party.



4. Often, labels will include supplementary safety information including a written description of hazards, first aid, and disposal guidelines. If so, this information should be maintained.
5. Original container labels must be protected so that the identity of the contents and the hazards those contents present are known. All laboratory workers will ensure that original container labels are legible, not removed, or defaced *unless the container is emptied of all original contents and rinsed out.*
6. If the original container label is damaged or defaced, it must be replaced with a label bearing the same information, or be placed in a secondary container.

Label needing replacement

Globally Harmonized System (GHS) Standard: Under the new OSHA GHS Standard, original (primary) containers of chemicals as purchased from the supplier or manufacturer must contain additional information. At a minimum, the following six elements must be provided on all primary containers from distributors that are shipped after December 1 of 2015:

A new visual feature of the GHS labels is the pictogram. There are nine (9) of these symbols, each signifying different health or physical hazards as shown below:

Health Hazard	Flame	Exclamation Mark
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non Mandatory)
Gas Cylinder	**Corrosion**	**Exploding Bomb**
• Gases under Pressure	• Skin Corrosion/burns • Eye Damage • Corrosive to Metals	• Explosives • Self-Reactives • Organic Peroxides
Flame over Circle	**Environment**	**Skull and Crossbones**
• Oxidizers	• Aquatic Toxicity	• Acute Toxicity (fatal or toxic)

Chapter 40 of this *Chemical Hygiene Plan* further describes the meaning of these pictograms and related hazard classifications which are integral to the new United Nations hazard classification system. This system has been adopted by U.S. OSHA and is in use by a number of other countries, all seeking uniformity in classification of hazards, container labelling, and the content and order of Safety Data Sheets.

7.4 SECONDARY CONTAINER LABELS

Secondary or "working" container labels must also be labeled with certain information under both the older and the new GHS Standard in all workplaces. At a minimum, the secondary container must (1) identify the chemical or solution by common name and (2) provide the appropriate hazard warnings for the substance. Several hazard identification systems are available and are discussed in **Section 7.5** to come. The two most common workplace container labels are shown below with the National Fire Protection Association (NFPA) system on the left and the Hazardous Materials Information System (HMIS) on the right. The two systems are similar in that each has a hazard rating system of 0-4 with "4" representing the greatest hazard. Additional information on each of these hazard label systems is provided in Section 7.5 of this Plan.

Remember: In addition to the hazard warning provided by these label systems, any Secondary Label must also show the product name or identity of the substance!

The new GHS pictograms may also be used to signify the hazards presented by the chemical or solution – either singly with a product identifier or on a label that also has space for the chemical name as shown below:

Normally, the information necessary to complete any of these hazard warning systems is available on the chemical's Safety Data Sheet.

Important Note: In laboratories and studios though, if a chemical substance is freshly prepared or is to be stored in a container other than the original manufacturer's bottle, the following information must also be available on the container (in addition to the above information):

1. Concentration or approximate purity (*e.g.*, molarity, normality, percent, *etc.*);
2. Date of formulation;
3. Name of user; and,
4. Chemical substances developed in the laboratory shall be assumed to be hazardous in the absence of other information. Chemical mixtures or solutions, unless reaction results are otherwise known or verified, should, at a minimum, be considered to retain the greatest hazard characteristics of each of its components.

7.5 SDSs AND GENERAL CHEMICAL LABELING REQUIREMENTS

Safety Data Sheets (SDSs) for hazardous chemicals in a given laboratory shall be readily available to all employees in that laboratory by accessing a MSDS database or files with an accessible computer or with hard copies which are accessible and convenient. All laboratory personnel (and students) must be made aware of the location of the MSDSs and the means for their rapid retrieval and review.

1. If a chemical substance is produced in the laboratory for another use outside of the laboratory, the MSDS and labeling provisions of the *OSHA Hazard Communication Standard* and this CHP apply. The Laboratory Supervisor / Principal Investigator shall ensure these requirements are met.

2. The OSHA exemptions from labeling requirements for chemical transfers from a labeled container into a container that is intended only for the immediate use of the employee who performed the transfer do not apply in laboratory or studio situations. The number and variety of chemical containers and close proximity of laboratory workers in laboratories, art studios, and workshops does not allow for use of that exemption for general workplaces.
3. Laboratory areas that have special or unusual hazards (radiation, x-ray, laser operations, flammable materials, biological hazards, etc.) should be posted with the appropriate warning signs. This signage may be in addition to the BSU Laboratory door signs to be affixed at entry ways in order to fulfill specific regulatory requirements.

7.6 WASTE LABELS

Laboratory Waste Labels: All wastes, from laboratories, or general industry, must undergo a "waste determination" by the generator to determine whether or not they constitute a "hazardous waste" as defined by the federal Resource Conservation and Recovery Act (RCRA). Significant penalties may be applied for failure to correctly make this determination or handle, store, and dispose of the wastes properly. As considerable training or expertise may be necessary to accurately make such a determination, BSU follows the RCRA Subpart K standard specific to academic laboratories.

Under this approach, all chemical (and for our purposes, biological) wastes generated in laboratories are considered "LAB WASTES". Briefly, several rules apply to this program:

1. Laboratory personnel generating wastes must receive training in these procedures;
2. All *Lab Wastes* must be kept in closed containers that are compatible with the contents;
3. A Lab Waste label must be affixed to the container when waste is first deposited into the container or at the time a container is determined to be a waste and the "start of accumulation date" recorded;
4. The *Lab Waste* label informationmust be completed so that lab staff, emergency responders, and waste managers are aware of the health and physical hazards presented by the waste and so that adequate information is conveyed to make the required hazardous waste determination;
5. All *Lab Waste* containers must be removed from the laboratory no longer than six (6) months following the "start of accumulation" date;
6. Waste managers must have additional training in order to make the "hazardous waste determination", although the lab staff may declare the waste to be a "hazardous waste" on their own, if desired, by checking the appropriate box.

Below is the *Lab Waste* label that must be completed and affixed to all containers of wastes generated in laboratories or art studios next to a completed example:

LAB WASTE

Accumulation Start Date: _____

Dept:_____Bldg/Rm:_____

Contact:_____Phone:_____

Waste Name: _____

Chemical Waste Composition %

_____ ____

_____ ____

_____ ____

_____ ____

_____ ____

_____ ____

_____ ____

Hazard properties (check any known):

☐ Toxin/Poison ☐ Heavy Metals: ____ ppm

☐ Flammable ☐ Oxidizer ☐ Pharmaceutical

☐ Corrosive: pH ____ ☐ Listed Const.:_____

☐ Reactive to: ☐ air ☐ water ☐ shock

☐ Cyanides: ____ ppm ☐ Sulfides: ____ ppm

☐ Carcinogen ☐ Irritant ☐ Sensitizer

☐ Solvents ☐ Chlorinated solvents

☐ Biohazard ☐ Peroxide former

Other: _____

EHS Use Only (unless known): Date:_____

☐ **Hazardous Waste or** ☐ **Non-Hazardous?**

Wastes must be removed within 6 months!

Contact the EHS Office (tlrussell@bsu.edu, or 5-2807) with questions or for pickup.

LAB WASTE

Accumulation Start Date: *1-10-14*

Dept: *Chem* Bldg/Rm: *CP492*

Contact: *C. Cardinal* Phone:*5-1241*

Waste Name: *Spent Solvent/Cleaner*

Chemical Waste Composition %

Acetone *30*

Methanol *25*

Acetic Acid *10*

Water *35*

Hazard properties (check any known):

☐ Toxin/Poison ☐ Heavy Metals: ____ ppm

✓ Flammable ☐ Oxidizer ☐ Pharmaceutical

✓ Corrosive: pH *3.8* ☐ Listed Const.:_____

☐ Reactive to: ☐ air ☐ water ☐ shock

☐ Cyanides: ____ ppm ☐ Sulfides: ____ ppm

☐ Carcinogen ☐ Irritant ☐ Sensitizer

✓ Solvents ☐ Chlorinated solvents

☐ Biohazard ☐ Peroxide former

Other: *F003 listed hazardous waste*

EHS Use Only (unless known): Date:_____

✓ **Hazardous Waste or** ☐ **Non-Hazardous?**

Wastes must be removed within 6 months

Contact the EHS Office (tlrussell@bsu.edu, or 285-2807) with questions or for pickup.

Our purpose here is only to introduce this label. **Chapter 16, Section 16.1, of this Plan** provides detailed information regarding this process, hazardous waste identification, labeling, handling, and disposal. The written *BSU Laboratory Waste Management Plan* and the more general *BSU Waste Management Guide* (**Chapter 33**) should also be reviewed.

Other Waste Labels: Other (non-hazardous) waste labels may be required or advisable (mercury-contaminated articles, PCB-containing items, etc.), for particular chemicals or items. Examples of several such labels are provided below:

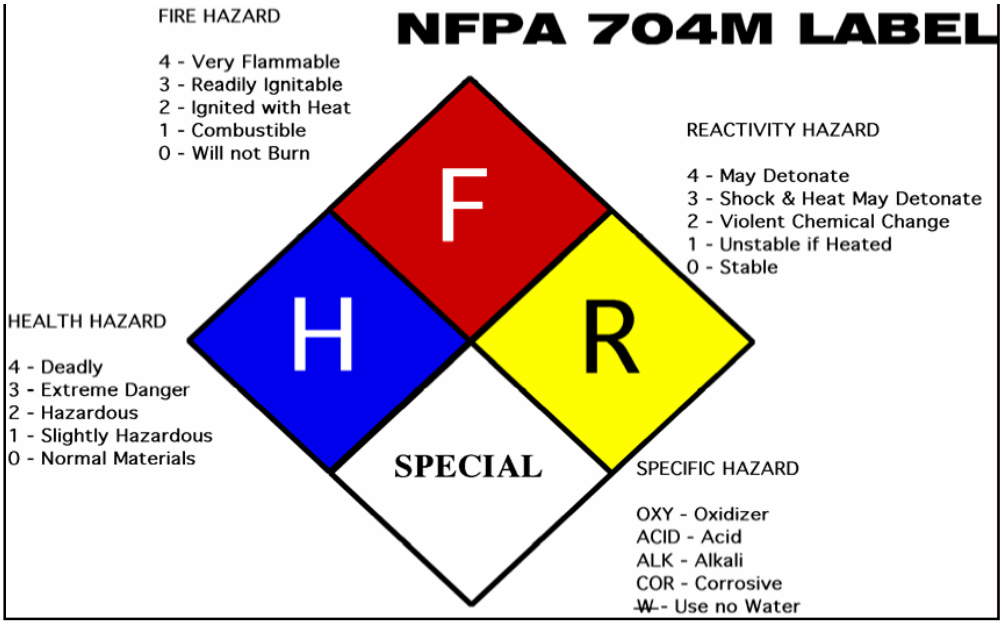
The EHS Office should be contacted regarding the proper labeling of waste containers, as well as to arrange for their proper disposal. The management of such waste materials are discussed in **Chapter 16** of this Plan.

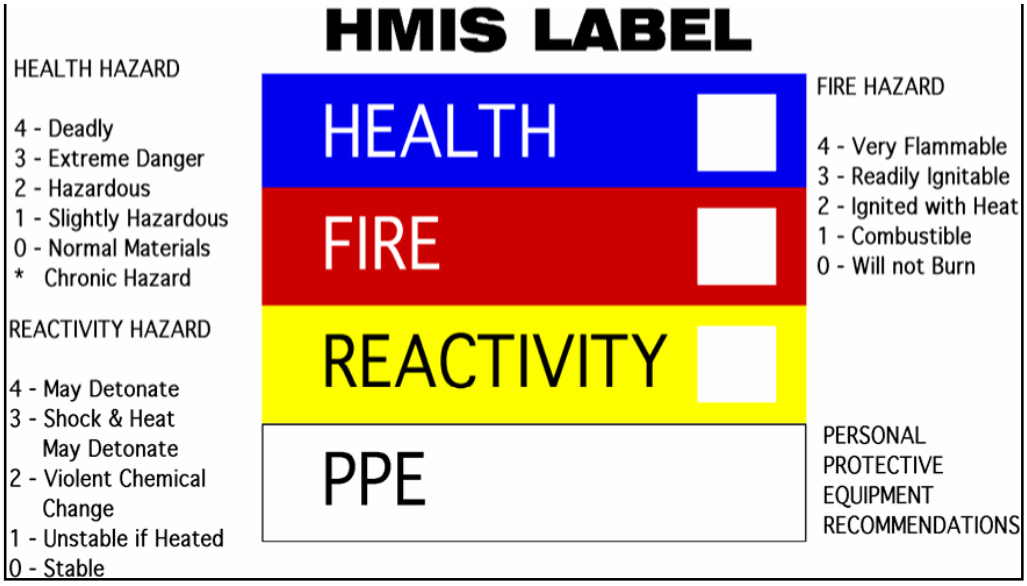
7.7 HAZARD LABELS AND SYSTEMS

As presented in the preceding **Chapter 7.3,** the University will predominantly be using the ***National Fire Protection Association (NFPA),*** the ***Hazardous Material Information System (HMIS),*** or the more recent ***Globally Harmonized System Pictograms*** to convey the physical and health hazards presented by materials in containers, tanks, or areas. Hazard labels are to be provided on chemical or biological containers that are not correctly labeled, on items that do not have the original labels, or to denote the hazards presented in speciric rooms or areas.

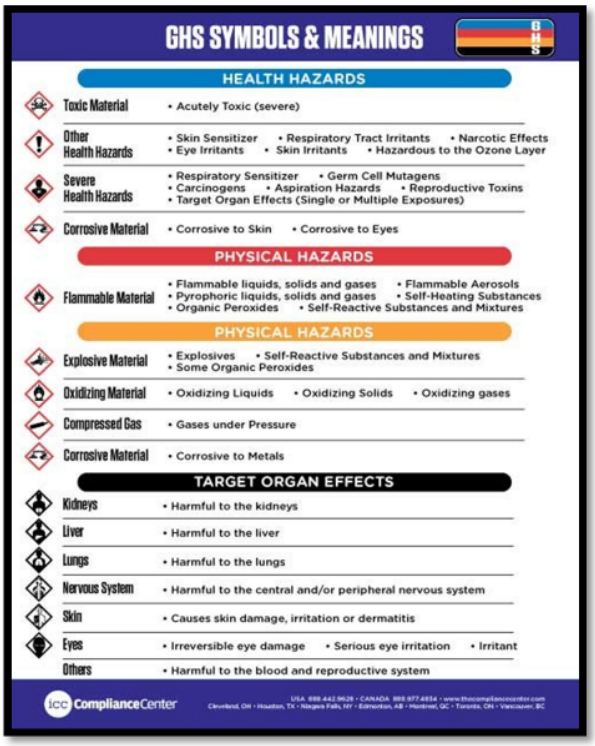
Both the NFPA and HMIS systems include numerical ratings for the acute health, flammability and reactivity hazards. These are expressed in the color-coded **HEALTH**, **FIRE**, **REACTIVITY** and **SPECIAL** boxes. The HMIS also allows assignment of the required personal protective equipment for use of, or exposure to, the particular chemical substance.

The nature and degree of these hazard classes is shown on the following label pictures for both the NFPA and HMIS systems:

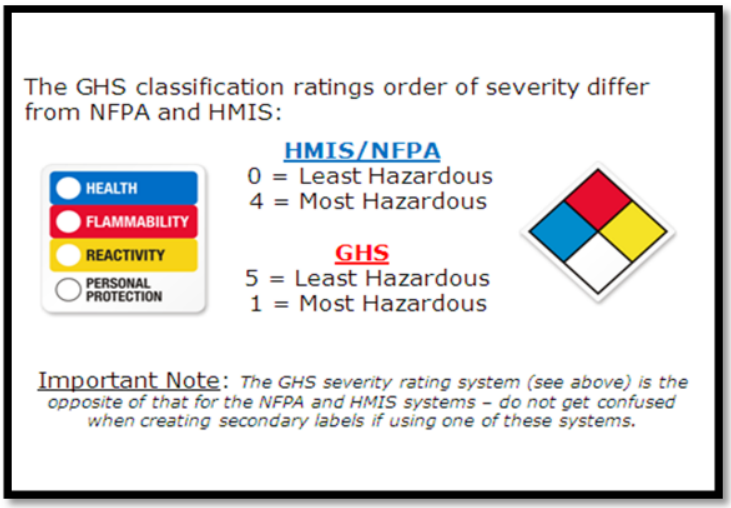




The most recent labeling system utilizes the Globally Harmonized System (GHS) pictograms:



A critical note is that the GHS and the NFPA/HMIS systems have an important hazard ranking difference. The GHS labeling system does not include numeric hazard rankings, relying instead on the pictograms themselves to identify the nature and degree of the hazard. As noted on GHS Safety Data Sheets though, the physical and health hazards of a particular substance do have rankings. However, these rankings vary from 1 to 5 with the "1" denoting the greatest hazard, whereas the NFPA and HMIS label systems rank the degree of hazard from 0 to 4 with "4" representing the greatest hazard.



Numerous other container labeling systems exist, some of which are proprietary or offered by particular chemical supply houses. Any of these labeling systems may be acceptable if they are better suited to particular lab or studio activities, so long as laboratory staff and students are trained in their use, the particular information conveyed, and its meaning.

The use of DOT labels to identify the hazards of a particular chemical may also be acceptable, and these are often received on shipping containers and gas cylinders. It is not recommended, however, that BSU personnel apply these labels for hazard recognition in the laboratory or workplace. These would normally only be applied by BSU staff who are DOT-trained in the shipping of hazardous materials and applied to containers or packages that will be shipped in commerce.

DOT Shipping Labels:

Notes

(a) If you have unlabeled or unidentified containers with chemicals, please contact your Departmental Laboratory Supervisor or the EHS Office for assistance. DO NOT bring chemicals onto BSU property from outside sources for personal use.

(b) Employees are not to use or handle hazardous chemicals that are not properly labeled, for which a MSDS is not available, or which presents hazards for which the employee has not been trained. The EHS Office should be contacted if such a situation arises.

(c) Remember that no chemical labeling system portrays all of the potential hazards that may be associated with the chemical. The label may provide only general guidance for immediate reference, or the most immediate hazard. The MSDS should be sought and reviewed to identify all of the potential hazards of the chemical and use and exposure precautions.

7.8 IDENTIFICATION OF OTHER HEIGHTENED CHEMICAL HAZARDS

Laboratory Safety Officers, PIs, or Laboratory Managers are also responsible for identifying the following hazardous chemicals (Particularly Hazardous Substances, and chemicals with unknown hazards and characteristics) that are required to be used in an area specially designated for such use:

1. Select Carcinogens;

2. Reproductive toxins;

3. Acute toxins; and

4. Unknowns: Chemicals which are synthesized in the laboratory and which are byproducts for which the composition and/or health or physical hazards are unknown.

The identification of the first three of these categories of chemicals in the laboratory, *Select Carcinogens*, *Reproductive Toxins*, and *Compounds with a High Degree of Acute Toxicity,* is important as, under the *OSHA Laboratory Standard,* they are *Particulary Hazardous Substances*. These are substances that pose such significant threats to human health that the *Standard* requires special provisions be established to prevent harmful exposure of researchers, faculty, or students. The enhanced precautions necessary when handling these chemicals are described in Chapter 18 of this Plan and a listing of their identities is provided in **Chapter 23.3, Appendix III, Table 10.**

8.0 EXPOSURE INCIDENTS AND MONITORING

All employees must follow the directions on the container, in the SDS/MSDS, or in the Standard Operating Procedure (SOP) for the actions or precautions to be taken in the event of an exposure to any chemical, biological, or radioactive substance. OSHA has established "Permissible Exposure Limits" (PELs) for laboratory employees' exposures to certain regulated substances. Other organizations, including National Institutes for Occupational Safety and Health (NIOSH) and the American Conference for Governmental Industrial Hygienists (ACGIH) have also developed occupational exposure levels for specific substances that may be referenced. Exposure levels to certain chemical substances must be determined and monitored under certain circumstances according to OSHA regulations. A medical surveillance program may also need to be established for certain specified employees whose work assignments involve regular and frequent handling of toxicologically significant quantities of a chemical. In addition, the BSU Environmental Health and Safety Office, at the request of the Laboratory Safety Officer or Chemical Hygiene Officer, is responsible for making determinations regarding the conduct of, or requirements for, area and/or personal exposure monitoring in specific circumstances.

PELs are specified in the **OSHA regulation 29 CFR 1910, Subpart Z Toxic and Hazardous Substances** (see **Chapter 23.3, Appendix III, Table 12**). In addition, PELs are usually indicated on the SDS/MSDSs, and can be obtained from the BSU EHS Office.

These limits are defined as:

Eight-hour time weighted average (TWA)

The average concentration to which an employee may be exposed to a particular chemical for up to eight hours per day, five days per week.

Short Term Exposure Limit (STEL)

The average concentration to which an employee may be exposed to a particular chemical for up to fifteen minutes per day.

Ceiling (C) limit

The maximum concentration to which an employee may be exposed to a particular chemical at any time.

Immediately Dangerous to Life or Health (IDLH)

Condition that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment. Workers should not be exposed to such an environment without proper personal protective equipment.

Often, a notation of *Skin* is printed with an exposure limit. This indicates that skin absorption of that chemical occurs readily which would contribute to an employee's overall exposure. Employee exposure to dermal absorption of chemical substances can often be monitored through the use of biological testing.

8.1 EXPOSURE INCIDENTS

The University has established procedures for responding to job-related injuries. These procedures should be followed in the event of hazardous exposure due to the use of hazardous chemicals in the laboratory.

Examples of events or circumstances which might result in hazardous exposure include:

1. A spill, reaction, or leak which rapidly releases a hazardous chemical in an uncontrolled manner;
2. Direct skin or eye contact with a hazardous chemical;
3. Ingestion or inhalation of a chemical.

Examples of occurrences that may indicate exposure to a chemical include the following:

1. Symptoms such as headache, rash, nausea, tearing, irritation or redness of eyes, irritation of nose or throat, dizziness, loss of motor dexterity or judgement which disappear when the employee is removed from the exposure area and which reappear when the employee returns to working with the same hazardous chemical;
2. Two or more employees in the same laboratory work area exhibit similar symptoms; or
3. Exposure monitoring indicates exposures above regulated or recommended limits.

If an employee is exposed to a chemical and the exposure results in an injury or illness that requires treatment by medical personnel:

1. Ensure that medical personnel see the individual immediately;
2. Provide a copy of the SDS to the medical personnel involved. Along with the SDS, provide any additional information you have on the chemical, its concentration, and when, where, and how it was used and how the exposure occurred.
3. If the exposure was to a secondary chemical or compound, provide all available information from the labeled container(s).
4. Clean up any incidental spillage and/or notify the EHS Office so that the incident can be investigated, and any necessary spill control quickly undertaken.

8.2 ACCIDENT REPORTING

The following procedure governs the reporting of accidents, injuries, or illness incidents at Ball State University:

Work Related Accidents/Illnesses and Worker's Compensation

This contains important information about procedures for handling **work related injuries or illnesses** that occur in the Ball State work environment.

Reporting an Accident

Accident reports should continue to be completed by the injured employee's supervisor and should be forwarded to the Health Center within twenty-four (24) hours of the accident's occurrence. The Health Center FAX number is 285-1103.

Regardless of the nature or severity, all injuries incurred when on the job must be reported to supervision at once, during the same shift on which the injury occurred. The Health Center provides and/or directs the medical care for employees injured on the job. The Health Center hours are 8:00 a.m. to 4:30 p.m. Monday, Thursday, and Friday and 9:00 a.m. to 6:30 p.m. on Tuesday and Wednesday. The doors lock and last patients are accepted at 4:30 p.m. and 6:30 p.m. respectively.

Accident Report Form

The accident report form to document all on-the-job injuries can be printed from HR Forms on the BSU website: HR Forms

Form: Worker's Compensation First Report (of Employee Injury/Illness)

Medical Treatment

Employees injured outside Health Center operating hours who are in need of immediate medical treatment but whose injuries are not so severe as to warrant Emergency Room treatment, should be referred to the US HealthWorks medical clinic on 3911 W. Clara Lane which is open 8:00 a.m. to 8:00 p.m. seven days a week, except major holidays. After Health Center and US HealthWorks hours or due to the severity of the injury, such injured employees should be referred to the IU-BMH Emergency Room which is open twenty-four (24) hours a day every day.

The right to direct the medical treatment of employees injured on the job is retained by the University. Therefore, the decision of when and where to send an employee for medical treatment will be made by the person in charge of the affected employee's shift based on the nature and extent of the injury. If an employee is referred to US HealthWorks or the Emergency room, the person in charge of that shift who made the referral should leave a voice mail message for Employee Relations at 285-1823, so that the University may begin to manage the worker's

compensation claim and verify worker's compensation coverage when contacted by the medical provider on the next business day.

If an employee is referred outside of the University for emergency treatment, the employee must follow-up at the Health Center the next day the Health Center is open. Although US HealthWorks or the Emergency Room clinics may advise the employee to return there or to his/her personal physician for follow-up treatment, such non-emergency visits are not covered by worker's compensation.

Departmental Regulations

In addition, specific internal departmental regulations for handling and reporting on the job injuries should continue to be followed.

Contact Us

Questions regarding worker's compensation or on the job injuries should be directed to Diane Drake at e-mail address lddrake@bsu.edu, or at 285-1823.

8.3 EXPOSURE REPORTING

As indicated above, and in addition to any injury reports for Human Resources, all incidents of hazardous exposure (including disposition) or accidents resulting in injury should be reported to, and documented by, the BSU Chemical Hygiene Officer. If no further assessment of the incident is deemed necessary, the reason for that decision should be included in the documentation. If the event is determined to require investigation, a formal exposure assessment or incident investigation will be initiated by the CHO. The purpose of an exposure assessment or investigation is not to determine whether there was a failure to follow proper procedures, but to identify the hazardous chemical(s) involved and determine whether an exposure might have caused harm to an employee. An exposure assessment may include the following items:

1. Interviews with the employee and complainant (if different);
2. Obtaining the following information:

    - The names of chemicals which may be involved
    - Other chemicals used by the employee
    - All chemicals used by others in the immediate area
    - Other chemicals stored in the immediate area
    - Symptoms exhibited or claimed by the employee comparison of symptoms with those referenced in the Material Safety Data Sheet for each involved chemical

- Observation of control measures and personal protective equipment in use during the event
- Notation of any on-site exposure monitoring performed previous to or during event

3. Monitoring or sampling the air or surfaces in the area for suspect chemicals (when appropriate); and
4. Determination of whether the current control measures were adequate during the time of the incident.
5. Completion of an **Incident Report** (see **Chapter 25, Form 5,** for the form) on the accident, exposure, release, or spill and submittal to the Chemical Hygiene Officer.

8.4 ENVIRONMENTAL MONITORING

The Chemical Hygiene Officer and the EHS Industrial Hygienist will be responsible for environmental monitoring in the laboratories.

1. The Laboratory Supervisor or Principal Investigator should request employee monitoring if it is believed that action levels or PELs may potentially be exceeded for any chemicals, biological agents, or physical contaminants.

2. Employee exposures to any substance regulated by an OSHA standard will be measured when there is reason to believe that exposure levels routinely exceed the action levels or PELs specified in **Chapter 23.3, Appendix III, Table 12**. Recommended exposure limits developed by the ACGIH or NIOSH may also be reviewed and exposure monitoring performed relative to those substances or recommended exposure levels.

3. Certain toxic substances (29 CFR 1910.1000 et.seq.) may require initial exposure determinations depending on their use or presence. These standards are not replaced by the OSHA *Occupational Exposure to Hazardous Chemicals in Laboratories* standard. Users of these materials are expected to adhere to the provisions of all applicable substance-specific standards if employee exposure routinely exceeds the OSHA-mandated permissible exposure limit (or Action Level, if specified). Among these are the following elements or compounds (see 29 FR 1910.1001, et.seq. for specific standard as shown below):

Asbestos, tremolite, anthophyllite and actinolite	.1001
4-Nitrobiphenyl	.1003
alpha-Naphthylamine	.1004
4,4'-Methylene bis(2-chloroaniline)	.1005
Methyl chloromethyl ether	.1006
3,3'-Dichlorobenzidine (and salts)	.1007
bis-Chloromethyl ether	.1008

beta-Naphthylamine	.1009
Benzidine	.1010
4-Aminodiphenyl	.1011
Ethyleneimine	.1012
beta-Propiolactone	.1013
2-Acetylaminofluorene	.1014
4-Dimethylaminoazobenzene	.1015
N-Nitrosodimethylamine	.1016
Vinyl Chloride	.1017
Arsenic (inorganic)	.1018
Lead	.1025
Cadmium	.1027
Benzene	.1028
Cotton dust	.1043
1,2-Dibromo-3-chloropropane	.1044
Acrylonitrile	.1045
Ethylene oxide	.1047
Formaldehyde	.1048
4,4'-Methylenedianiline	.1050
Methylene Chloride	.1052
Non-Asbestiform tremolite, anthophyllite and actinolite	.1101

The University may need to document through exposure and engineering studies, or by monitoring, that the action levels for these particular compounds are not exceeded under routine use by employees. The word "routine" is intended to convey a situation that would be similar to an industrial setting where the ambient concentration of a substance is at a characteristic level as a result of the workplaces conditions and the particular process(es) involved.

5. Employee's exposures to OSHA regulated substances shall not exceed the permissible exposure limit (PEL) specified in 29 CFR (Code of Federal Regulations) Part 1910, subpart Z. Refer to **Table 16, Chapter 23.3, Appendix III, Table 12**. Absent a promulgated standard for a particular chemical, standards of other recognized professional agencies such as TLVs adopted by the ACGIH, or RELs by NIOSH, may be consulted.

6. Monitoring results shall be provided to the Department, the Chemical Hygiene Officer, the Principal Investigator, and to the employee(s) following receipt and quality assurance review.

SUMMARY: EMPLOYEE EXPOSURE MONITORING

NOTE: Employee (and student) exposure determinations shall be done in accordance with paragraph (d) of 29 CFR 1910.1450.

INITIAL MONITORING
Initial monitoring will be performed if there is reason to believe that exposure levels for an OSHA-regulated substance routine ly exceed the action level or, in the absence of an action level, the permissible exposure limit (PEL).

The Permissible Exposure Limits for OSHA-regulated substances can be found in 29 CFR part 1910, subpart Z as indicated below:

TABLE Z-1 Limits for Air Contaminants. – 1910.1000 TABLE Z-1
TABLE Z-2 – 1910.1000 TABLE Z-2
TABLE Z-3 Mineral Dusts – 1910.1000 TABLE Z-3

PERIODIC MONITORING
Periodic monitoring will be conducted if the initial monitoring performed demonstrates employee exposure over the action level (or in the absence of an action level, the permissible exposure limit). Ball State Unviersity shall immediately comply with the exposure monitoring provisions of the relevant standard. Please refer to Section 9 "Medical Program" for more information.

Within 15 working days after the receipt of any monitoring results, the employee will be notified of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

Any Ball State University employee (or student) with a reason to believe that exposure levels for a substance exceed the action level or, in the absence of an action level the PEL, may initiate the monitoring process. Monitoring can be requested by calling the Environmental Health and Safety Office at 765-285-2807.

9.0 MEDICAL PROGRAM

9.1 GENERAL PROVISIONS

The BSU Medical Program includes the following provisions and requirements

1. An opportunity for medical surveillance, including medical consultation and follow-up, shall be provided under the following circumstances:

    a. Where exposure monitoring of contaminant concentrations exceeds the action level for an OSHA regulated substance that has medical surveillance requirements;

    b. Whenever an employee is exposed to or working at contaminant concentrations exceeding OSHA PELs or other recognized exposure standards;

    c. Whenever a laboratory employee develops signs or symptoms that may be associated with a hazardous chemical, radiological, or biological agent to which the employee may have been exposed to in the laboratory;

    d. Whenever two (2) or more laboratory employees exhibit similar exposure symptoms following work or exposure;

    e. Whenever a spill, leak, or explosion results in the likelihood of a hazardous exposure, as determined by the Chemical Hygiene Officer;

    f. To all employees required to wear a respirator; and,

    g. To all emergency spill and exposure response team members.

2. All examinations shall be provided by, or under the supervision of, a licensed physician, at no cost to the employee, without loss of pay, and at a reasonable time and place. A physician experienced in occupational medicine shall be used whenever possible. Normally, the service is provided by the BSU Health Center.

3. First aid kits with contents approved by the EHS Department will be supplied by the Department having principal control of the laboratory. First aid kits (**see Section 11.7**) will be maintained and checked periodically for expired or missing items. Immediate medical assistance, if required, is available through the University Police (call 5-1111) or 911. It is strongly recommended that

laboratory personnel maintain proficiency in First Aid, including CPR and Bloodborne Pathogen protocols, through training courses offered at BSU.

4. Where medical consultations or examinations are provided, the examining physician shall be provided with the following information:

    a. The identity of the hazardous chemical(s) to which the employees may have been exposed.

    b. A description of the conditions under which the exposure occurred including quantitative exposure data, if available.

    c. A description of the signs and symptoms of exposure that the employee is experiencing, if any.

5. For examinations or consultations provided to employees, a written opinion from the examining physician shall be obtained by the Laboratory Supervisor and the Chemical Hygiene Officer. It shall include:

    a. Recommendations for further medical follow-up;

    b. Results of the examination and associated tests;

    c. Any medical condition revealed that places the employee at an increased risk of exposure to a hazardous substance found in the workplace; and,

    d. A statement that the employee has been informed of the results of the examination or consultation.

9.2 ACCIDENTS

1. Laboratory accidents that involve a personal injury that appears to require medical assistance should be immediately reported to the University Police (call 5-1111 or 911).

2. Personnel responding to any injury that appears to require emergency first aid shall notify the Laboratory Supervisor or Safety Officer at the first, safe opportunity.

3. An Incident Report form (see **Chapter 25, Form 5**) must be filed with the Department and the Chemical Hygiene Officer for any laboratory accident involving personal injury. A BSU Injury report must also be completed if any injury occurs for which medical attention beyond minor first aid is needed (see Section 8.2)

4. If a spill or incident represents a hazard to other building occupants, it should be reported immediately to them, the Chemical Hygiene Officer, and to the University Police.

5. Serious and reported accidents and near-accidents shall be investigated by the Department, Laboratory Supervisor, and the CHO. Results will be communicated to the Department and will be recorded.

10.0 PERSONAL PROTECTIVE EQUIPMENT

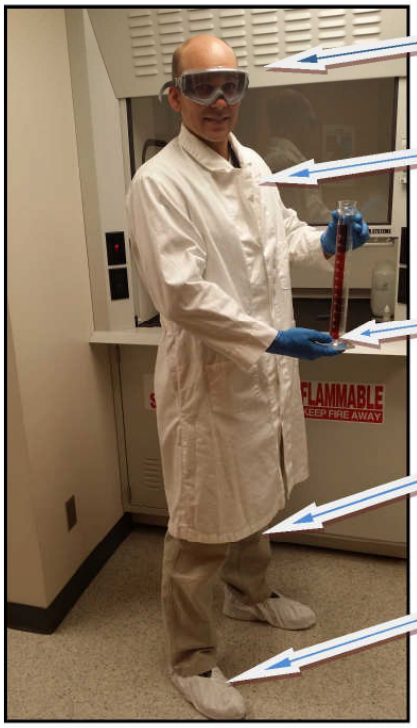
The OSHA Laboratory Standard, and normal safety practices, require that before Personal Protective Equipment (PPE) is employed in laboratories that all efforts be made to first control the exposure of employees (and students) to contaminants or injury through the use of engineering (i.e., ventilation, barriers, safety cabinets) or administrative controls (i.e., product substitution, proper housekeeping, work rotation, training) .

The Laboratory Supervisor will be responsible (with technical assistance from the CHO and BSU EHS Office) for performing the necessary hazard assessments, specifying work paractices and engineering controls where possible; and, when necessary, selecting additional personal protective equipment, acquiring approved equipment, maintaining availability, and establishing equipment cleaning and disposal procedures as defined in appropriate SOPs and the Job Hazard Assessment (See **Chapters 21 and 26** of this document pertaining to SOPs **and Forms 3 and 4 of Chapter 25** regarding prevention of job hazards). Laboratory workers should be advised on the proper selection, use and limitations of personal protective equipment and be thoroughly trained in the use of such equipment, before they are allowed to use the equipment or be potentially exposed to any chemical hazards. Personal protective equipment, excluding safety glasses and shoes, should be removed when leaving work areas.

The baseline PPE required for work or presence in active laboratories, chemical/biological storerooms, and lab preparation rooms is exhibited on the following two (2) pages. This standard equipment may be modified based on hazard assessments performed as described above. Further, adjustments or replacements to the required PPE may be justified in certain instances – e.g., long-sleeved smocks or gowns in art studios in lieu of lab coats.

Following the Selection Guide are more detailed requirements for the various types of PPE, their selection, and use.

BSU Laboratory PPE Selection Guide



- Safety Glasses or Goggles
- Lab Coat
- Chemically Resistant Gloves
- Long Pants
- Closed Toe Non-mesh shoes (or resistant covers)

Standard Personal Protective Equipment (PPE) for Laboratory Work with Hazardous Chemicals or Biosafety Level 2 or Above.

The PPE shown on the left should be modified as prescribed in the *Laboratory PPE Selection Guide* attached -- or as determined by a hazard assessment of the work being performed and the chemicals, biological agents, or other materials or equipment being used in the laboratory or procedure.

1. Cotton clothing that provides protection from chemical spills should be worn. Clothing which completely covers the legs must be worn at all times in the laboratory. Shorts and skirts that do not completely cover the leg are inappropriate apparel in the laboratory and are not permitted. Synthetic fabrics should be avoided.
2. Wear shoes which completely cover the feet. Sandals, perforated shoes, open-toed shoes, open-backed shoes, or high-heeled shoes are not permitted in the laboratory. Leather shoes with slip-resistant soles are preferred.
3. For your safety, hair longer than shoulder length and loose clothing must be confined when working in the laboratory.
4. Wear disposable gloves that are provided when working in the laboratory. Inspect the gloves for defects before wearing. Verify the gloves are resistant to the chemicals being handled. Always remove gloves and wash hands before exiting the laboratory. Upon removal, discard disposable gloves in the wastebasket or infectious waste container as appropriate. Non-disposable gloves may be provided for certain tasks – cryogenics, acids, etc.
5. For your protection, jewelry should not be worn while working in the laboratory. Dangling jewelry can become entangled in equipment and can conduct electricity. Chemicals can seep under the jewelry and cause injuries to the skin. Chemicals can ruin jewelry and change its composition.
6. Always check the Safety Data Sheets (SDSs), ChemTracker, SOPs, and other resources for the necessary safety precautions for the chemicals used in your procedure or to which you may be exposed in the laboratory.

BALL STATE UNIVERSITY	Environmental Health and Safety Office North Service Building	765-285-2807 tlrussell@bsu.edu

BSU Laboratory PPE Selection Guide (by Task)

	If your task/activity involves:	Use the following PPE:
Chemicals	Solids of low or moderate toxicity	○ Disposable gloves – use resistance/compatibility chart
	Minimal amounts of liquids (less than 0.1 liters) with acute or chronic toxicity	○ Safety glasses or goggles ○ Appropriate chemical-resistant gloves ○ Clothing covering body – long sleeves and pants, closed-toe shoes
	More than minimal amounts of liquids with acute or chronic toxicity (pure chemicals, mixtures or solutions)	○ Safety glasses or goggles ○ Appropriate chemical-resistant gloves ○ Lab coat ○ Acid-resistant apron if more than 4 liters of highly corrosive chemicals used ○ Consider flame-resistant, e.g., Nomex, lab coat if more than 4 liters of flammable liquids used
	Cryogenic liquids	○ Safety glasses or goggles ○ Face shield required if handling cryovials stored in liquid phase ○ Insulated cryogenic gloves ○ Lab coat recommended
	Potentially-explosive compounds	○ Safety goggles ○ Face shield ○ Heavyweight gloves ○ Nomex or equivalent fire-resistant lab coat
	Pyrophoric (air-reactive) solids or liquids	○ Safety glasses or goggles ○ Face shield recommended ○ Nomex or equivalent fire-resistant gloves ○ Appropriate chemical resistant gloves ○ Nomex or equivalent fire-resistant lab coat
	Particularly hazardous substances including carcinogens, reproductive toxins, and reagents of high acute toxicity	○ Safety glasses or goggles ○ Appropriate chemical resistant gloves ○ Lab coat ○ Respirators as needed
Biological Materials	BL1 microorganisms or viruses	○ Disposable gloves
	BL2 microorganisms, viruses, viral vectors, human materials or Old World primate materials	○ Disposable gloves ○ Lab coat
	Procedures outside of the Biosafety Cabinet without splatter guard when splashes or sprays are anticipated	○ Safety glasses or goggles ○ Disposable gloves ○ Lab coat
Radiation	Unsealed radioactive materials or waste	○ Safety glasses if there is a splash potential or if 10 milliCuries or more of 32P is used ○ Nitrile or other appropriate gloves ○ Lab coat
	Class 3B or 4 laser	○ Appropriate eye protection
	○ and if UV laser	○ Gloves ○ Lab coat
	Laser(s) modified by optics	○ Appropriate eye protection
	Open ultraviolet light source	○ Safety glasses or goggles with UV protection
	○ and if face enters UV beam	○ UV face shield
	○ and if hand enters UV beam	○ Gloves
	○ and if body enters UV beam	○ Lab coat
	Infrared-emitting equipment	○ Appropriately-shaded goggles ○ Lab coat
Other Hazards	Handling hot surfaces and objects such as autoclaved materials and heated glassware	○ Heat-resistant gloves ○ Lab coat
	Glassware under pressure or vacuum	○ Safety glasses or goggles ○ Face shield recommended ○ Lab coat
	Cutting and connecting glass tubing	○ Safety glasses or goggles ○ Cut-resistant gloves
	Sonicator or other loud equipment	○ Ear plugs or ear muffs

(Acknowledgement: Table adopted from Harvard University document)

10.1 EYE PROTECTION

Refer to the BSU Eye Protection Policy located in **Chapter 23.2, Appendix II.B**.

1. Appropriate eye protection should be worn at all times during laboratory work or potential exposure to hazardous chemicals

2. Before each use, eye and face protection equipment is to be inspected for damage, (i.e. cracks, severe scratches, debris). If deficiencies are noted, the equipment should be cleaned, repaired or replaced before use.

3. The BSU Eye Protection Policy applies to ALL persons: faculty, staff, students, and visitors. It is the responsibility of the faculty member or the area supervisor to enforce the Department protective eyewear policy. Failure to do so may subject an individual to personal liability.

10.2 GLOVES

1. Chemical resistant gloves shall be worn whenever the potential for hazardous skin contact exists. The material safety data sheet for the substance or glove selection charts should be referenced. (**See Chapter 23.2, Appendix II.A**) Standard operating procedures should specify glove requirements, if any.

2. Suitable gloves must always be worn when working with hazardous substances. Choose gloves made of material known to be (or tested and found to be) resistant to permeation by the substance in use. In some cases, two gloves should be worn on each hand to ensure that no exposure will occur in the event of damage to, or compromise of, the outer glove.

3. Adequate quantities of gloves in the appropriate sizes and chemically resistant construction materials must be maintained for laboratory worker and student use.

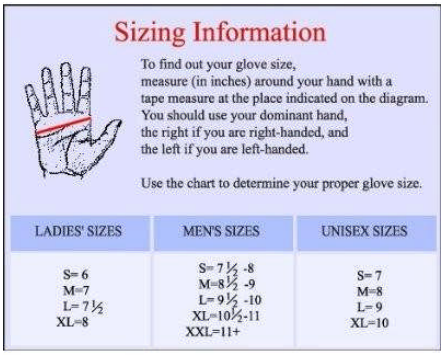
4. Contaminated gloves shall be removed before touching surfaces outside the work area (i.e., doorknobs, faucet handles).

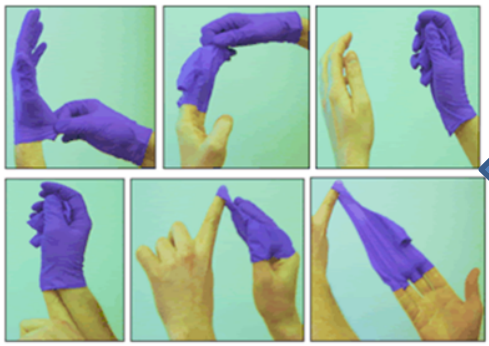
5. Before each use, gloves are to be inspected for damage and contamination, i.e., tears, punctures, discoloration. If deficiencies are noted, the gloves should be cleaned, repaired, or replaced before use.

6. Heat resistant gloves shall be used for handling hot objects. Asbestos containing gloves should not be used.

7. Abrasion resistant gloves (e.g. leather) should be worn for handling broken glass and other similar materials, but should not be used to handle chemicals.

8. In order to prevent the unintentional spread of hazardous chemicals or biological, always remove gloves before handling objects such as doorknobs, phones, keyboards, pens, etc.





Proper method for removing gloves

10.3 SHOES

1. No sandals or open-toed shoes shall be worn in the laboratory. Shoes worn should have non-skid soles and should have reasonable heel heights.

2. Safety shoes, toe guards or the equivalent should be worn if there is potential for injury from heavy objects. Safety shoes must meet the requirements of ANSI Z41 as adopted by OSHA.

3. Before each use, shoes should be inspected for damage, deterioration, contamination, (i.e., tears, punctures, discoloration). If deficiencies are noted, the shoes should be cleaned, repaired or replaced before use.

4. Any special shoe requirements or restrictions shall be specified in the Job Hazard Assessment or Standard Operating Procedures for the laboratory activity.

10.4 CLOTHING

1. Laboratory coats or aprons should be worn by laboratory employees and students whenever a reasonable risk of chemical exposure to skin or street clothing exists or when specified by SOPs. They should be kept in an appropriate

clean storage area. Disposable laboratory coats are recommended when working with highly toxic materials such as select carcinogens, mutagens, or teratogens. Chemical resistance and permeability of the coats/aprons must be evaluated relative to the chemicals in use.

2. Fire-resistant (FR) lab coats should be worn whenever working with highly flammable or pyrophoric materials.

3. Clothing should be cleaned regularly. Clothing contaminated with hazardous materials must be either decontaminated before reuse or disposed of. Laboratory coats may be laundered commercially or on-site.

4. The commercial launderer of any contaminated work clothing shall be notified of any potentially contaminating substances.

5. Before each use, clothing is to be inspected for damage, deterioration, contamination, (i.e. tears, punctures, or discoloration). If deficiencies are noted, the clothing should be cleaned, repaired or replaced before use.

6. For some laboratory procedures or chemical usage, chemically resistant aprons or suits may be necessary based on the chemical characteristics and procedures involved.

7. Lab coats, gloves, and other chemical protective clothing must be removed before leaving the laboratory or studio work area.

10.5 HEARING PROTECTION

1. Hearing protection (noise attenuating ear muffs or plugs) are required whenever employees are exposed to 85 dBA or greater as an eight-hour time weighted average. If there is difficulty hearing a normal conversation at a distance of three (3) feet in the lab or work area, noise measurements should be taken.

2. Hearing protection is to be inspected before each use for proper fit and function, tears, and contamination. If deficiencies are noted, the hearing protector should be cleaned, repaired or replaced before use.

3. Contact the Industrial Hygienist in the BSU EHS Office (285-2832) for noise dosimetry measurements, possible engineering controls, and information on the types of acceptable hearing protection if there are any concerns.

10.6 RESPIRATORS

All employees to be issued respirators for any reason must follow all the requirements set forth in the *BSU Respiratory Protection Program*. OSHA requirements exist for even the voluntary (not employer required) use of respirators in the workplace or laboratory. Contact the Industrial Hygienist in the BSU EHS Office (285-2832) for information on the use of respirators and related fit-testing and medical evaluation requirements.

Respiratory hazards should be controlled at their point of generation by using engineering controls and good work practices. In keeping with this goal, the use of respirators as the primary means of protecting employees from airborne hazards is considered acceptable only in very specific situations and only with prior approval from the BSU Environmental Health and Safety Office. The routine use of respirators as a means of primary control is strongly discouraged.

Approval may be granted only for such situations as short-time temporary experiments where engineering controls are not feasible, and situations in which the use of respiratory protection is an added or supplemental control. The following requirements must be followed when using respirators:

1. Before anyone can wear a respirator, the conditions of the OSHA Standard on Respiratory Protection (29 CFR 1910.134-135, see Part XIII) must be met as discussed below with respect to (a) medical approval, (b) training, and (c) fit testing.

2. IOSHA regulations require a medical evaluation of all personnel intending to use a respirator. After review of a medical questionnaire, the physician may approve the subject for use of a respirator. Based on the questionnaire, a physical examination may also be required before the employee may be approved for respirator use. Training and fit testing will be conducted by the EHS Industrial Hygienist following the medical evaluation.

3. The type of respirator to be used will be selected in consultation with the CHO and the BSU EHS Office. Respirators can be purchased only after such consultation, and are assigned to individuals for their exclusive use. Personnel must participate in a Respirator Training Program prior to using a respiratory device. This training is provided by qualified personnel in the BSU EHS as specified by the BSU Respiratory Protection Plan and includes discussion of the proper use, maintenance, testing, cleaning, and storage of respiratory equipment.

4. All users must undergo fit testing (conducted by the BSU EHS Industrial Hygienist) when a respirator is first issued and subsequently as required by OSHA regulations (annually). The EHS Office will also maintain records of respirator users.

Selection of Respirators

Employer must select and provide an appropriate respirator based on the respiratory hazards to which the worker is exposed and workplace and user factors that affect respirator performance and reliability.

User Seal Check

An action conducted by the respirator user to determine if the respirator is properly seated to the face.

Positive Pressure Check

Negative Pressure Check

11.0 EMERGENCY EQUIPMENT

11.1 GENERAL

Emergency equipment for each laboratory should be located at visually apparent locations in the lab or as indicated on a floor plan for the particular laboratory, Department, or building to be included in **Chapter 28**. Each laboratory employee shall be familiar with the location, application and correct use, where applicable, of the following equipment.

1. Fire extinguishers,
2. Fire blankets (if any),
3. Fire alarms,
4. Fire doors,
5. Smoke detectors,
6. Sprinkler or other fire suppression systems
7. Safety showers,
8. Eye wash units,
9. First aid kits,
10. Spill Response Kits

11.2 SAFETY SHOWERS AND EYE WASHES

1. Safety showers and eye washes should be properly maintained and be easily accessible to the employees.
2. Inspections:
    a. Access should be checked daily by laboratory personnel.
    b. Eye wash units should be flushed and checked for adequate flow once each week by laboratory personnel who will run them until water is clear.
    c. Safety showers and eye wash function will also be flushed and tested on a monthly basis by BSU FPM and EHS personnel during normal school terms. These units will be flushed and tested at other BSU Campus locations on a semi-annual basis.

BALL STATE UNIVERSITY **Environmental Health and Safety Office**

WEEKLY EYEWASH FLUSHING

To ensure a properly-functioning eyewash station with clean water in the event of an emergency--laboratories, studios, shops, and any other locations must flush their eyewash station weekly. When performing a weekly eyewash flush, check the following:

- **Access and signage:** Ensure that the eyewash station is easily identifiable and unobstructed. Carts, chairs, glassware and equipment can all obstruct an eyewash station, which may slow the response in the event of an emergency. If you have to use an eyewash station in an emergency you won't be able to see very well!

- **Operation** Ensure that the eyewash station activates easily with one-handed control, the flow removes eyepiece covers, and water flows evenly and in a steady stream.

- **Water** Allow the eyewash station to run for 1-3 minutes to flush stagnant water from the line. If this is your first time flushing the station, you may have to run it longer to ensure that the water is clean.

- **Replace the eyepiece covers.** Reposition the eyepiece covers and wipe the device clean.

REPORT MALFUNCTIONING EYEWASH STATIONS TO BSU WORK CONTROL AT 285-5081.

Helpful hints:

- **Make sure you know where the water drains!** Often a bucket or a tray has to be positioned under the unit's drain to collect the water.

- **Have a roll of paper towels on hand** in case of water leakage.

- **A large tray may be needed to collect the water** under units that pull down from the wall to activate.

- **Dispose of the rinse water to a sink drain.**

If you have questions or if you are unable to flush your eyewash station, contact the Environmental Health & Safety Office. The EHS Office routinely checks the operation of eyewashes but cannot perform the necessary flushing and inspection on a weekly basis.

Environmental Health & Safety Office
Ball State University
765-285-2807 or tlrussell@bsu.edu

11.3 FIRE EXTINGUISHERS

1. Fire extinguishers should be provided within 30 feet of a laboratory work area and located along normal paths of travel.

2. Access must be maintained and the location should be conspicuously marked in an appropriate manner.

3. Monthly inspections are performed by FPM EHS Office personnel and verify that:

   a. The extinguisher is in its designated location.

   b. Access is maintained.

   c. The pin is in place and attached with unbroken wire.

   d. The indicator, if present, should be in the full range.

   e. No indication of physical damage.

These inspections are documented by EHS personnel.

4. Thorough inspections and necessary maintenance of the fire extinguishers will be conducted at least annually by the EHS Office. Maintenance of extinguishers involves a complete and thorough examination, including the mechanical parts, the weight and condition of the extinguishing agent, and the agent's expelling device. The inspection shall be conducted by qualified individuals and documented.

5. Discharged fire extinguishers must be immediately reported to the Safety Specialist in the BSU EHS Office for replacement or recharge.

11.4 BLANKETS / FIRE BLANKETS

1. If fire blankets are provided their location must be indicated and accessible.

2. Weekly Inspections:

   a. Blanket should be in its designated place.

   b. Access should be maintained

   c. The location should be conspicuously marked.

   d. The blanket shall not be contaminated or damaged.

11.5 FIRE ALARMS

1. Access to fire alarms and their location must remain unobstructed.

2. Inspections of fire alarm and suppression systems will be conducted periodically by Facilities Planning and Maintenance or their contractors.

   a. Fire alarms should be conspicuously marked.

   b. <u>FIRE ALARMS ARE NOT TO BE TESTED BY LABORATORY PERSONNEL!</u>

c. The inspections will be documented.

11.6 SMOKE OR HEAT DETECTORS

1. Should be installed and selected for the appropriate hazards per building codes, fire codes and fire insurer's requirements.
2. Inspections will be performed periodically by FPM or their contractors. The detection system should be tested to assure proper working order per manufacturer's and/or fire insurer's instructions.
3. SMOKE DETECTORS ARE NOT TO BE TESTED BY LABORATORY PERSONNEL!

11.7 FIRST AID KITS

1. First aid kits will be available and maintained for treatment of minor injuries or for short term emergency treatment until medical assistance arrives.
2. The first aid kits should be kept adequately stocked and maintained
3. First aid kits will be kept in an accessible and marked location in the laboratory or nearby as indicated in the laboratory layout.
4. Monthly inspections of the kit availability and contents must be performed.

11.8 FIRE DOORS

1. Fire doors should be provided as required per building codes, fire codes and fire insurer's requirements. Fire doors must not be blocked open, and must be maintained and allowed to close properly.
2. Inspections will be conducted periodically by FPM.
3. FIRE DOORS ARE NOT TO BE TESTED BY LABORATORY PERSONNEL!

11.9 FIRE SUPPRESSION SYSTEMS

1. The fire suppression system must be selected based on the hazards.
2. Inspections—periodically, by FPM or its contractors.
   a. All system components must be checked for physical condition.
   b. The system should be activated and checked as appropriate for the type of system.
   c. FIRE SUPPRESSION SYSTEMS ARE NOT TO BE TESTED BY LABORATORY PERSONNEL!
   d. The inspections should be documented.

11.10 EMERGENCY LIGHTING

1. Emergency lighting must be adequate to provide lighting for egress during an emergency situation or power failure.
2. Inspections--Annually by BSU FPM or contractors
   a. Emergency lighting must be activated to assure it is operational.
   b. Inspections should be documented.

11.11 CHEMICAL SPILL AND CONTAINMENT KITS

Each laboratory or Department area in which hazardous chemicals are used must maintain an appropriate spill control kit as supplied by the Department with consultation of the Chemical Hygiene Officer. Specific devices, neutralizers, or supplies may be needed for a number of specific chemicals that may be used in the laboratory including hydrofluoric acid, formaldehyde, mercury, etc. The location of the spill response equipment should be visually obvious or otherwise shown on the laboratory layout maintained for the particular laboratory in **Chapter 28**. The necessary spill containment supplies will be identified by the BSU EHS Office in concert with the various Departments and laboratories.

12.0 EMERGENCY PROCEDURES

OSHA regulations at 29 CFR 1910, Subpart E, require all places of employment, including laboratories, whether free-standing or in a Department building, to have a written emergency action plan including evacuation plans. The laboratories must maintain a comprehensive safety program consistent with the guidelines outlined in the ACS publication, "*Safety in Academic Chemistry Laboratories*" and in accordance with applicable OSHA standards and regulations. Evacuation plans for the individual laboratories and/or the buildings in which they are housed, also showing the locations of emergency response equipment, should be posted in each laboratory and included in **Chapter 28** of this Plan.

Despite our commitment to safety, however, we recognize that accidents happen due to the very nature of the work undertaken in laboratories and support areas. Therefore it is requisite that all personnel know what to do in the event of an emergency or accident. Personnel must be trained in what actions they should take in the event of a spill and, equally important, those actions that they should not take.

No emergency plan can include all the contingencies for every emergency situation. The most important component of emergency planning is prevention. Prevention measures include:

1) *Planning* - Investigating the hazardous aspects of experimentation and thinking about "worst case scenarios" can greatly reduce risk.

2) *Employee training* and facility inspection programs.

3) *Engineering design.* Using devices such as fume hoods for chemicals or interlocks for lasers will also reduce risk.

4) *Administrative Controls*. Adopting and using Standard Operating Procedures, enforcing the Eye Protection Policy in your lab, and maintaining a chemical inventory are examples of using administrative controls to prevent injury.

5) Using appropriate *personal protective equipment*.

If a **MEDICAL EMERGENCY** occurs:

Immediately provide the minimum necessary first aid to prevent further injury to the victim. Locate an individual who has received first aid training if possible.

Eye Exposure -- If chemicals have splashed into the eyes, flush the eyes at an eyewash station for 15 minutes or until emergency medical personnel arrive and evaluate the accident (or, follow the instructions on the chemical MSDS).

Skin Exposure -- If chemicals have splashed onto the body, drench the victim with water at a safety shower, while removing any contaminated clothing. Continue flushing the skin for 15 minutes or until emergency medial personnel arrive. Have a spare lab coat available to protect the modesty of the victim.

Thermal Burns – Burns from a clothing fire or large splash of hot material can be life threatening if they are deep, extensive or located on critical areas of the body. Severe burns of the hands, feet, face and genital areas are considered critical.

To extinguish a clothing fire:

- Stop the person on fire from running.
- Drop the person to the floor. Standing will allow flames to spread upward to eyes and nose.
- Roll the person to snuff out the flames.
- Cool the person. Remove loose smoldering clothing. Use cold water or ice packs to cool burns and minimize injury.
- Do not attempt to remove burned clothing that is in contact with damaged skin.
- Get medical assistance immediately.

If the injury requires more than a band-aid (as a general rule), but is not life threatening, call the University Health Center at (28)5-8431. If the injury is potentially severe or life-threatening, call (28)5-1111 or 911. As noted earlier**,** the University has an internal policy for response and reporting of injuries and medical assistance. Refer to **Chapter 8, Section 2, *Accident Reporting*.** However, the first priority is to obtain the emergency or medical response necessary.

Provide emergency and medical personnel the following information:

- Name, location and nature of the emergency
- Identity of chemical involved.
- Amount of chemical involved.
- Area of the body affected.
- Symptoms.

The laboratory supervisor, safety office, principal investigator, or a designee, should meet the Emergency Personnel at the laboratory entrance and give them any relevant information regarding the emergency.

YOU SHOULD NOT TRANSPORT AN INJURED PERSON TO THE HEALTH CENTER, NOR SHOULD YOU SUGGEST A VICTIM WALK OR DRIVE TO THE HEALTH CENTER. If medical attention is needed, you are expected to call for help. This help is available at all hours.

Employees and students must notify their immediate supervisor or instructor of all illnesses related to exposure to hazardous chemicals and hazards.

Obtain an accident report form from the Lab Supervisor, the Department, the CHO, or the Safety Specialist in BSU EHS. Complete the form while including as many of the details of the accident as possible. Sign the form and return it to the Lab Supervisor and the Safety Specialist in EHS. ALL ACCIDENTS, NO MATTER HOW MINOR, MUST BE REPORTED. This is an extremely important document because it serves to protect everyone involved.

If a **FIRE** occurs:

RESPONSE TO FIRE OR SUSPECTED FIRE

1. If a burning odor or smoke is present, pull a fire alarm to activate the fire alarm system.
2. If possible, shut off gas and pressurized air in your area.
3. If you can help control the fire without personal danger and have received training, take action with available fire extinguisher. If not, leave the area.
4. Never allow the fire to come between you and an exit.
5. Leave the building, checking as you leave to make sure everyone has left the immediate area. Close doors behind you to confine the fire.
6. PULL THE FIRE ALARM TO EVACUATE THE BUILDING. Do not rely upon the alarm to alert the fire officials.
7. Once you have evacuated, CALL (28)5-1111 AND REPORT THE LOCATION OF THE FIRE and the material burning if known. Answer all of the questions that the dispatcher asks. Do not hang up until the dispatcher does first.

Meet the Emergency Personnel at the door and give them any relevant information.

Use common sense - a solvent fire in a beaker in a fume hood is easily extinguished by covering the beaker and depriving the fire of oxygen. Using a fire extinguisher on the same beaker may cause the solvent to spill, thus increasing the hazard!

If you are absolutely certain that you have extinguished the fire, call (28)5-1111 or 911 to report that the fire is out. If there is time, the fire truck response will be canceled, although fire safety officials will still come out to assess the damage and file a report.

You are expected to utilize good judgment - it may not be necessary to evacuate the building for a small incipient fire in the lab. If, however, there is any chance that the fire may endanger others or may cause serious damage, do not hesitate to pull the fire alarm. Never feel embarrassed about being over-cautious.

Immediately after a fire extinguisher has been used, call the BSU EHS Safety Specialist (28)5-2815 to request that it be recharged or replaced.

See the Laboratory Supervisor or the Safety Specialist to obtain a copy of the incident report form.

If an **EMERGENCY** occurs:

The chemicals involved, quantities, flammability, toxicity, and several other factors will determine the appropriate response to a chemical spill or uncontrolled reaction. The *BSU Spill Preparedness and Response Plan* should be referenced for actions to be taken in the event of a spill or release of chemicals, radioactive materials, or etiologic agents.

HIGH HAZARD (MAJOR) EMERGENCY -

Chemical emergencies such as large spills, spills involving highly hazardous or flammable materials, releases of toxic or corrosive gases or substances should be treated as are other types of emergencies. These could include one or more of the following conditions:

- Immediate danger to life and health
- Involves a large area of the laboratory
- Injury to persons has occurred or is likely
- Is an immediate threat to persons and the public
- Involves an infectious agent
- Involves a highly toxic flammable, corrosive, or reactive material
- If the nature of the emergency is unknown
- If it is uncertain how to handle the emergency.
- Other assistance is needed – technical, supplies, or manpower

1. ISOLATE THE AREA and instruct non-responders to evacuate the laboratory area;
2. PULL THE FIRE ALARM AND EVACUATE THE BUILDING;
3. CALL UNIVERSITY POLICE AT (28)5-1111. Notify the dispatcher of the type and location of emergency; they will notify the appropriate emergency personnel.
4. If you do call (28)5-1111, be sure to meet or designate someone to meet the emergency personnel at the building entrance, stairwell, door, or the building loading dock. You can then give them any relevant information and direct them to the exact location of the emergency.

5. If possible, identify the materials involved and collect the relevant MSDSs.
6. If there are injured victims, provide the minimum necessary first aid ONLY IF YOU ARE SURE THAT THERE IS NO DANGER TO YOURSELF. If providing assistance will endanger yourself, DO NOT attempt intervention; wait for emergency response personnel.

LOW HAZARD (MINOR) EMERGENCY -

If the emergency consists of only the following conditions, treat the emergency as low hazard.

- There is no fire hazard hazard.
- Involves low to moderately toxic or infective materials in small amounts.
- The spilled material is of low volatility, toxicity, or infectivity
- Involves on-site treatable injury
- The spill or release can be confined
- The incident can be handled by the individual investigator who is trained in handling of the subject chemical(s) and spill response

1. Remove all ignition sources and obstacles from the area;
2. Retrieve the spill response kit;
3. Don the necessary protective apparel;
4. Isolate the area and have students and other persons relocate away from the incident
5. For a small spill, use an absorbent material or other materials from the spill response kit or other sources.
6. Use a treatment reagent that will neutralize the spill if available;
7. Surround the spill with the absorbent material to confine its area
8. Where blood or potentially infectious materials are involved, follow the *Universal Precautions* for blood-borne pathogen procedures.
9. Absorb the spilled chemical(s) with the absorbent material
10. The area should be decontaminated with soap and water after clean up. This should be followed by a prescribed disinfectant if potentially infectious agents are involved.
11. Residue should be placed in an appropriate container for subsequent treatment and waste characterization.
12. Contact the EHS Office for assistance if the spill or incident is beyond the training or capability of laboratory staff, or if the spill is of a nature or quantity where assistance is needed.

BSU SPILL RESPONSE PROCEDURES

REMEMBER: DO FIRST AID FIRST, THEN ASSESS THE SPILL – Is the Spill Major or Minor?

Minor Spill - Definition

If Department, shop, lab, or local staff have the training, protective equipment, and spill response supplies to control and cleanup the release, and the spill is:

- Less than 1 gallon spill of a low toxicity chemical
- Less than 1/2 quart (500 ml) of a highly hazardous chemical (carcinogen, reproductive hazard, or has NFPA/HMIS health or physical hazard rating of 3 or 4)
- Blood and/or body fluids or class 1 or 2 biological material,
- Not a likely release to a waterway or drain, **and:**
- **Without an injury, chemical or biological exposure, and no fire or explosion has occurred!**

Minor Spill Response

1. Notify fellow workers or students in vicinity of spill.
2. Secure area, by restricting access and posting signs.
3. Remove any potential ignition sources, unplug nearby electrical equipment, and ventilate the area if safe and possible.
4. Gather and review safety information on spilled chemical. Review chemical's Material Safety Data Sheet (MSDS) for a hazard assessment and other pertinent information.
5. Refer to the *BSU Spill Preparedness &Response Guide*
6. Locate an appropriate Spill Kit, if available.
7. Don appropriate personal protective equipment (PPE) which usually includes chemical splash goggles, gloves, apron, coveralls, or lab coat. If high splash potential exists, also wear a face shield and protective clothing.
8. Confine and contain spill. Cover spill with appropriate absorbent material. Neutralize acid and base spills prior to cleanup.
9. Clean up spill using a scoop or other suitable item and place material in appropriate disposal container.
10. Decontaminate spill surface with mild detergent and water, as appropriate. Carefully remove PPE, place non-reusable items in disposal container and thoroughly wash hands.
11. Label the cleanup waste container. Contact EH&S Office to arrange for waste disposal.
12. Investigate cause of spill and review with EHS Office. Document spill, response, and follow-up with staff.
13. Replenish spill kit or supplies.

Major Spill - Definition

A chemical or biological spill or release involving any of the following:

- Injury, fire, explosion, or exposure to hazardous chemical
- More than 1 gallon spill of a low toxicity chemical
- Over 1/2 quart (500 ml) of a highly hazardous chemical
- Unknown chemical, product, or material
- Mercury, hydrofluoric acid, reactives or pyrophorics
- Biological spill of a quantity or location needing assistance
- Beyond training or capability of Department or local staff

Major Spill Response

1. **Notify and evacuate fellow workers to a safe area. Post the attached sign or isolate the area.**

DO NOT ATTEMPT TO CLEAN A MAJOR SPILL ON YOUR OWN!

2. If spill poses a fire hazard--activate nearest fire alarm. Call BSU University Police at 911 (765-285-1111) and give details of spill including specific location, chemical, quantity, and if anyone is injured.

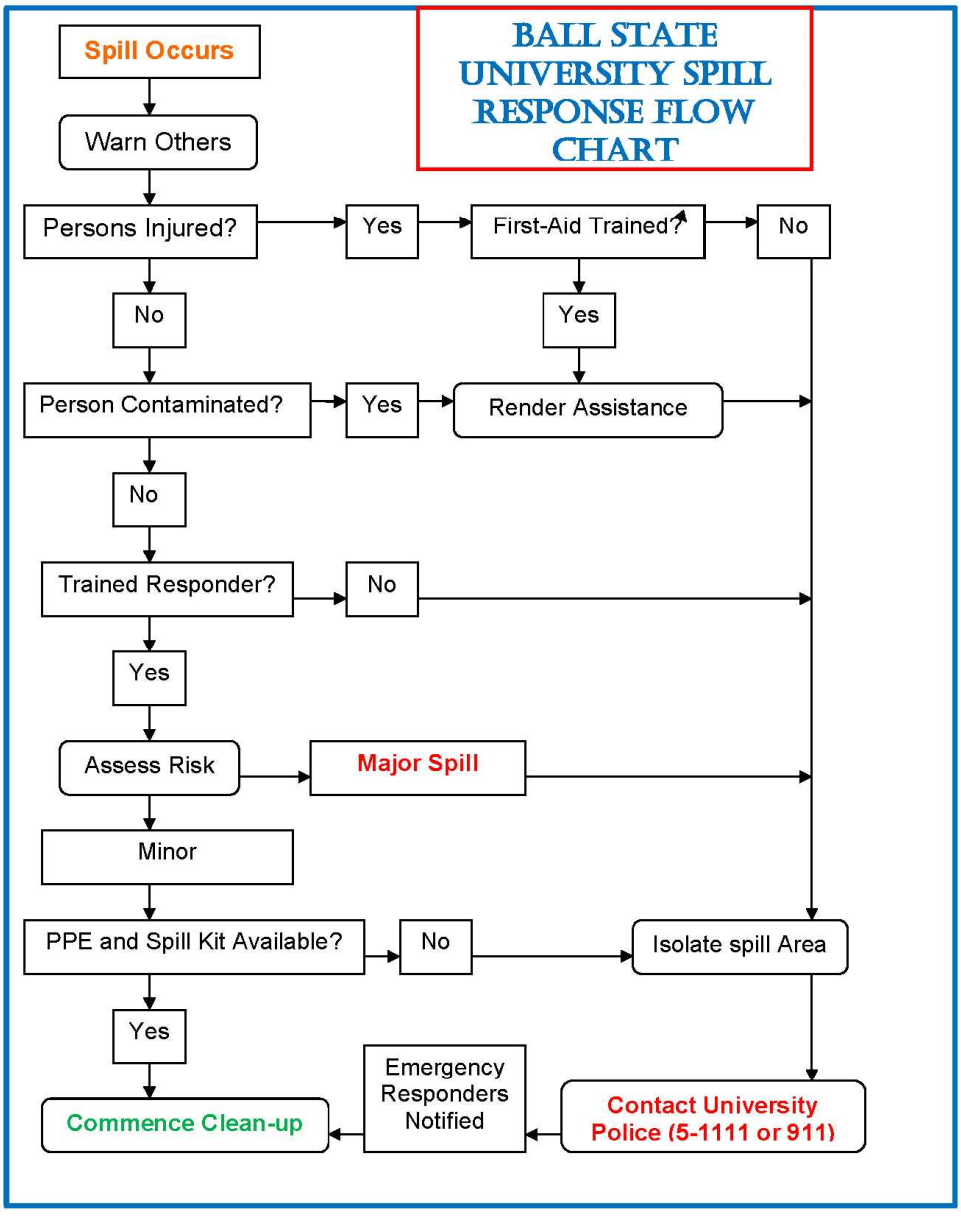
3. In case of an **injury or chemical contamination**:
   a. Wear PPE and move victim from spill area.
   b. If first aid trained, administer first aid as appropriate. Assist person to Health Center or Emergency Department (after hours) for treatment. If possible, bring chemical label or MSDS.
   c. Locate nearest emergency safety shower or eyewash. Remove contaminated clothing and flush affected areas (eyes or skin) with copious amounts of water for 15 minutes. Use soap on skin surfaces.

4. University Police will contact EH&S and either EHS staff or outside personnel will respond to the spill.

5. Staff knowledgeable about the spill should provide responders with all pertinent information and MSDS.

6. The responders or designee will inform staff when it is safe to re-enter spill area.
7. Investigate cause of spill. Complete Incident Report, response and follow-up with staff and contact EHS Office.

For further information contact:
Environmental Health & Safety Office
Ball State University
Muncie, Indiana 47306
Phone: 765-285-2807
FAX: 765-285-6607
tlrussell@bsu.edu



Only those staff members or students who know the identity and characteristics of the material involved, have had the required training, possess the required PPE, and have the necessary spill cleanup materials readily available should attempt to cleanup the spill or released material.

Building Evacuation Procedures:

Emergency response for all police, fire, and medical emergencies will be initiated by calling (28)5-1111.

Also refer to the BSU Emergency Response Guidelines prepared by the Crisis Management Team.

Evacuation is announced by the sounding of the emergency evacuation alarm.

All alarms sounding in a building are to be reported via (28)5-1111 as soon as possible.

1. Building code requirements result in stairways being the safest locations in a building in the event of a fire. Stairways are routinely checked for people needing assistance by the firefighters.
2. Personnel should not use elevators as a means of evacuation. The high potential for electrical or mechanical malfunctions coupled with the increased risk of smoke inhalation has resulted in elevators being described as "death traps". Persons on elevators when the alarm bells sound are advised to exit at the first opportunity and evacuate via the nearest stairway.
3. Within the Department, Supervisors, Faculty, TA's, and Safety personnel are expected to make a quick visual inspection of the floor (including labs, offices, bathrooms, and stairwells) to make sure that everyone is leaving the building. If performing this inspection poses unreasonable risk, then proceed to the nearest stairwell and exit the building.
4. If requested, accompany and assist persons with disabilities.
5. Shut all doors behind you as you go unless there are persons following you.
6. Evacuees should not stop immediately after exiting the building, but proceed well away from the building so as to be clear of the fire and also not impede the movements of firefighters and firefighting equipment. Move at least 100 feet from the building and stay away from building entrances.

Classroom instructors are expected to interrupt class activity, and advise students to evacuate the building.

Disabled students and personnel (e.g., persons with physical, visual, or hearing impairments, etc.) have the primary responsibility for requesting assistance. It is suggested that instructors determine, in advance, if any students require assistance during an emergency. If assistance is requested, the instructor should so advise the class without making any specific individual arrangements. Should the evacuation alarm sound, the instructor should request assistance to move students with physical

disabilities to the nearest enclosed stairway or designated evacuation point. Other arrangements can include: assisting a blind or visually impaired person from the building, informing a deaf student that an alarm is sounding. Instructors must inform emergency officials of the location (s) of disabled students.

Unless specifically requested and considered advisable by those providing the assistance, moving persons in wheelchairs down a stairway is not recommended. One individual should remain with the disabled person, if this can be done without unreasonable personal risk. Others should evacuate the building and advise emergency responders of the location of the persons remaining in the building so that the evacuation may be completed by the emergency personnel. Elevators should not be used to move persons with disabilities for the reasons outlined above

The building should not be reentered unless indicated safe by fire officials or University Safety Personnel at the scene.

13.0 RECORD KEEPING

1. Accident /Incident records shall be retained by the Departments for five (5) years with copies forwarded to the Division of EHS.

2. Medical records shall be retained by the University for the duration of employment plus thirty years.

3. Industrial hygiene monitoring records, Material Safety Data Sheets (MSDSs)/Safety Data Sheets (SDS), sampling results, and other exposure records shall be maintained by the University for thirty years.

4. Laboratory inspection forms (**see Form 1A and 1B of Section 25.0**) shall be maintained for at least 2 years.

5. Laboratory or Art safety training records must be maintained throughout the tenure of a student or faculty and for three (3) years beyond that time.

14.0 EMPLOYEE TRAINING

It will be the responsibility of the Laboratory Safety Officer, Supervisor, or Principal Investigator in charge of a laboratory to inform those employees, for whom they are responsible, of the potential hazards associated with the use of the specific chemicals and procedures performed within that laboratory. The **Ball State University Chemical Hygiene Plan Training and Awareness Certification** (**Chapter 25)** or other similar training record must be signed to acknowledge awareness of the hazards associated with the specific laboratory. Training must include the following information:

1. The physical and health hazards of chemicals or biologicals within that specific laboratory;
2. The measures employees can take to protect themselves from these hazards, including work practices, engineering controls, and personal protective equipment; and,
3. The actions to be taken (or not taken) in the event of a spill or release of the chemical, biological, or radioactive material

14.1 TRAINING

1. All laboratory employees must be trained on the hazards of the chemicals, radioactive materials and biological agents present in their work area.

2. The goal of the training program is to assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs.

3. This training shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present. It shall also be provided prior to assignments involving new exposure situations or working with new chemicals that present new exposure or safety hazards. The training shall be coordinated through the Laboratory Supervisor, or their designee, as appropriate. The Chemical Hygiene Officer or EHS Office may assist in such training or provide general laboratory safety training.

4. The training should specifically include:

    a. Handling hazardous chemicals or biological materials or infectious agents;
    b. Characteristics and hazards of the chemicals or materials being handled;
    c. Exposure signs and symptoms;
    d. Fire training--prevention and response;
    e. Emergency response and evacuation;
    f. Location and interpretation of MSDS's;
    g. Engineering controls;
    h. First aid;
    i. Personal hygiene;
    j. Protective clothing;

k. Chemical or infectious waste disposal;
l. Contents and availability of the CHP;
m. Review of PELs and action levels;
n. Laboratory hazards specific to work area;
o. Respirator protection and fit testing program;
p. Identification and labeling of chemicals and wastes; and,
q. Standard Operating Procedures (SOPs) for the chemicals or biologic materials
r. The contents of the *OSHA Laboratory Standard* and Appendices

5. Training will be documented with the following information (**see Form 4-Chapter 25.0)**:

a. Trainer and/or media used,
b. Content of Training,
c. Attendees by signature,
d. Date, and
e. Location

14.2 REFERENCE MATERIALS

1. Reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals can be found in the BSU Libraries, The EHS Office, and through the University Departments and faculty that are responsible for the individual laboratories.

2. The following reference texts are available through the EHS Office:

a. *Dangerous Properties of Industrial Chemicals*, Sax and Lewis
b. *Handbook of Safety, Health, and Environmental Data,* Genium
c. *Occupational Health Guidelines for Chemical Hazards, NIOSH*
d. Code of Federal Regulations, 29 CFR Part 1910 (OSHA) and 40 CFR 260, et seq., (Solid and Hazardous Waste Management).
e. *Safety in Academic Chemistry Laboratories*, 7th edition, American Chemical Society
f. *Pocket Guide to Chemical Hazards*, National Institute for Occupational Safety and Health
g. *Condensed Chemical Dictionary*, Sax and Lewis
h. *Prudent Practices in the Laboratory*, National Research Council
i. *Indiana Fire Code,* 675 IAC 22, Indiana Fire Prevention and Building Safety Commission (includes International Fire Code).

3. Recommended reference sources concerning safe operations in laboratories include the following:
   a. *CRC Handbook of Laboratory Safety,* CRC Press, Inc., current edition
   b. *Guide for Safety in the Chemical Laboratory,* Van Nostrand Reinhold Company
   c. *Improving Safety in the Chemical Laboratory,* John Wiley and Sons
   d. *Safe Storage of Laboratory Chemicals,* John Wiley and Sons
   f. *Safety in Academic Chemistry Laboratories,* American Chemical Society

4. Current Safety Data Sheets (SDS) or Material Safety Data Sheets (MSDS) for all hazardous chemicals shall be maintained by the Laboratory Supervisor or Department and be supplemented or updated as new chemicals or MSDSs are received. MSDS's are also commonly available on the supplier or distributor's web site.

14.3 TRAINING RESOURCES

The EHS Office can provide the following training programs:

General Laboratory Safety	*Bloodborne Pathogens*
Respirator Training and Fit Testing	*Accident Investigation*
Fume Hoods	*Fire Safety*
Chemical Management (Waste)	*Personal Protective Equipment*
Hazard Communication	*Wastewater Management*
Laboratory Waste Management	*Hazardous Waste Management*

Many other training programs can be quickly developed by EHS staff upon need or request by the various BSU Departments. Chemical specific training may also be provided through the chemical supply houses from which the chemicals are ordered.

15.0 VISITOR AND CONTRACTOR TRAINING

Visitors and contractors allowed access to laboratories or chemical and storage areas must be made aware of the existence and content of this CHP and be given the opportunity to review it.

15.1 DEFINITIONS

1. *Visitor* - individual who is on site by invitation and who is not involved in the operations or processes of the laboratory and is not present in a contractual capacity.
2. *Contractor* - individual who is on site to complete a contracted responsibility and whose direct compensation is not being paid by the University

15.2 TRAINING AND AWARENESS

Visitor and contractor training will be the responsibility of the individual or Department issuing the invitation, the agency awarding the contract, or EHS, as appropriate. For extended or unattended visits, the visitor should be trained on this *Chemical Hygiene Plan*, the location of SDSs/MSDSs for chemicals in the area, necessary PPE, the location of all emergency equipment, and emergency procedures and alarm systems. At a minimum, for short visits or limited potential for exposure to hazardous chemicals, the visitor or contractor should be made aware of the BSU Chemical Hygiene Plan and be given an opportunity to review it.

Visitors should be accompanied by laboratory personnel trained in the CHP and accompanying protocols and procedures. That PPE utilized by staff and students in the laboratory or studio shall be required for visitors or contractors or advance notice be given of the attendant hazards and the need to provide their own PPE for the visit or on-site work to be performed.

16.0 WASTE MANAGEMENT AND DISPOSAL PROCEDURES

Ball State University is required to comply with Federal, State, and local regulations regarding the identification, labeling, accumulation, storage, packaging, transportation, and disposal of waste, spent, or unwanted chemicals. Due to the variety and quantity of materials handled, it is important that all laboratories work closely with the BSU EHS Office to correctly identify, characterize, label , accumulate, and dispose of hazardous (and non-hazardous chemicals and biologic wastes according to these requirements.

16.1 LABORATORY WASTE MANAGEMENT

The labels for laboratory wastes were introduced in **Section 7.6** of this Plan. Those are essential, but only one component of the BSU *Laboratory Waste Management Plan*. The complete written *Laboratory Waste Management Plan* is provided in **Section 33** of this Plan. The following is a summary, or checklist, of the major requirements of the EPA Laboratory Waste Management requirements as expressed in the BSU Plan.

BALL STATE UNIVERSITY	**Environmental Health and Safety Office** **North Service Building**	**Contact: Tom Russell, CHMM** **765-285-2807** tlrussell@bsu.edu

Chemical Waste / Lab Waste Management in Laboratories and Art Studios/Workshops

This checklist is for managing Lab Wastes (Chemical Wastes) in science education and research laboratories, and art studios and workshops, on the main campus of Ball State University. Other generators of chemical wastes (maintenance shops, housing, dining, etc.) must follow the general chemical and hazardous waste handling procedures for waste generators under U.S.EPA/IDEM hazardous waste regulations.

- ☐ Determine that the material is unwanted and is not going to be reused at any time.
- ☐ Determine the container the Lab Waste will be stored in – contact the EHS with questions or if acceptable containers are needed:
  - This container must be in good condition and compatible with the waste.
  - Large volumes of waste should be stored in U.S. DOT approved Hazardous Material shipping containers.
- ☐ Apply a BSU *Lab Waste* label (yellow) to the container at the time of first filling and complete the label fully and accurately:
  - Ensure a descriptive chemical name is printed on the label (no acronyms).
  - Ensure location and contact name is printed on the label.
  - Ensure the *accumulation start date* is printed on the label.
  - Ensure the waste components and hazards are recorded on the label.
- ☐ Use secondary containment (trays or cabinets) to segregate containers according to hazard class and compatibility.
- ☐ Ensure each container is closed at all times (except when adding Lab Wastes). See *working container* and *inline system policies* for more information.
- ☐ Do not exceed the smaller of 55-gallons or 220 lbs of Lab Waste.
- ☐ Ensure that any Lab Wastes are removed by EHS within 6 months of the *start of accumulation date* on any container – contact the EHS for pickup.
- ☐ Require that all personnel and students who manage Lab Wastes have training.
- ☐ Ensure all personnel and students working in the Lab Waste generation and storage areas know emergency and spill procedures:
  - Post emergency/spill/injury procedures near the lab/studio door.
  - Ensure everyone working in the area is familiar with the location and operation of emergency eye washes, showers, fire extinguishers, spill control equipment.
- ☐ Contact the EHS Office to request removal of any Lab Waste containers that are nearly full or upon approaching 6 months of storage--whichever comes first.
- ☐ **Do not dilute or dispose of Lab Wastes via drain/sewer, in trash, dumping on The ground, or by evaporation.**

Environmental Health and Safety Office, Ball State University, North Service Building, 3401 North Tillotson Avenue, Muncie, Indiana 47306, http://cms.bsu.edu/about/administrativeoffices/facilities/ehs

With the exceptions noted below, the disposal of chemical wastes and byproducts down the drain to the sewer system is prohibited unless specifically approved by the BSU EHS Office and the Muncie Sanitary District. Refer to the BSU document, ***Disposal of Laboratory Wastes: Requirements for Chemical Disposal to Sinks and Drains*** provided as **Chapter 37** in this Plan.

Such practices can cause damage to the building drain piping, create hazards for service personnel, cause problems for the sewer lines and wastewater pumping stations, interfere with wastewater treatment facility operations, or pass through the treatment systems causing damage to the receiving waterways.

A first and important step in proper waste management is to minimize or eliminate the types of wastes and volumes generated that require off-site disposal. This topic is discussed below, as well as in the ***BSU Waste Management Guide*** in **Chapter 34** of this CHP.

16.2 WASTE MINIMIZATION AND VOLUME REDUCTION PROCEDURES

A. General

1. Do not dispose of chemicals unnecessarily. If you have no further need of a reagent, solvent, preservative, or other material, determine whether your colleagues or other University Departments can use it.

2. Do not mix chemicals (e.g., halogenated solvents with non-halogenated solvents). Mixing of chemicals reduces the amount of materials that may be reused or redistributed and increases disposal costs. If at all possible, do not combine other chemicals with organic solvents. Acids, bases, heavy metals, carcinogens, oxidizers, cyanides, sulfides, pesticides, and <u>especially HALOGENATED ORGANIC SOLVENTS</u> (chloroform, methylene chloride, fluoride, etc.) should be collected in separate, labeled, and dated waste containers.

3. If possible recover, redistill, and reuse your <u>ORGANIC SOLVENTS.</u>

B. Water Soluble Solvents

1. Small quantities (100 ml) of low toxicity flammable or combustible liquids that are water miscible may (if approved) be disposed via the sanitary sewer system. Refer to the BSU document, ***Disposal of Laboratory Wastes: Requirements for Chemical Disposal to Sinks and Drains*** provided as **Section 37** in this Plan.

2. Water mixable solutions that are resistant to biodegradation or contain toxic materials should not be disposed using this method.

C Neutralization

1. CONCENTRATED ACIDS AND BASES may never be poured directly down the sink drain, even in a steady stream of water.

2. Strong acids (with the EXCEPTION of chromic acid) and bases should be neutralized to a pH of 6.0 to 9.0 prior to any sink disposal. After neutralizing, allow time for the solution to cool and check and record the pH before pouring down the sink.

3. The rate of pouring any neutralized acid or base solution to cool and check the pH before pouring down the sink. The rate of pouring any acid or base solution should not exceed 100 ml per minute.

4. Refer to the BSU document, ***Disposal of Laboratory Wastes: Requirements for Chemical Disposal to Sinks and Drains*** provided as **Section 37** in this Plan.

D. Chromic Acid

1. Use of chromic acid for cleaning equipment should be avoided since it is a potential carcinogen.

2. A potassium hydroxide solution in an alcohol or commercial cleaning agents like Nochromax, Alconox, Liqui-Nox, Lift-Away, or "Micro" liquid lab cleaner are suitable alternatives.

E Non-Hazardous Waste

Certain chemicals may be disposed of as non-hazardous solid waste so long as they have not been mixed with other chemicals that may cause them to be listed or characteristic hazardous wastes. Refer to the ***BSU Waste Management Guide (Section 33)*** for details on identifying hazardous wastes. Non-hazardous and non-toxic wastes may be disposed with in regular solid waste containers, dumpsters, or roll-offs as long as they do not contain free liquids.

F. Drain Disposal

Treatment (e.g., neutralization) or drain disposal, even as described above, of any chemical waste must be performed in accordance with the BSU document, ***Disposal of Laboratory Wastes: Requirements for Chemical Disposal to Sinks and Drains*** provided as **Section 37** in this Plan.

. Additional information on waste disposal may be obtained by calling the BSU Environmental Specialist at (28)5-2807.

16.3 WASTE CHARACTERIZATION AND ACCUMULATION

The BSU EHS Office attempts to schedule chemical waste pickups on a quarterly basis when the University is not in session during winter, and spring breaks, and during the academic summer (2 events). The University does maintain on-site hazardous waste accumulation areas, so it is possible for the EHS Office to pickup wastes from laboratories between the scheduled waste vendor pickups and store them properly on campus in the interim. It is incumbent upon the individual Departments to accumulate and store their wastes, particularly hazardous wastes, safely and in accordance with federal, state, and local regulations until they are retrieved by the EHS Office. Contact the BSU Environmental Specialist in the EHS Office at (28)5-2807 for waste pickups.

16.4 OTHER WASTE MANAGEMENT GUIDES

The **BSU Waste Management Guide**, provided in **Chapter 34** of this Plan, along with the ***Disposal of Laboratory Wastes: Requirements for Chemical Disposal to Sinks and Drains*** provided as **Section 36** summarize the procedures for the identification, accumulation, handling, and disposal of hazardous and other waste materials on the BSU Campus. Any questions on these Guides or proper waste management should be directed to the BSU Environmental Specialist at (28)5-2807.

17.0 FUME HOOD SAFETY AND VENTILATION

17.1 GENERAL GUIDELINES

1. General laboratory ventilation shall provide air flow into the laboratory from non-laboratory areas (negative pressure differential in the lab) and out to the exterior of the building.

2. Laboratory doors should remain closed, except for during egress and entrance.

3. Ball State Environmental Control should be notified if any deficiencies are noted in the heating, ventilation, or air conditioning systems serving the laboratory. Call Work Control at (28)5-5081.

17.2 HOOD USE

The laboratory fume hood is the major protective device available to laboratory workers. It is designed to capture chemicals that escape from their containers or apparatus and to remove them from the lab workers proximity and the laboratory environment before they can be inhaled. Chemical characteristics to be considered in requiring fume hood use are physical state, volatility, toxicity, flammability, eye and skin irritation, odor, and the potential for producing aerosols. A fume hood should be used if a proposed chemical procedure exhibits any one of these characteristics to a degree that:

1. Airborne concentrations might approach the action level (or permissible exposure limit);
2. Flammable vapors might approach one tenth of the lower explosion limit;
3. Materials of unknown toxicity are used or generated; or
4. The odor produced is annoying to laboratory occupants or adjacent units.

Procedures that can generally be carried out safely outside the fume hood include those involving

1. Water-based solutions of salts, dilute acids, bases, or other reagents,
2. Very low volatility liquids or solids,
3. Closed systems that do not allow significant escape to the laboratory environment, and
4. Extremely small quantities of otherwise problematic chemicals. The procedure itself must be evaluated for its potential to increase volatility or produce aerosols.

The hood sash should remain at the proper indicated sash height when it is in use (12-18 inches). When adjustments are needed to laboratory equipment or operations within the hood while chemical emissions are being produced, the hood sash should not be raised beyond the 80 feet per minute (fpm) indicator.

17.3 CHEMICAL FUME HOOD MAINTENANCE AND INSPECTIONS

The following are fundamental aspects of the BSU fume hood surveillance program:

1. Daily hood function inspections -- Daily (or "before each use") inspections by the Laboratory Safety Officer, faculty, or Principal Investigator should be conducted:

    a. Visually inspect the hood area for storage of materials and other visible blockages.
    b. Ensure that installed monitors and function switches and lights are operable and indicate the unit is functioning properly.
    c. If hood function indicating devices are not a part of your hood, or are not operational, place a 1 inch by 6 inch piece of soft tissue paper (e.g., KimWipe® or a ribbon), tinsel, or other light weight flow indicator at the hood opening and observe it for appropriate directional flow into the hood.
    d. If the hood is not operating properly, notify FPM Work Control (28)5-5081 for the necessary repairs. Label the subject fume hood as inoperable and do not allow its use. Contact the EHS Office to mark the unit as not usable pending repair.

2. Periodic hood function inspections

    The quality and quantity of ventilation is to be evaluated upon installation, annually, and whenever a change in local ventilation devices is made. These evaluations are the responsibility of EHS Office who should be contacted by the Department or Laboratory Manager if any hoods are found to be not working or of questionable performance. The fume hood inspection protocol is provided in **Chapter 35** to this Plan.

    a. Capture or face velocity will be measured with a velometer or anemometer. Hoods for most common chemicals should have an average face velocity of 80-120 linear feet per minute at sash opening of 12 inches or higher. Face velocity readings should not vary by more than 20%. A minimum of six readings shall be used to determine average face velocity.

    b. Any fume hood that cannot maintain an average face velocity above 70 fpm at the appropriate sash height, or a velocity in excess of 125 fpm will be marked for repair and is not to be used.

    c. Local exhaust devices should be smoke tested to determine if the contaminants they are designed to remove are being adequately captured by the hood.

    d. Inspections consist of measuring the face velocity of the hood and using a smoke stick to check its containment effectiveness visually. If the laboratory hood passes both the face velocity and smoke containment tests, then it is posted visually with an updated certification date or label. If the hood does not pass the survey and the problem is so severe that it is unsafe for use, then it is labeled with a "DO NOT USE" sign. It is the responsibility of researchers and laboratory supervisors to notify the Chemical Hygiene Officer or EHS Office if any hoods in their laboratory do not have an updated certification label.

e. If a hood fails inspection due to a problem that FPM, Environmental Control, can correct (*e.g.,* a slipping fan belt, cracked duct work) then the Laboratory Supervisor or Department should submit a work order to Work Control to have it repaired. Work Control is to notify the Chemical Hygiene Officer (BSU EHS Office) when the repairs have been made, and the fume hood is then re-inspected. If a hood functions poorly due to incorrect use (*e.g.*, cluttered hoods) then the EHS Office will notify the Laboratory Supervisor and Department.

3. Fume hood maintenance

   a. Exhaust fan maintenance, (i.e., lubrication, belt tension, fan blade deterioration and rpm), shall be in accordance with the manufacturer's recommendation or as adjusted for appropriate hood function.

   b. Ductwork should be inspected for corrosion, buildup of condensate or particulate, and dampers checked and lubricated for appropriate operation.

   b. Any air cleaning equipment such as charcoal or HEPA filters should be monitored for contaminant buildup. If not supplied with differential pressure gauges or audible alarms, the filters should be leak tested.

17.4 OTHER CONTAINMENT DEVICES

Biological Safety Cabinets

Biological Safety Cabinets (BSC), also known as tissue culture hoods or laminar flow hoods, are the primary means of containment for working safely with infectious microorganisms. Cabinets are available that either exhaust to the outside or that recirculate HEPA filtered air to the laboratory. They are not to be used for working with volatile or hazardous chemicals unless they are specifically designed for that purpose and are properly vented. Generally, the only chemical work that should be done in a BSC is that which could be done safely on a bench top involving chemicals that will not damage the BSC or the HEPA filter. For proper cabinet selection and use see, the CDC publication, *Primary Containment for Biohazards*.

Glove Boxes or Gas Cabinets

Other containment devices, such as glove boxes or vented gas cabinets, may be required when it is necessary to provide an inert atmosphere for the chemical procedure taking place, when capture of any chemical emission is desirable, or when the standard laboratory fume hood does not provide adequate assurance that overexposure to a hazardous chemical will not occur. The presence of biological or radioactive materials may also mandate certain special containment devices. High strength barriers coupled with remote handling devices may be necessary for safe use of extremely shock sensitive or reactive chemicals.

Highly localized exhaust ventilation, such as is usually installed over atomic absorption units, may be required for instrumentation that exhausts toxic or irritating materials to the laboratory environment.

Ventilated chemical storage cabinets or rooms should be used when the chemicals in storage may generate toxic, flammable or irritating levels of airborne contamination.

17.5 VENTILATION FAILURE

1. Questionable ventilation or requests to evaluate ventilation throughput or efficiency should first be made to the FPM Environmental Control Department through Work Control at (28)5-5081.

2. Ventilation problems or fume hood alarms that are sounding should be reported to FPM Environmental Control at (28)5-5081.

3. In the event of a total or catastrophic ventilation failure:
    i. Take steps to cease operations (if doing so will not cause harm). This may include stabilizing the experiment, shutting off utilities, closing the sash, and closing the laboratory door.
    ii. If appropriate, pull the fire alarm to evacuate the building. Otherwise, keep people from entering the lab.
    iii. Notify your Laboratory Supervisor, and FPM Environmental Control
4. In the event the ventilation concern can not be corrected through the efforts of FPM Environmental Control, the EHS Office should be contacted at (28)5-2807.
5. If a fume hood, or other ventilation dependent device or area, can not be positively confirmed as operational, the equipment or device should not be utilized until it is repaired.

18.0 WORK WITH PARTICULARLY HAZARDOUS MATERIALS

While many of the chemical substances discussed in this Chapter are not handled on our Campus, the following information is included in this Plan for consideration by the various university Departments in their purchasing and laboratory activity considerations. The OSHA regulations specifically require that these materials, and the procedures for their identification and safe handling, be included in this Chemical Hygiene Plan. In fact, several of the chemicals are used in considerable quantities or as incidental components of other compounds or solutions in BSU laboratories.

18.1 IDENTIFICATION OF PARTICULARLY HAZARDOUS SUBSTANCES

A. Identification and Classification of Particularly Hazardous Substances

As defined earlier in this Chemical Hygiene Plan, *Hazardous Chemicals* are chemicals for which there is scientific evidence that adverse acute or chronic health effects may occur in exposed workers.

There are some substances, however, that pose such significant threats to human health that they are classified as **"Particularly Hazardous Substances"** (PHSs). The OSHA Laboratory Standard requires that special provisions be established to prevent the harmful exposure of researchers to PHSs. General procedures for working with such materials will follow. Three categories of *Particularly Hazardous Substances* are defined in the OSHA Lab Standard: Carcinogens, Reproductive Toxins, And Compounds with a High Degree Of Acute Toxicity.

1. **Select Carcinogens**

Certain potent carcinogens are classified as "select carcinogens" and treated as PHSs. A select carcinogen is defined in the OSHA Lab Standard as a substance that meets one of the following criteria:

(a) It is regulated by OSHA as a carcinogen,

(b) It is listed as "known to be a carcinogen" in the latest *Annual Report on Carcinogens* published by the National Toxicology Program (NTP),

(c) It is listed under Group 1 ("carcinogenic to humans") by the *International Agency for Research on Cancer* (IARC), or

(d) It is listed under IARC Group 2A or 2B, ("probably carcinogenic to humans") or under the category "reasonably anticipated to be a carcinogen" by the NTP, *and* causes statistically significant tumor incidence in experimental animals after:

(i) inhalation exposure of 7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;
(ii) repeated skin application of less than 300 mg/kg of body weight per week; or
(iii) oral dosages of less than 50 mg/kg of body weight per day.

The table below lists some of the more common substances meeting criteria (a), (b), or (c). For a more comprehensive listiong of these and other PHSs, see **Chapter 23.3, Appendix III, Table 10** of this CHP.

Partial List of Select Carcinogens

acrylonitrile	diethylstilbestrol
analgesic mixtures containing phenacetin	dimethylaminoazobenzene
arsenic and certain arsenic compounds	ethylene oxide
asbestos	ethylenimine
azathioprine	2-acetylaminofluorene
benzene	formaldehyde
benzidinemustard gas	melphalan
betel quid containing tobacco (chewing)	methoxsalen with ultraviolet A therapy
4-aminobiphenyl	methylene chloride (1,1-dichloromethane)
4-nitrobiphenyl	α-naphthylamine
(1,4-butanediol dimethylsulfonate (myleran)	β-naphthylamine
bis(chloromethyl) ether	N,N'-*bis*(2-chloroethyl)-2-naphthylamine (chlornaphazine)
chlorambucil	N-nitrosodimethylamine
4,4'-methylene-*bis*(2-chloroaniline)	β-propiolactone
3,3'-dichlorobenzidine (and its salts)	shale oils
chloromethyl methyl ether	smokeless tobacco products (oral use)
1,2 dibromo-3-chloropropane	soots and soot extracts
chromium and certain chromium compounds	thorium dioxide
coal tars	tobacco smoke
coal-tar pitches	treosulphan
conjugated estrogens	vinyl chloride
cyclophosphamide	diethylstilbestrol

2. **Reproductive Toxins**

Reproductive toxins act during pregnancy and cause adverse effects on the fetus; these effects include embryolethality (death of the fertilized egg, embryo or fetus), malformations (teratogenic effects), and postnatal functional defects. Examples of embryotoxins include

thalidomide, and physical agents such as radiation. Women of childbearing potential should note that embryotoxins have the greatest impact during the first trimester of pregnancy. Because a woman often does not know that she is pregnant during this period of high susceptibility, special caution is advised when working with all chemicals, especially those rapidly absorbed through the skin (*e.g.*, formamide, DMSO, *etc.*). Pregnant women and women intending to become pregnant should consult with their laboratory supervisor and Occupational Health Services before working with substances that are suspected to be reproductive toxins. As minimal precautions, the general procedures outlined in Part VII.C below should be followed for work with such compounds.

The following table lists some common materials that are highly suspected to be reproductive toxins.

Partial List of Reproductive Toxins

acrylic acid	hexachlorobenzene
aniline	iodoacetic acid
benzene	lead compounds
cadmium	mercury compounds
carbon disulfide	nitrobenzene
N,N-dimethylacetamide	nitrous oxide
dimethylformamide (DMF)	phenol
dimethyl sulfoxide (DMSO)	polychlorinated and polybrominated biphenyls
diphenylamine	toluene
estradiol	vinyl chloride
formaldehyde	xylene
formamide	

The above list is not intended to be complete, and it is the responsibility of researchers (in consultation with their laboratory supervisors) to evaluate each compound involved in their work and to determine whether it should be handled as a reproductive toxin. A more complete list is provided in **Chapter 23.3, Appendix III, Table 10** to this Plan. Women who are pregnant or are planning for pregnancy should review this section and **Section 36** regularly.

3. **Compounds with a High Degree of Acute Toxicity**

Compounds that have a high degree of acute toxicity comprise a third category of particularly hazardous substances as defined by the OSHA Lab Standard. Acutely toxic agents include

certain corrosive compounds, irritants, sensitizers (allergens), hepatotoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes. High acute toxicity includes any chemical that falls within any of the following OSHA-defined categories:

a. A chemical with a median lethal dose (LD50) of 50 mg or less per kg of body weight when administered orally to certain test populations.

b. A chemical with an LD50 of 200 mg less per kg of body weight when administered by continuous contact for 24 hours to certain test populations.

c. A chemical with a median lethal concentration (LC50) in air of 200 parts per million (ppm) by volume or less of gas or vapor, or 2 mg per liter or less of mist, fume, or dust, when administered to certain test populations by continuous inhalation for one hour, provided such concentration and/or condition are likely to be encountered by humans when the chemical is used in any reasonably foreseeable manner.

Substances which have a high degree of acute toxicity are interpreted by OSHA as being substances defined as "toxic" and “highly toxic” agents in 29 CFR 1910.1200 (see Table below), and substances which “may be fatal or cause damage to target organs as the result of a single exposure or exposures of short duration.”

Compounds with a High Degree of Acute Toxicity (Table)

Exposure Route	Toxic	Highly Toxic
Oral LD_{50} (Albino rats)	50-500 mg/kg	<50 mg/kg
Skin Contact LD_{50} (Albino rabbits)	200-1000 mg/kg	<200 mg/kg
Inhalation LD_{50} (Albino rats)	200-2000 ppm/air	<200 ppm/air

Some of the more common compounds in current use in research laboratories and which have a high degree of acute toxicity are listed below:

Partial List of Compounds with a High Degree of Acute Toxicity

acrolein	hydrazine
acrylic acid	hydrogen cyanide
acrylonitrile	hydrogen fluoride
allyl alcohol	hydrogen sulfide
allylamine	methyl fluorosulfonate
bromine	methyl iodide
chlorine	nickel carbonyl
diazomethane	nicotine
diborane (gas)	nitrogen dioxide
l,2-dibromoethane	osmium tetroxide
dimethyl sulfate	ozone
ethylene oxide	sodium azide
phosgene	sodium cyanide (and other cyanide salts)

The above list is not intended to be complete, and it is the responsibility of the researcher (in consultation with their laboratory supervisor) to evaluate each compound involved in their work and to determine whether it is a substance with a high degree of acute toxicity. A more complete list is provided in **Chapter 23.3, Appendix III, Table 10**. Compounds so classified generally must then be handled using these procedures for particularly hazardous substances. Note, however, that in some circumstances (*e.g.,* when very small quantities of material are being used) it may not be necessary to employ all of the special precautions described. It is the responsibility of the laboratory or safety supervisor to determine whether a compound with a high degree of acute toxicity is to be treated as a "particularly hazardous substance" in the context of its specific use in his or her laboratory.

In evaluating the hazards associated with work with toxic substances, it is important to note that a number of factors influence the response of individuals to exposure to a toxic compound. For example, people are rarely exposed to a single biologically active substance. With this point in mind, it is noteworthy that one toxin can influence the effect of a second. Several classic examples are the dramatically enhanced lung carcinogenicity of combined exposure to asbestos and tobacco smoke, and the potentiating activity of phorbol esters on skin carcinogenesis initiated by polycyclic hydrocarbons. There are insufficient data at present to identify which substances potentiate (or possibly even antagonize) the effects of others, but is important for laboratory workers to be cognizant that such interactions can occur. This point underscores the importance of maintaining good laboratory practices at all times, and with all chemicals.

As a final point, it is also noteworthy that the response of an organism to a toxin typically increases with the dose given, but the relationship is not always a linear one. As one example, some carcinogenic alkylating agents show a biphasic dose-mutation curve resembling a hockey stick pointed upward from left to right. It is now well established that the resistance of many organisms to mutagenesis by low doses of simple alkylating agents is due in large measure to a genoprotective system; once that system saturates, at the breakpoint in the curve, the organism becomes much more sensitive to the toxin. This example illustrates two points. First, we have systems that protect against low doses of many toxins (not all, but many). But, as a second, cautionary note, it is pointed out that between individuals there are differences in the levels of genoprotection and other toxin defense systems. These differences are in part genetically determined but also are determined in part by the aggregate exposure of the individual to all chemicals within and outside of the laboratory. Accordingly, it is difficult to estimate exactly how sensitive a given person will be on a given day to a given substance. This point urges once again that a cautious approach be taken in handling all chemicals in the workplace and that appropriate steps be taken at all times to keep exposure to chemicals as low as possible.

18.2 DESIGNATED AREAS

A key requirement of the *OSHA Laboratory Standard* is that all work with particularly hazardous substances be confined to designated areas. A designated area is defined as a laboratory, an area of a laboratory, or a device such as a laboratory hood that is posted with warning signs to ensure that all employees working in the area are informed of the hazardous substances in use there.

It is the responsibility of Laboratory Supervisors or Safety Officers to define the designated areas in their laboratories. These areas shall be posted with conspicuous signs reading ***DESIGNATED AREA FOR USE OF PARTICULARLY HAZARDOUS SUBSTANCES—AUTHORIZED PERSONNEL ONLY***. (Other suggested signage is illustrated in **Chapter 23.1**, **Appendix I, Figures 1-4**.) In some cases it may be appropriate to post additional signs describing unusual hazards present and/or identifying the specific hazardous substances in use. Regardless, the designated area must be clearly marked and access controlled.

18.3 GENERAL PROCEDURES FOR WORK WITH SUBSTANCES OR MODERATE TO HIGH CHRONIC TOXICITY OR HIGH ACUTE TOXICITY

The following general procedures should be followed in work with substances with **high acute toxicity—** *i.e.* substances that can be fatal or cause serious damage to target organs as the result of a single exposure of short duration. These procedures should also be employed in laboratory operations using those **carcinogens and reproductive toxins** for which infrequent, small quantities do not constitute a significant hazard, but which can be dangerous to workers

exposed to high concentrations or repeated small doses. A substance that is not known to cause cancer in humans, but which has shown statistically significant, but low, carcinogenic potency in animals, generally should also be handled according to the procedures outlined in this section. Work with more potent carcinogens and reproductive toxins requires the additional precautions described below.

(1) **Information**

Before beginning a laboratory operation, each researcher should consult the appropriate literature for information about the toxic properties of the substances that will be used. The precautions and procedures described below should be followed if any of the substances to be used in significant quantities is known to have high acute or moderate chronic toxicity. If any of the substances being used is known to be highly toxic, it is desirable that there be at least two people present in the area at all times. These procedures should also be followed if the toxicological properties of any of the substances being used or prepared are unknown. If any of the substances to be used or prepared are known to have high chronic toxicity (*e.g.*, compounds of certain heavy metals and strong carcinogens), then the precautions and procedures described below should be supplemented with the additional precautions outlined in this CHP.

(2) **Zero skin contact**

Contact with the skin is a frequent mode of injury. Many toxic substances are absorbed through the skin with sufficient rapidity to produce systemic poisoning. *Avoid all skin contact with particularly hazardous substances* by using suitable protective apparel including the appropriate type of gloves or gauntlets (long gloves) and a suitable laboratory coat or apron which covers all exposed skin. Always wash your hands and arms with soap and water immediately after working with these materials. In the event of accidental skin contact, the affected areas should be flushed with water and medical attention should be obtained as soon as possible.

(3) **Use laboratory hoods**

Inhalation of toxic vapors, mists, gases, or dusts can produce poisoning by absorption through the mucous membrane of the mouth, throat, and lungs, and can seriously damage these tissues by local action. Inhaled gases or vapors may pass rapidly into the capillaries of the lungs and be carried into the circulatory system. This absorption can be extremely rapid. *Procedures involving volatile toxic substances and those operations involving solid or liquid toxic substances that may result in the generation of aerosols must be conducted in a hood or other suitable containment device.* The hood should have been evaluated previously to establish that it is

providing adequate ventilation and has an average face velocity of not less than 80 linear ft/min. See **Chapters 17 and 34** for further discussion of the operation of laboratory hoods.

(4) **Be prepared for accidents**

The laboratory worker should always be prepared for possible accidents or spills involving toxic substances. To minimize hazards from accidental breakage of apparatus or spills of toxic substances in the hood, containers of such substances should generally be stored in pans or trays made of polyethylene or other chemically resistant material and (particularly in large scale work) apparatus should be mounted above trays of the same type of material. Alternatively, the working surface of the hood can be fitted with a removable liner of sorbent plastic-backed paper. Such procedures will contain spilled toxic substances in a pan, tray, or sorbent liner and greatly simplify subsequent cleanup and disposal.

If a major release of a particularly hazardous substance occurs outside the hood, then the room or appropriate area should be evacuated and necessary measures taken to prevent exposure of other workers. If necessary, call Campus Police at (28)5-1111 or 911 for assistance and equipment for spill clean-up. Spills should only be cleaned up by personnel trained in response and familiar with the chemical(s) involved after donning suitable personal protective apparel the application and use for which they have been trained and cleared. If a spill of a toxicologically significant quantity of toxic material occurs outside the hood, a supplied-air full-face respirator may be necessary. Contaminated clothing and shoes should be thoroughly decontaminated or incinerated.

(5) **Don't contaminate the environment**

Vapors that are discharged from experiments involving particularly hazardous substances should be trapped or condensed to avoid adding substantial quantities of toxic vapor to the hood exhaust air. The general waste disposal procedures outlined in **Chapter 16** and the BSU Waste Management guide (**Chapter 33**) should be followed; however, certain additional precautions should be observed when waste materials are known to contain substances of moderate or high toxicity. Volatile toxic substances should never be disposed of by evaporation in the hood. If practical, *waste materials and waste solvents containing toxic substances should be decontaminated chemically by some procedure that can reasonably be expected to convert essentially all of the toxic substances to nontoxic substances* (for a discussion, see *Prudent Practices for Handling and Disposal of Chemicals from Laboratories,* pp. 56-100 and *Destruction of Hazardous Chemicals in the Laboratory* by G. Lunn and E. B. Sansone). If chemical decontamination is not feasible, the waste materials and solvents containing toxic substances should be stored in closed, impermeable containers so that personnel handling the containers will not be exposed to their contents. In general, liquid residues should be contained in glass or polyethylene bottles half-filled with vermiculite. All containers of toxic wastes should be

suitably labeled to indicate the contents (chemicals and approximate amounts) and the type of toxicity hazard that contact may pose. For example, containers of wastes from experiments involving appreciable amounts of weak or moderate carcinogens should carry the warning: CANCER SUSPECT AGENT. All wastes and residues that have not been chemically decontaminated in the exhaust hood where the experiment was carried out should be disposed of in a safe manner that ensures that personnel are not exposed to the material.

(6) **Record keeping**

Every research or academic group in each BSU Department is required to maintain a list of all particularly hazardous substances in storage or use in their laboratories. It is recommended that Laboratory Safety Officers be assigned the responsibility for ensuring that this inventory list is kept up to date. In addition, records that include amounts of material used and names of workers involved should be kept as part of the laboratory notebook record of all experiments involving particularly hazardous substances.

(7) **Restrict access to areas where particularly hazardous substances are in use**

Those operations involving particularly hazardous substances in which there is the possibility of accidental release of harmful quantities of the toxic substance must be carried out in designated areas.

18.4 ADDITIONAL PROCEDURES FOR WORK WITH SUBSTANCES OF KNOWN HIGH CHRONIC TOXICITY

All of the procedures and precautions described in the preceding section should be followed when working with substances known to have high chronic toxicity. In addition, when such substances are to be used in quantities in excess of a few milligrams to a few grams (depending on the hazard posed by the particular substance), the additional precautions described below should also be used. A substance that has caused cancer in humans or has shown high carcinogenic potency in test animals (but for which a regulatory standard has not been issued by OSHA) will generally require the use of these additional procedures. However, this determination will also depend on other factors, such as the physical form and the volatility of the substance, the kind and duration of exposure, and the amount of material to be used. Besides strong carcinogens, substances in the high chronic toxicity category include potent reproductive toxins and certain heavy metal compounds such as dimethylmercury and nickel carbonyl.

(1) **Approvals**

Permission must be obtained from your Department head, Laboratory Safety Officer, Principal Scientist or research supervisor prior to any work with substances of known high chronic

toxicity. It is the supervisor's responsibility to approve all plans for experimental operations and waste disposal. For those chemicals that require prior approval (**see Section 20**), signed forms (See **Section 25.0, Form 2**) are required before conducting the project.

(2) **Restrict access to areas where substances of high chronic toxicity are being used and stored**

Any volatile substances having high chronic toxicity should be stored in a ventilated storage area in a secondary tray or container having sufficient capacity to contain the material should the primary container accidentally break. All containers of substances in this category should have labels that identify the contents and include a warning such as the following: ***WARNING! HIGH CHRONIC TOXICITY or CANCER SUSPECT AGENT***. Storage areas for substances in this category should be designated areas, and special signs should be posted if a special toxicity hazard exists. With the exception of materials that require refrigeration, substances of high chronic toxicity should be stored in areas maintained under negative pressure with respect to surrounding areas (*e.g.*, fume hoods).

All experiments with and transfers of such substances or mixtures containing such substances should be done in a designated area such as an efficient laboratory hood. When a negative pressure glove box in which work is done through attached gloves is used, the ventilation rate in the glove box should be at least two volume changes per hour, the pressure should be at least 0.5 in. of water lower than that of the external environment, and the exit gases should be passed through a trap or HEPA filter. Positive-pressure glove boxes are normally used to provide an inert anhydrous atmosphere. If these glove boxes are used with highly toxic compounds, then the box should be thoroughly checked for leaks before each use. If gases are vented from a glove box, they should be passed through a suitable trap or filter or directly into the hood system. Laboratory vacuum pumps used with substances having high chronic toxicity should be protected by high-efficiency scrubbers or HEPA filters and vented into an exhaust hood. Motor-driven vacuum pumps are recommended because they are easy to decontaminate. (*Note:* decontamination of a vacuum pump should be carried out in an exhaust hood). Designated areas should be clearly marked with a conspicuous sign reading: DESIGNATED AREA FOR USE OF PARTICULARLY HAZARDOUS SUBSTANCES—AUTHORIZED PERSONNEL ONLY. Only authorized and instructed personnel should be allowed to work in or have access to such designated areas.

(3) W**ear suitable personal protective apparel**

Proper gloves should be worn when transferring or otherwise handling substances or solutions of substances having high chronic toxicity (see *Prudent Practices,* pp. 158-160). Two gloves should generally be worn on each hand. In the event of an accident, the outer, contaminated gloves can then be removed and the researcher can immediately take steps to deal with the

accident. To avoid contamination of the general laboratory environment, protective gloves should be removed when leaving a designated area (*e.g.,* to answer the telephone). In some cases, the laboratory worker or the research supervisor may deem it advisable to use other protective apparel such as an apron of reduced permeability covered by a disposable coat. Extreme precautions such as these might be taken, for example, when handling large amounts of certain heavy metals and their derivatives or compounds known to be potent carcinogens. After working with such substances, laboratory workers should remove any protective apparel that has been used and thoroughly wash hands, forearms, face, and neck. If disposable apparel or absorbent paper liners have been used, these items should generally be placed in a closed and impervious container that should then be labeled in some manner such as the following: CAUTION: CONTENTS CONTAMINATED WITH SUBSTANCES OF HIGH CHRONIC TOXICITY. Nondisposable protective apparel should be thoroughly washed, and containers of disposable apparel and paper liners should be incinerated.

(4) **Protect the environment and dispose of waste materials properly**

Surfaces on which high-chronic-toxicity substances are handled should be protected from contamination by using chemically resistant trays or pans that can be decontaminated after the experiment or by using dry, absorbent, plastic-backed paper that can be disposed of after use.

Wastes and other contaminated materials from an experiment involving substances of high chronic toxicity should be collected, together with the washings from flasks, and either decontaminated chemically or placed in closed, suitably labeled containers for incineration. If chemical decontamination is to be used, a method should be chosen that can reasonably be expected to convert essentially all of the toxic materials into nontoxic materials. For example, residues and wastes from experiments in which β-propiolactone, *bis*(chloromethyl)ether, or methyl chloromethyl ether have been used should be treated for 10 min with concentrated aqueous ammonia. In the event that chemical decontamination is not feasible, wastes and residues should be placed in an impermeable container that should be closed and labeled in some manner such as the following: CAUTION: COMPOUNDS OF HIGH CHRONIC TOXICITY or CAUTION: CANCER SUSPECT AGENT. In general, liquid wastes containing such compounds should be placed in glass or (usually preferable) polyethylene bottles half filled with vermiculite and these should be transported in plastic or metal pails of sufficient capacity to contain the material in case of accidental breaking of the primary container. Consult the BSU EHS Office for instructions on the disposal of contaminated waste materials.

Normal laboratory work should not be resumed in an area that has been used for work with substances of high chronic toxicity until it has been adequately decontaminated. Work surfaces should be thoroughly washed and rinsed. If experiments have involved the use of finely divided solid materials, dry sweeping should not be done. In such cases, surfaces should be cleaned by

wet mopping or by use of a vacuum cleaner equipped with a high efficiency particulate air (HEPA) filter. All equipment (*e.g.*, glassware, vacuum traps, and containers) that is known or suspected to have been in contact with substances of high chronic toxicity should be washed and rinsed before they are removed from the designated area.

(5) **Be prepared for accidents**

Be prepared for the release of a substance of high chronic toxicity by formulating a contingency plan to deal with any accident that may occur. Make sure that the necessary equipment and materials are on hand to deal with possible accidents before beginning work with substances of high chronic toxicity.

(6) **Medical Surveillance**

If you anticipate being involved in continued experimentation with a substance of high chronic toxicity (*i.e.*, if you regularly use toxicologically significant quantities of such a substance three times a week), then a qualified physician should be consulted to determine whether it is advisable to establish a regular schedule of medical surveillance or biological monitoring. See **Chapter 9** for a further discussion of medical surveillance.

18.5 SPECIAL HANDLING PROCEDURES FOR SOME COMMON PARTICULARLY HAZARDOUS SUBSTANCES

This section outlines special handling procedures for some specific particularly hazardous substances that may be used in Department of Chemistry, Human Performance, and Biology laboratories. The information presented in this section is not meant to be complete, and researchers and laboratory workers should consult the appropriate literature and their Laboratory Supervisor or Safety Officer before working with these particularly hazardous substances.

(1) **Acrylonitrile (CH_2CHCN)**

Acrylonitrile is regulated as a human carcinogen by OSHA and also is listed as a substance with a high degree of acute toxicity. The PEL (permissible exposure limit) is 2 ppm as an 8-hour time-weighted average or 10 ppm as averaged over any 15-min period. Dermal or eye contact with liquid acrylonitrile is also prohibited. *Work involving significant quantities of acrylonitrile should be conducted using the general procedures outlined in both Sections 18.3 and 18.4.* Laboratory hoods that have been demonstrated to provide sufficient protection should be used, and closed systems are recommended for laboratory operations.

(2) **Benzene (C_6H_6)**

In humans, acute inhalation exposure to benzene can produce a picture of acute delirium, characterized by excitement, euphoria, and restlessness and, if the exposure is significantly high, the symptoms may progress to depression, drowsiness, stupor, and even unconsciousness. The concentration required to produce this symptom complex is 1000 ppm or higher. These concentrations will also produce irritation of the eye, nose, and respiratory tract. Chronic inhalation exposure to 25-50 ppm of benzene can produce changes in the blood picture that include macrocytosis, decrease in the total red blood count, decrease in platelets, decrease in the hemoglobin concentration, or decrease in leukocytes. Any or all of these hematologic effects may be seen in any individual. Usually, the worker will be asymptomatic while these effects are observed in the blood picture. Continued exposure at somewhat higher concentrations (probably more than 100 ppm) can insidiously result in a more severe blood disorders that include leukopenia or even aplastic anemia, with symptoms of headaches, dizziness, loss of appetite, nervousness, irritability, and perhaps bleeding manifestations, *i.e.*, nosebleeds, easy bruisability, or hematuria. Severe cases may have fatal outcomes. Benzene is designated as a "Human Carcinogen" (OSHA).

Recently, a number of reports have been published that describe leukemia in workers who have had aplastic anemia. These cases have been reported in Italy and Turkey in workers exposed to grossly high concentrations of benzene. In addition, there is some indication that an excess of leukemia may occur without a preceding picture of aplastic anemia in workers who have been repeatedly exposed to benzene at concentrations of more than 100 ppm.

The current OSHA PEL for benzene is 10 ppm as an 8-hour time-weighted average (TWA), 25 ppm for a ceiling concentration for time period such that the 8-hour TWA is not exceeded, and a peak above the ceiling of 50 ppm for no more than 10 min. Benzene is a flammable liquid and should not be exposed to heat or flame. An explosion hazard also exists when its vapors are exposed to flame. Benzene may react vigorously with oxidizing agents such as bromine pentafluoride, chlorine, chromic acid, nitryl perchlorate, oxygen, ozone, perchlorates, aluminum chloride plus fluorine perchlorate, sulfuric acid plus permanganates, potassium peroxide, silver perchlorate plus acetic acid, and sodium peroxide.

Experiments involving the use of benzene should be conducted employing the general procedures outlined in Section 18.3; all operations in which there is the possibility of the accidental release of harmful quantities of benzene should be carried out in a designated area.

(3) **Bis(chloromethyl)ether (BCME), Chloromethyl Methyl Ether, and Other Chloromethyl Ether Derivatives**

Because of the high volatility of *bis*(chloromethyl)ether (BCME), inhalation is the route of exposure that presents the greatest hazard to humans. BCME vapor is severely irritating to the skin and mucous membranes and can cause corneal damage that heals slowly. The substance has caused lung cancer in humans. BCME is highly toxic to animals via inhalation: LD_{50} (rats, 7-hour inhalation) = 7 ppm. It is moderately toxic via the oral and skin routes: LD_{50} (rats, oral) = 280 mg/kg; LD_{50} (rabbits, skin) = 368 mg/kg. Its vapors are strongly irritating to the eyes of rats. Rats and hamsters subjected to 10 or 30, 6-hour exposures of 1 ppm BCME showed evidence of tracheal and bronchial hyperplasia, as well as effects on the central nervous system. BCME is carcinogenic to mice following inhalation, skin application. or subcutaneous administration. In newborn mice, it is carcinogenic by inhalation and subcutaneous administration. BCME is a lung carcinogen in humans.

The TLV for BCME is 0.001 ppm (1 ppb; 5 mg/m^3). The substance is classified by ACGIH as a human carcinogen. OSHA has classified BCME as a cancer-suspect agent and has stringent regulations (29 CFR 1910.1008) for its use if its concentration in a material exceeds 0.1%. *Work involving chloromethyl ether derivatives must be carried out with the general procedures outlined in Parts 18.3 and 18.4.*

(4) **Carbon Monoxide (CO)**

Carbon monoxide is a direct and cumulative poison. It combines with the hemoglobin of the blood to form a relatively stable compound, carboxyhemoglobin, and renders it useless as an oxygen carrier. When about one-third of the hemoglobin has entered into such combination, the victim dies. The gas is a treacherous poison because of its odorless character and insidious action. Exposure to 1500-2000 ppm CO in air for 1 hour is dangerous, and exposure to 4000 ppm is fatal in less than 1 hour. Headache and dizziness are the usual symptoms of CO poisoning, but occasionally the first evidence of poisoning is the collapse of the patient.

Carbon monoxide should be used only in areas that have adequate ventilation employing the general procedures outlined in Part VII.C. A trap or vacuum break should always be used to prevent impurities from being sucked back into a CO cylinder.

(5) **Carbon Tetrachloride (CCl_4)**

The current OSHA PEL and TLV for carbon tetrachloride are 10 ppm as an 8-hour time-weighted average, 25 ppm as a ceiling for any period of time provided the 8-hour average is not exceeded, and 200 ppm for 5 min in a 4-hour period; in 1980, the ACGIH proposed a change to 5 ppm for an 8-hour time weighted average and a ceiling exposure level of 20 ppm for up to 15 min on the basis that carbon tetrachloride is suspected to have carcinogenic potential in humans. ACGIH also states that skin contact may account for a substantial part of toxic responses.

The carcinogenic potency of carbon tetrachloride is low and in *most of its uses in laboratories, it need not be treated as a particularly hazardous substance.* In cases where large quantities of carbon tetrachloride are in frequent use, then the general procedures outlined in Section 18.3 should provide adequate protection. All operations should be carried out in a hood, not only because of the carcinogenicity of the substance, but also because of its other toxic effects and its volatility. Nitrile rubber is the recommended material for gloves and other protective clothing. As a closing note: the toxicity of CCl_4 is enhanced synergistically if alcohol is consumed after exposure.

(6) **Chlorine (Cl_2)**

Chlorine is classified as a substance with a high degree of acute toxicity. Humans can generally detect the odor of chlorine at about 0.3 ppm. Minimal irritation of the throat and nose are noticed at about 2.6 ppm and painful irritation at about 3.0 ppm; at a range of 2.6-41.0 ppm, a group of "trained industrial hygienists" noted “strong irritation.” The subjective response to chlorine is less pronounced with prolonged exposure. Experimentally determined responses to chlorine by humans are not very consistent. Throat irritation occurs at about 6.6-15 ppm. However, an exposure for medical purposes of a large number of humans to 5-7 ppm for 1 hour did not result in serious or long-term consequences. Exposure to about 17 ppm causes coughing, and levels as low as 10 ppm may cause lung edema. Chronic effects on humans from long-term low-level exposures have been well documented. Animal exposures have indicated that prolonged exposure to approximately 1.7 ppm for 1 hour per day may cause deterioration in the nutritional state, blood alteration, and decreased resistance to disease. The TLV and the OSHA PEL are 1 ppm (3 mg/m^3) as a ceiling. NIOSH has recommended a ceiling limit of 0.5 ppm over any l5-min period. The ACGIH l5-min exposure limit is 3 ppm.

Chlorine should be kept away from easily oxidized materials. Chlorine reacts readily with many organic chemicals, sometimes with explosive violence. Because of the high toxicity of chlorine, *laboratory operations using it must be carried out in a hood employing the general procedures outlined in Section 18.3 of this Chapter.*

(7) **Chloroform ($CHCl_3$)**

Inhalation exposure to chloroform at concentrations greater than 1000 ppm can produce dizziness, nausea, and headaches. At higher concentrations, there can be disorientation and delirium progressing to unconsciousness. Such high exposure can also produce liver and possibly kidney damage. It is believed that chloroform can sensitize the heart to adrenaline, so it may cause cardiac arrhythmias and possibly death. High concentrations of the vapor can produce conjunctivitis. Liquid chloroform in the eyes will produce a painful corneal injury that usually heals in several days. Chronic exposure to chloroform at concentrations of 100-200 ppm has been reported to produce large livers. Continued contact with the skin can produce drying,

fissuring, and inflammation. In experimental studies, prolonged ingestion of high levels of chloroform by mice resulted in liver cancers and by rats, kidney tumors.

Although the fire hazard of chloroform is slight, exposure to heat or flame can result in generation of phosgene gas. Chloroform reacts violently with acetone plus a base, aluminum, disilane, lithium, magnesium, nitrogen tetroxide, potassium, perchloric acid plus phosphorus pentoxide, potassium hydroxide plus methanol, potassium *t*-butoxide, sodium, sodium hydroxide plus methanol, sodium methylate, or sodium hydride.

The current OSHA PEL for chloroform is 50 ppm as an 8-hour time-weighted average. This standard is also a ceiling level that should not be exceeded for any l5-min period. The ACGIH currently recommends that chloroform be treated as a suspect human carcinogen and recommends an 8-hour time weighted average exposure of 10 ppm.

Although chloroform has caused tumors in animals, its potency is low. *In most of its uses chloroform need not be treated as a particularly hazardous substance.* In cases where significant quantities of chloroform are in frequent use, the general procedures outlined in Part VII.C should provide adequate protection. The high volatility of chloroform emphasizes the importance of a hood for such operations. Polyvinyl alcohol gloves provide the best hand protection.

(8) **Dimethyl Sulfate ($(CH_3)_2SO_4$, DMS) and Diethyl Sulfate ($(CH_3CH_2)_2SO_4$, DS)**

Many cases of dimethyl sulfate poisoning have been reported. The common initial symptoms are headache and giddiness, with burning of the eyes. The patient's condition may worsen, with possible painful eyes, nose and throat irritation, loss of voice, coughing, difficulty in breathing and swallowing, vomiting, and diarrhea. The onset of the symptoms may be delayed up to 10 hours. Skin contact causes blistering and necrosis, and DMS can be absorbed through the skin in sufficient quantity to cause systemic intoxication. In the worst cases, there is severe inflammation of the mucous membranes and pulmonary injury that may be fatal; several deaths have occurred. For example, exposure to 97 ppm for 10 min was fatal. DMS is moderately toxic to animals via the oral route: LD_{50} (rats) = 440 mg/kg. Undiluted DMS produced moderate to severe irritation when applied to the skin of guinea pigs; 1% DMS produced mild irritation. DMS does not cause skin sensitization in animals. Undiluted DMS applied to rabbit eyes produced severe injury. Even a 1-hour exposure to 58 ppm has resulted in permanent eye damage in rats. During a 4-hour exposure, 30 ppm DMS killed five out of six rats, but 15 ppm was not lethal.

DMS has been shown to be carcinogenic in the rat by inhalation, subcutaneous injection, and following 1 hour per day exposures to 10 ppm DMS for 130 days. The TLV for DMS is 0.1 ppm (0.5 mg/m^3) as an 8-hour time-weighted average. DMS is classified as being suspected of

carcinogenic potential in humans by the ACGIH. The OSHA PEL for DMS is 1.0 ppm. These limits include a warning of the potential contribution of skin absorption to the overall exposure.

The general procedures outlined in Section 18.4 should be used when handling more than a few grams of DMS in view of its fairly high carcinogenic potency in rats by inhalation and its ability to penetrate the skin. It is particularly important to avoid skin contact by appropriate use of rubber gloves, a rubber apron, and other protective apparel, and to avoid inhalation of even low concentrations of vapor by working in a hood. Operations involving smaller quantities of DMS can be conducted using the general procedures presented in Section 18.3.

(9) **Ethylene Dibromide (l,2-Dibromoethane, EDB)**

Ethylene dibromide (EDB) is classified as a compound with a high degree of acute toxicity; the approximate oral lethal dose of EDB for humans is 5 mL. Skin absorption of EDB can also cause death, and inhalation of the vapor can produce pulmonary edema. EDB can cause severe irritation to all exposed tissues, respiratory tract, skin, and eye. Systemic effects include central nervous system depression, kidney injury, and severe liver necrosis. Ethylene dibromide is highly toxic to animals via inhalation. The maximum survival exposure of rats to EDB vapors in air is 3000 ppm for 6 min, 400 ppm for 30 min, and 200 ppm for 2 hours. It is moderately toxic via the oral and skin routes: LD_{50} (rats, oral) = 140 mg/kg; LD_{50} (rabbits, skin) = 300 mg/kg. EDB is markedly irritating to skin, and a 10% solution has caused serious but reversible corneal injury in rabbit eyes. Rats were repeatedly exposed to 50 ppm EDB for 6 months. Half died from pneumonia and upper respiratory tract infections. Slight changes in the liver and kidney were seen. EDB has induced a high incidence of tumors (squamous-cell carcinomas of the forestomach) in mice and rats following oral administration. The 1979 TLV for EDB was 20 ppm (155 mg/m^3) as an 8-hour time-weighted average. The exposure limit is 30 ppm over any l5-min period. These limits include a warning about the potential contribution of skin absorption to the overall exposure. In 1980, the ACGIH put EDB in category A 1b (human carcinogen). For this category, there is no assigned TLV, but the ACGIH recommends that those working with A 1b carcinogens should be properly equipped to ensure virtually no contact with the carcinogens. The OSHA PEL for EDB is 20 ppm, and the acceptable maximum peak is 50 ppm for 5 min in any 8-hour time period.

On the basis of the carcinogenicity data for EDB, *the procedures described in Section 18.4 should be followed when handling more than a few grams in the laboratory.* Operations involving smaller quantities should be carried out using the procedures outlined in *Section 18.3*. Serious skin injury can occur from direct exposure to EDB. The substance can penetrate neoprene and several other types of plastic; therefore, gloves and other protective apparel of these materials provide only temporary protection if EDB spills on them.

(10) **Hydrazine (H_2NNH_2)**

Hydrazine is classified as a compound with a high degree of acute toxicity; exposure to its vapors can cause respiratory tract irritation, excitement, convulsion, cyanosis, and decrease in blood pressure. The liquid can severely burn the eyes and skin. Hydrazine can cause fatty degeneration of the liver, nephritis, and hemolysis. Hydrazine also poses a dangerous fire and explosion risk and can explode during distillation if traces of air are present. Hydrazine is moderately toxic to animals via the inhalation, oral, and skin routes: LC_{50} (rats, 4-hour inhalation) = 570 ppm; LD_{50}(rats, oral) = 60 mg/kg; LD_{50}(rabbits, skin) = 283 mg/kg (hydrazine hydrate). It is a strong skin and mucous membrane irritant and a strong skin sensitizer. Hydrazine hydrate produced moderately severe irritation when applied to rabbit eyes. After repeated oral, skin, or injection exposure, the effects noted include weight loss, weakness, vomiting, and convulsions. The chief histological finding is fatty degeneration of the liver. Among guinea pigs and dogs exposed to hydrazine in the air 547 times, the dogs showed liver damage, with lesser damage to the kidneys and lungs, while the guinea pigs had pneumonitis and partial lung collapse.

Hydrazine and hydrazine salts have been shown to be carcinogenic in mice after oral and intraperitoneal administration and in rats following oral dosing. By the oral route, effects were found at doses of 24-36 (mg/kg)/day in mice and 20 (mg/kg)/day in rats. No tumors were observed in Syrian golden hamsters after oral administration. The ACGIH has classified hydrazine as suspected of carcinogenic potential in humans. The TLV for hydrazine is 0.1 ppm (0.1 mg/m^3) and the OSHA PEL is 1.0 ppm (1 mg/m^3) as 8-hour time-weighted averages. These limits include a warning about the potential contribution of skin absorption to the overall exposure. NIOSH has (1978) recommended a ceiling limit of 0.03 ppm in any 2-hour period.

When more than a few grams of hydrazine are to be used in the laboratory, the general procedures outlined in both Section 18.3 and 18.4 should be used because hydrazine is carcinogenic in animal tests, quite volatile, and readily absorbed through the skin. Nitrile rubber is recommended for gloves and other protective apparel. Prompt washing with water effectively removes hydrazine from skin that it has splashed on. Hydrazine should not be used in the vicinity of a flame or under conditions where sparks can occur, as an explosion or fire can result.

(11) **Hydrogen Bromide (HBr) and Hydrogen Chloride (HCl)**

Both hydrogen bromide (HBr) and hydrogen chloride (HCl) are toxic gases that are severely irritating to the upper respiratory tract. The acids formed neutralize the alkali of the tissues and can cause death as a result of edema or spasm of the larynx and inflammation of the upper respiratory system. Concentrations of 0.13-0.2% are lethal for human beings in exposures lasting a few minutes. However, because of their odor, usually these gases provide adequate

warning for prompt voluntary withdrawal from contaminated atmospheres. These gases are also corrosive to the skin and mucous membranes and can cause severe burns. Exposure to high concentrations may also result in dermatitis. Contact with the eyes rapidly causes severe irritation of the eyes and eyelids.

Hydrogen bromide and hydrogen chloride are corrosive gases that have pungent, irritating odors. Although both are colorless, they fume in moist air because of their high solubility in water. In a cylinder under pressure, both exist in the form of a gas over a liquid (under such conditions, the cylinder pressure is equal to the vapor pressure of the substance contained; at 25 °C, this is 4.22 MPa (613 lb/in^2) for HCl and 2.20 MPa (320 lb/in^2) for HBr). As long as liquid is present in the cylinder, the pressure will remain fairly constant. Although neither HBr nor HCl is combustible, both act with common metals to form hydrogen, which may form explosive mixtures with air.

Operations involving significant quantities of hydrogen bromide and hydrogen chloride should be conducted with the general procedures outlined in Section 18.3 of this Chapter. Laboratory workers should wear protective apparel, including rubber gloves, suitable gas-tight chemical safety goggles, and clothing such as a rubber or plastic apron. Proper respiratory equipment should be available. These gases should be handled only in adequately ventilated areas. A check valve, vacuum break, or trap should always be used to prevent foreign materials from being sucked back into the cylinder because this can cause the development of dangerous pressures. Leaks of HBr or HCl will be evident by the formation of dense white fumes on contact with the atmosphere. Small leaks of HCl can be detected by holding an open bottle of concentrated ammonium hydroxide near the site of the suspected leak; the formation of dense white fumes confirms the existence of a leak. Cylinder-valve leaks can usually be corrected by tightening the value packing nut (by turning it clockwise as viewed from above).

(12) **Hydrogen Cyanide (HCN)**

Prior approval from the Chemical Hygiene Officer and Department head is required before using hydrogen cyanide (see **Chapter 25**).

(13) **Hydrofluoric Acid (HF)**

The use of anhydrous hydrogen fluoride requires prior approval from the Chemical Hygiene Officer and Department Chairperson. All forms—dilute or concentrated solutions or the vapor—of hydrofluoric acid (HF) cause severe burns. Inhalation of anhydrous HF or HF mist or vapors can cause severe respiratory tract irritation that may be fatal. Death from pulmonary edema occurred within 2 hours in three of six workers splashed with 70% HF solution despite prompt showering with water. Anhydrous HF is a clear, colorless liquid that boils at 19.5 °C. Because of its low boiling point and high vapor pressure, anhydrous HF must be stored in

pressure containers. A 70% aqueous solution is a common form of HF. Hydrofluoric acid is miscible with water in all proportions and forms an azeotrope (38.3% HF) that boils at 112 °C. Anhydrous or concentrated aqueous HF causes immediate and serious burns to any part of the body. Dilute solutions (<30%) and gaseous HF are also harmful, although several hours may pass before redness or a burning sensation is noticed. These burns may still be quite severe and progressively damaging to the skin and deeper tissues. Undissociated HF readily penetrates skin and deep tissue where the corrosive fluoride ion can cause necrosis of soft tissues and decalcification of bone; the destruction produced is excruciatingly painful. Fluoride ion also attacks enzymes (*e.g.*, of glycolysis) and cell membranes. The process of tissue destruction and neutralization of the hydrofluoric acid is prolonged for days, unlike other acids that are rapidly neutralized. Because of the insidious manner of penetration, a relatively mild or minor exposure can cause a serious burn [N. H. Proctor, J. P. Hughes, and M. L Fischman, *Chemical Hazards of the Workplace*, J. B. Lippincott Co., Philadelphia, 1988, p. 279]. Occasionally workers fail to recognize the importance of seeking medical attention for HF burns *before* pain commences. By the time the victim is affected with progressively deep and more painful throbbing and burning, serious damage may have taken place. Exposures under fingernails can be a particularly painful problem if ignored. Wearing clothing (including leather shoes and gloves) that has absorbed small amounts of HF can result in serious delayed effects such as painful slow-healing skin ulcers.

When handling HF, it is crucial to ensure adequate ventilation by working only in a hood so that safe levels (3 ppm) are not exceeded. All contact of the vapor of the liquid with eyes, skin, respiratory system, or digestive system must be avoided by using protective equipment such as a face shield and neoprene or polyvinyl chloride gloves. The protective equipment should be washed after each use to remove any HF on it. Safety showers and eyewash fountains should be nearby. Anyone working with HF should have received prior instructions about its hazards and in proper protective measures and should know the recommended procedure for treatment in the event of exposure (C.F. Reinhardt, *et al.*; *Am. Ind. Hyg. Assn. J.,* 1966, 27, 166).

Note that any BF_4^- salt in prolonged contact with glass containers will produce enough HF to etch glass and perhaps release HF gas.

Spills and leaks—The vapors of both anhydrous HF and aqueous 70% HF produce visible fumes if they contact moist air. This characteristic can be useful in detecting leaks but cannot be relied on because of atmospheric variations. Spills of HF must be treated immediately to minimize the dangers of vapor inhalation, body contact, corrosion of equipment, and possible generation of hazardous gases. Spills should be contained and diluted with water. The resulting solution should be neutralized with lime before disposal.

Waste disposal—Waste HF should be slowly added to a larger volume of a stirred solution of slaked lime to precipitate calcium fluoride, which is chemically inert and poses little toxic hazard (sodium fluoride is highly soluble and toxic). Alternatively, hydrofluoric acid can be diluted to about 2% concentration with cold water in a polyethylene vessel, neutralized with aqueous sodium hydroxide, and treated with excess calcium chloride solution to precipitate calcium fluoride.

In the event of exposure—Anyone who knows or even suspects that he or she has come into direct contact with HF should immediately flush the exposed area with large quantities of cool water. Exposed clothing should be removed as quickly as possible while flushing. Medical attention should be obtained promptly, even if the injury appears slight. On the way to the physician, the burned area should be immersed in a mixture of ice and water. If immersion is impractical, a compress made by inserting ice cubes between layers of gauze should be used. Make sure that the physician understands that the injury was caused by HF and requires treatment very different from other acid burns. Even in the case of very small exposure, washing alone may not be sufficient to completely prevent injury. For minor exposures such as small hole in a glove, application of a calcium glutaconate antidote gel can bind free fluoride ion not removed by washing.

If HF liquid or vapor has contacted the eyes, the eyes should be flushed with large quantities of clean water while the eyelids are held apart. This flushing should be continued for at least 15 minutes. Medical attention should be obtained promptly.

Anyone who has inhaled HF vapor should be removed immediately to an uncontaminated atmosphere and kept warm. Medical help should be obtained promptly. Anyone who has ingested HF should drink a large quantity of water as quickly as possible. Do not induce vomiting. Again, medical help should be obtained promptly. After the acid has been thoroughly diluted with water, if medical attention is delayed, the person should be given milk or two fluid ounces of milk of magnesia to drink to soothe the burning effect.

(14) **Hydrogen Sulfide (H_2S)**

Hydrogen sulfide is extremely dangerous. Human exposure to relatively low concentrations of H_2S has caused corneal damage, headache, sleep disturbances, nausea, weight loss, and other symptoms suggestive of brain damage. Higher concentrations can cause irritation of the lungs and respiratory passages and even pulmonary edema. Exposure to 210 ppm for 20 min has caused unconsciousness, arm cramps, and low blood pressure. Coma may occur within seconds after one or two breaths at high concentrations and be followed rapidly by death. For example, workers exposed to 930 ppm H_2S for less than 1 min died. Hydrogen sulfide is moderately toxic to animals via the inhalation route: LC_{50} (mice, 1 hour) = 673 ppm; LC_{50} (mice, 7.5 hours) = 140

ppm. Exposure to 10-13 ppm for 4-7 hours has caused eye irritation. Skin absorption of H_2S is slight and not considered significant. However, prolonged or repeated skin contact might cause mild irritation. Guinea pigs that had 0.78 in^2 of their skin exposed to 100% H_2S vapors for 1 hour experienced slight swelling. The TLV for H_2S is 10 ppm (14 mg/m^3) as an 8-hour time-weighted average. The short-term exposure limit (15 min) is 15 ppm. The OSHA PEL has a ceiling limit of 20 ppm and a peak of 50 ppm over any l0-min period. NIOSH (1977) has recommended a 10-min ceiling of 10 ppm. Part of the danger of low exposure to H_2S is that the sense of smell is impaired and dangerous levels may be reached without detection.

Partly because of the disagreeable odor of H_2S, but also because of its toxicity, laboratory operations with it should be carried out in a hood. *Use the general procedures outlined in Section 18.3 when working with hydrogen sulfide.* Cylinders of H_2S should not be stored in small, unventilated rooms, as deaths have resulted from people entering such rooms containing a leaking cylinder.

(15) **Mercury (Hg)**

The element mercury is a liquid metal with a vapor pressure of 0.00185 mm at 25 °C. This corresponds to a saturation concentration of 20 milligrams of mercury per cubic meter of air or 2.4 parts per million of air. The American Conference of Governmental Industrial Hygienists has established a threshold limit for mercury vapor of 0.05 milligrams of mercury per cubic meter of air for continuous 40-hour per week exposure. Long term chronic exposure to mercury vapor in excess of 0.05 mg of mercury per cubic meter of air may result in cumulative poisoning. The use of mercury in laboratory amounts in well-dilution-ventilated areas is fairly safe; however special precautions must be followed when working with large quantities of mercury.

Mercury poisoning from exposure by chronic inhalation produces a variety of symptoms. The characteristic effects are emotional disturbances, unsteadiness, inflammation of the mouth and gums, general fatigue, memory loss, and headaches. Kidney damage may result from poisoning by mercurial salts. In most cases of exposure by chronic inhalation, the symptoms of poisoning gradually disappear when the source of exposure is removed. However, improvement may be slow and complete recovery may take years. Skin contact with mercury compounds produces irritation and various degrees of corrosion. Soluble mercury salts can be absorbed through the intact skin and produce poisoning.

The general procedures outlined in Section 18.3 should be followed when working with large quantities of liquid mercury. Every effort should be made to prevent spills of metallic mercury because the substance is extremely difficult and time consuming to pick up. Droplets get into cracks and crevices, under table legs, and under and into equipment. If spills are frequent and

Hg is added to the general air level, the combined concentration may exceed the allowable limits.

Storage—Containers of large quantities of mercury should be kept closed and stored in secondary containers in a well-ventilated area. When breakage of instruments or apparatus containing mercury is a possibility, the equipment should be placed in an enameled or plastic tray or pan that can be cleaned easily and is large enough to contain the Hg. Transfers of Hg from one container to another should be carried out in a hood, over a tray or pan to confine any spills.

Cleanup of spills—Pools of metallic Hg can be collected by suction by using an aspirator bulb or a vacuum device made from a filtering flask, a rubber stopper, and several pieces of flexible and glass tubing. Alternatively, mercury-spill cleanup kits are available commercially. When a large spill, pressure system rupture, or heating of mercury is involved, the BSU EHS Office will be glad to survey the area and advise on the degree of hazard which may exist and necessary preventive measures to be undertaken. If Hg has spilled on the floor, the workers involved in cleanup and decontamination activities should wear plastic shoe covers. When the cleanup is complete, the shoe covers should be disposed of and the workers should thoroughly wash their hands, arms, and face several times. Normally, the EHS Office should be notified of any releases involving mercury and the cleanup and assessment left to that Office.

Waste Disposal—Significant quantities of metallic Hg from spills or broken thermometers or other equipment, and contaminated Hg from laboratory activities should be collected in thick-walled high-density polyethylene bottles for reclamation. Rags, sponges, shoe covers, and such used in clean-up activities, and broken thermometers containing small amounts of residual mercury, should be placed in a sealed plastic bag, labeled, and disposed of by the EHS Office.

(16) Metal carbonyl compounds (including nickel carbonyl ($Ni(CO)_4$), iron carbonyl ($Fe(CO)_5$), and osmium carbonyl ($Os(CO)_{12}$)

The use of carbonyl compounds requires prior approval from the Chemical Hygiene Officer and Department (see Part VIII of this Chapter). Volatile carbonyl compounds are very dangerous. These compounds should not be handled in the laboratory outside a protective hood.

Most metal carbonyl cluster compounds (*e.g.,* $Os_3(CO)_{12}$) are not especially volatile and crystalline forms may be examined under the microscope (*e.g*., in room 319). Otherwise all metal carbonyl cluster compounds should be manipulated in the hoods or stored in sealed containers on bench tops or in the refrigerators when not in use.

(17) **Nitrogen Dioxide (NO_2)**

Nitrogen dioxide ($N0_2$) is classified as a highly acute toxin; it is a primary irritant, acting primarily on the lungs and to a lesser extent on the upper respiratory tract. It is certainly one of the most insidious of the gases. The inflammation of the lungs may cause only slight pain, but the edema that results may easily cause death. One hundred ppm of $N0_2$ in air is a dangerous concentration for even a short exposure, and 200 ppm may be fatal in a short time. Nitrogen dioxide gas is reddish brown, has an irritating odor, and must be avoided by the use of an air-purifying respirator equipped with an acid gas cartridge or canister; at concentrations greater than 50 times the TLV, a positive-pressure atmosphere-supplying respirator must be used and, in IDLH atmospheres, a pressure-demand self-contained breathing apparatus or a positive-pressure air-line respirator that has escape-cylinder provisions is required. Toxic quantities of $N0_2$ can be produced whenever $HN0_3$ is used as an oxidizing agent.

Nitrogen dioxide should be handled using the general procedures outlined in Section 18.3. Nitrogen dioxide is a deadly poison, and no one should work with a cylinder of this substance unless they are fully familiar with its handling and its toxic effect. Ventilation is extremely important, and respiratory protective equipment should always be available. Only stainless steel fittings should be used.

(18) **N-Nitrosodialkylamines and Certain Other N-Nitroso Compounds**

N-Nitrosodimethylamine is strongly hepatotoxic and can cause death from liver insufficiency in experimental animals. It is carcinogenic in at least 10 animal species, including subprimates. The main targets for its carcinogenic activity are the liver, lung, esophagus, trachea, and nasal cavity. Although data are not available on the toxicity of N-nitrosodiethylamine in humans, the closely related compound N-nitrosodimethylamine has caused extensive liver damage as a consequence of ingestion, inhalation, and topical application to the skin.

The general procedures outlined in Sections 18.3 and 18.4 should be followed when working with N-nitrosodialkylamines. All work with N-nitrosodialkylamines should be carried out in a well ventilated hood or in a glove box equipped with a HEPA filter. To the extent possible, all vessels that contain N-nitrosodialkylamines should be kept closed. All work should be carried out in apparatus that is contained in or mounted above unbreakable pans that will contain any spill. All containers should bear a label such as the following: CANCER-SUSPECT AGENT. All personnel who handle the material should wear plastic, latex, or neoprene gloves and a fully buttoned laboratory coat.

Storage—All bottles of N-nitrosodialkylamines should be stored and transported within an unbreakable outer container, storage should be in a ventilated storage cabinet (or in a hood).

Clean-up of spills and waste disposal—Because N-nitrosodialkylamines are chemically stable under usual conditions, disposal is best carried out by incineration. Contact the EHS Office to arrange for the disposal of waste and contaminated materials. For incineration of liquid wastes, solutions should be neutralized if necessary, filtered to remove solids, and put in closed polyethylene containers for transport. All equipment should be thoroughly rinsed with solvent, which should then be added to the liquid waste for incineration. Great care should be exercised to prevent contamination of the outside of the solvent container. If possible, solid wastes should be incinerated; if this is not possible, solid wastes from reaction mixtures that may contain N-nitrosodialkylamines should be extracted and the extracts added to the liquid waste. Similarly, any rags, paper and such that may be contaminated should be incinerated. Contaminated solid materials should be enclosed in sealed plastic bags that are labeled CANCER—SUSPECT AGENT and with the name and amount of the carcinogen. The bags should be stored in a well-ventilated area until they are incinerated. Spills of N-nitrosodialkylamines can be absorbed by Celite R or a commercial spill absorbent. After the absorbent containing the major share of the nitrosamine has been picked up (avoid dusts; do not sweep), the surface should be thoroughly cleaned with a strong detergent solution. If a major spill occurs outside of a ventilated area, the room should be evacuated, the BSU EHS Office should be contacted, and the cleanup operation should be carried out by persons equipped with self-contained respirators. Those involved in this operation should wear rubber gloves, laboratory coats, and plastic aprons or equivalent protective apparel.

(19) **Phosgene ($COCl_2$)**

Phosgene is classified as a substance with a high degree of acute toxicity. In humans, the symptoms of overexposure to phosgene are dryness or a burning sensation in the throat, numbness, vomiting, and bronchitis. An airborne concentration of 5 ppm may cause eye irritation and coughing in a few minutes. The substance can cause severe lung injury in 1-2 min at a level of 20 ppm. Exposure to concentrations above 50 ppm is likely to be fatal. Phosgene is extremely toxic to animals via inhalation. Thus, 74% of a group of rats died from exposure to 55-100 ppm for only 10 min. Liquid phosgene is likely to cause severe skin burns and eye irritation. Pulmonary edema, bronchiolitis, and emphysema were found in cats and guinea pigs exposed to 2.5-6.25 ppm of phosgene/day for 2-41 days. A variety of animals exposed to 0.2 or 1.1 ppm for 5 hours per day for 5 days also had pulmonary edema. The TLV and the OSHA PEL for phosgene are 0.1 ppm (0.4 mg/m^3) as an 8-hour time-weighted average. NIOSH has recommended a limit of 0.2 ppm over any l5-min period. Note that phosgene gas is formed by the thermal decomposition of most chlorinated hydrocarbon compounds.

Laboratory operations involving phosgene require the use of the general procedures outlined in Section 18.3. Work with phosgene should always be carried out within a hood. Unused

quantities of phosgene greater than 1 g should be destroyed by reaction with water or dilute alkali. Note that for many applications phosgene can be replaced by the less hazardous reagents diphosgene and triphosgene.

(20) **Selenium (Se) and its compounds**

Selenium poses a serious risk of poisoning by inhalation or swallowing and there is serious danger of cumulative effects to exposure. Selenium is a steel gray or purplish powder, also fabricated into pellets, sticks or plates, insoluble in water. Selenium dioxide, selenous acid, and the alkali-metal selenites and selenates are colorless powders or crystals. Hydrogen selenide irritates the nose, eyes, and lung tissue, and disturbs the digestive and nervous systems. Solutions of selenium compounds may burn the skin and causes severe pain by skin absorption. Selenium dioxide dust irritates the respiratory system, eyes, and skin, and is particularly harmful by skin absorption. Swallowing will cause severe irritation and poisoning. Prolonged exposure to selenium dust may cause chronic effects such as dermatitis, fatigue, digestive upset, and bronchitis. Avoid breathing dust. Avoid contact with skin and eyes. TLV (selenium compounds as Se) 0.2 mg/m^3.

Cleanup of spills—Selenium powder may be mixed with sand and treated as normal refuse, as may the disulfide. Soluble selenites and selenates can be dissolved in water and run to waste, diluting greatly with running water. Sodium carbonate should be applied liberally to spillages of selenium dioxide, selenic and selenous acids and selenyl and selenium chlorides, which may then be mopped up cautiously with plenty of water, this being run to waste, diluting greatly with running water.

Waste disposal—Packaged lots: place in separate labeled container for disposal. Small quantities: Wear rubber gloves, safety goggles, respirator, or work in hood, laboratory coat. Aqueous solutions of soluble salts should be made strongly acidic with hydrochloric acid. Slowly add sodium sulfite to the cold solution with stirring, thus producing sulfur dioxide, the reducer. Heat to form element. Allow to stand overnight. Filter, wash, dry, and recycle or send for disposal. Selenium or insoluble salts can be recycled or sent for disposal.

(21) **Sodium Cyanide (NaCN) and other cyanide salts**

Inorganic cyanide salts are classified as substances with a high degree of acute toxicity. Sodium cyanide is among the fastest acting of all known poisons. The lethal oral dose for humans is 200 mg. The symptoms of cyanide overdose include weakness, headache, confusion, and, occasionally, nausea and vomiting. Higher doses may be followed by almost instantaneous death. Solutions are irritating to the skin, nose, and eyes, and cyanide is absorbed through the skin. Sodium cyanide is highly toxic to animals via the oral route: LD_{50}(rats) = 6.4 mg/kg. It can be corrosive to the skin and the eyes, for it is highly alkaline. Sodium cyanide can also produce

toxic symptoms via skin absorption and inhalation. The TLV and the OSHA PEL for cyanide are both 5 mg/m^3 as an 8-hour time-weighted average. These limits include a warning of the potential contribution of skin absorption to the overall exposure. In 1976, NIOSH recommended that the 5-mg/m^3 limit be retained but that its basis be changed from an 8-hour TWA to a 10 min ceiling.

Proper gloves should be worn when handling dry sodium cyanide. Rubber gloves and splash proof goggles should be worn when substantial amounts of sodium cyanide solution are used. Hydrolysis of sodium cyanide (and other cyanide salts) by water or acid generates HCN which is extremely hazardous. Consequently, *cyanide salts should always be handled using the general procedures outlined in Part VII.C.* All reaction equipment in which cyanides are used or produced should be placed in or over shallow pans so that spills or leaks will be contained. In the event of spills of HCN or cyanide solutions, the contaminated area should be evacuated promptly and it should be determined immediately whether anyone had been exposed to cyanide vapors or liquid splash. Consideration should be given to the need for evacuating other parts of the building or notifying other occupants that the spill has occurred. In general, it is usually best not to attempt to dilute or absorb such spills if they occur in well-ventilated areas.

Detection—Hydrogen cyanide has a characteristic odor that resembles that of bitter almonds; however, many people cannot smell it in low concentrations, and this method of detection should not be relied on. Vapor-detector tubes sensitive to 1 ppm of HCN are available commercially. The presence of free cyanide ion in aqueous solution may be detected by treating an aliquot of the sample with ferrous sulfate and an excess of sulfuric acid. A precipitate of Prussian blue indicates that free cyanide ion is present.

Storage— Sodium cyanide and acids should not be stored or transported together. An open bottle of NaCN can generate HCN in humid air, and HCN may be liberated from spills of sodium cyanide solutions.

Waste disposal—Waste solutions containing cyanides should be sealed in clearly marked bottles. Contact the Health & Safety Programs Unit to arrange disposal of these containers.

In the event of exposure—Anyone who has been exposed to HCN should be removed from the contaminated atmosphere immediately. Any contaminated clothing should be removed and the affected area deluged with water. Emergency medical attention should be obtained immediately.

19.0 RADIONUCLIDES

The Radiation Safety Committee and Radiation Safety Officer have strict policies and procedures for the handling, use and disposal of radioactive materials. These procedures shall be followed by anyone using radionuclides. Dr. Mohammed S. Islam of the Physics and Astronomy Department should be contacted in this regard at (28)5-8066.

20.0 OPERATIONS REQUIRING PRIOR APPROVAL

Using and storing certain chemicals may require prior approval. *Particularly Hazardous Substances* as defined in **Chapter 18** with high chronic toxicity are a major example. Some of these compounds include, but are not limited to: toxic or corrosive gases such as: Fluorine, Chlorine, Phosgene, Arsine, Anhydrous Hydrofluoric Acid, Carbon Monoxide, Hydrogen Sulfide, unstable Boron Hydrides; highly reactive or explosive chemicals such as: Polynitrated Compounds, unstable Organic Peroxides, Heavy Metal Azides or Acetylides; or highly toxic materials such as: Cholinesterase Inhibitors, some Pesticides or Magic Methyl and related chemicals. Refer to **Form 2 of Chapter 25.0** for the procurement and use of these compounds**.**

A number of other chemicals, or regulated activities, as listed in **Chapter 6 (Section 6.6)** may also require prior approval, training, certification, or licensing.

21.0 LABORATORY STANDARD OPERATING PROCEDURES (SOPs)

The development and adherence to Standard Operating Procedures (SOPs) is a significant requirement of the *OSHA Laboratory Standard*.

21.1 GENERIC SOPS

A number of generic SOPs are provided in **Chapter 26** for the most common categories of chemical hazards including flammables, corrosives, reactives, etc. These include the following:

SOP 1:	Standard Operating Procedure for Flammable Liquids
SOP 2:	Standard Operating Procedure for Corrosive Chemicals
SOP 3:	Standard Operating Procedure for Water Reactive Chemicals
SOP 4:	Standard Operating Procedure for Pyrophoric Chemicals
SOP 5:	Standard Operating Procedure for Reactive Liquids
SOP 6:	Standard Operating Procedure for Reactive Solids
SOP 7:	Standard Operating Procedure for Compressed Gases
SOP 8:	Standard Operating Procedure for Oxidizing Chemicals
SOP 9:	Standard Operating Procedure for Carcinogens
SOP 10:	Standard Operating Procedure for Reproductive Toxins
SOP 11:	Standard Operating Procedure for Acutely Toxic Chemicals
SOP 12:	Standard Operating Procedure for Acutely Toxic Gases
SOP 13:	Standard Operating Procedure for Handling Acid Solutions

However, most laboratories or procedures will require laboratory-specific SOPs.

21.2 LABORATORY SPECIFIC SOPs (FOR DEPARTMENTAL DEVELOPMENT OF SOPs)

A laboratory-specific SOP is required when a generic SOP provided in this CHP is deemed to be inadequate or not applicable to a procedure or the chemicals involved, or when the general requirements cited in the following sections of the CHP are insufficient to direct and protect a new laboratory worker in a commonly required and repeated laboratory procedure.

Chapter	**Content**
5.0	*General Laboratory Procedures*
6.0	*Chemical Storage*
10.0	*Personal Protection Equipment*
16.0	*Waste Disposal Procedures*
17.0	*Hood Safety and Ventilation*

Lab-specific SOPs should also be developed to indicate circumstances under which certain laboratory procedures, operations, or activities require prior approval from the Laboratory Supervisor before implementation (e.g., use of radioactive materials, bench top manipulation of volatile carcinogenic solvents without use of engineering controls, night or weekend work performed alone, reagent substitutions, etc.). The above listed Chapters of this Plan should be reviewed as part of the SOP development.

An executable laboratory specific Standard Operating Procedure is provided in **Chapter 26, Section 2 (26.2)** for use by the Laboratory Manager, Principal Investigator, or Safety Officer.

Laboratory Specific Standard Operating Procedure Outline. The BSU CHP Laboratory specific Standard Operating Procedure content outline is as follows:

Section 1: *Process, Hazardous Chemical, or Hazard Class SOP Identification*
Section 2: *Describe Process, Hazardous Chemical or Hazard Class*
Section 3: *Potential Hazards*
Section 4: *Personal Protective Equipment*
Section 5: *Engineering Controls*
Section 6: *Special Handling and Storage Requirements*
Section 7: *Spill and Accident Procedures*
Section 8: *Decontamination Procedures*
Section 9: *Waste Disposal Procedures*
Section 10: *Material Safety Data Sheet Locations*
Section 11: *Protocols*

The completed laboratory-specific SOPs should be placed in **Chapter 26** with the generic SOPs. Those generic SOPs may be discarded or revised if they are inapplicable or inaccurate, or as they are replaced by laboratory-specific SOPs. Each laboratory is free to develop their own procedures, outlines, or SOP templates, but the above information should be included regardless of the format used by the particular Department or Laboratory.

22.0 REVIEW AND REVISION OF CHEMICAL HYGIENE PLAN

The BSU generic Chemical Hygiene Plan will be reviewed annually by the Environmental Health and Safety (EHS) Office and by the various Departments, Department Chairpersons, or Laboratory Safety Officers. Requests for changes to the document may be made at any time during the year. Any request for changes that are more than editorial in nature will be reviewed by the respective Departments and EHS Office, if appropriate. If the Department Chair or appointed Safety Officers agree that the requested change can be made, then an amendment to the CHP will be drafted. If the Department, or its Safety Committee, cannot find a means of accommodating the request, the individual will be notified. If the individual wants to pursue the requested modification further, the issues will be documented and presented to the BSU EHS Office for discussion.

APPENDICES

23.1 APPENDIX I - FIGURE 1.

Designated Area Marking for Carcinogens

This is a

Designated Area for

Chemical Carcinogens

23.1 APPENDIX I - FIGURE 2.

Designated Area Marking for Reproductive Toxins

This is a
Designated Area for
Reproductive
Toxins

23.1 APPENDIX I - FIGURE 3.

Designated Area Marking for Highly Toxic Chemicals

This is a
Designated Area For
Highly Toxic Chemicals

23.1 - FIGURE 4.

Designated Area for Carcinogens, Reproductive Toxins, and Highly Toxic Chemicals

This is a

Designated Area for

Chemical Carcinogens,

Highly Toxic Substances,

and

Reproductive Toxins

23.2 APPENDIX II - PERSONAL PROTECTIVE EQUIPMENT

Part A. Glove Selection

Chemical Resistance of Common Glove Materials

Excellent, **G**ood, **F**air, **P**oor, "**-**" (No) Resistance to chemical exposure for chemical listed.

Chemical	Notes	Natural Rubber	Neoprene	Nitrile	PolyVinyl
Acetaldehyde	a	P	P	P	P
Acetic Acid	b	F	E	F	P
Acetone	b	P	P	P	P
Acrylonitrile	b	P	P	P	P
Ammonium Hydroxide (sat.)	b	P	E	E	P
Aniline	b	P	P	P	E
Benzaldehyde	b	P	P	P	G
Benzene	a	P	P	P	E
Benzyl Chloride	a	P	P	P	F
Bromine		P	F	-	-
Butane		P	G	P	G
Butyraldehyde	b	P	P	P	P
Calcium Hypochlorite		G	G	G	P
Carbon Disulfide		P	P	P	G
Carbon Tetrachloride	a	P	P	P	E
Chlorine		P	F	-	P
Chloroacetone		F	E	-	P
Chloroform	a	P	P	P	E
Chromic Acid	b	P	P	F	P
Cyclohexane		P	P	E	P
Dibenzyl Ether		P	P	-	P
Dibutyl Phthalate	b	F	F	-	E
Diethanolamine	b	F	E	E	-
Diethyl Ether		P	P	P	E
Dimethyl Sulfoxide	b	P	E	P	P
Ethyl Acetate	b	P	P	P	G
Ethylene Dichloride	a	P	P	P	G

Chemical	Notes	Natural Rubber	Neoprene	Nitrile	Vinyl
Ethylene Glycol	b	E	E	E	F
Ethylene Trichloride	a	P	P	P	F
Fluorine		P	P	-	P
Formaldehyde	b	P	F	E	P
Formic Acid	b	F	E	F	P
Glycerol		E	E	E	F
Hexane		P	P	E	E
Hydrobromic Acid	b	P	G	F	P
Hydrochloric Acid (conc.)	b	G	G	G	P
Hydrofluoric Acid (30%)	b	F	F	P	P
Hydrogen Peroxide		E	F	E	P
Iodine		G	G	-	G
Methylamine	b	P	G	E	P
Methyl Cellusolve	b	P	P	F	P
Methyl Chloride	a	P	F	-	P
Methyl Ethyl Ketone	b	P	P	P	F
Methylene Chloride	a	P	P	P	E
Monoethanolamine	b	F	E	E	F
Morpholine	b	P	P	P	F
Naphthalene	a	P	P	F	P
Nitric Acid (conc.)	b	P	F	P	P
Perchloric Acid		E	E	E	P
Phenol		P	G	P	P
Phosphoric Acid		E	E	E	P
Potassium Hydroxide (sat.)		E	E	E	P
Propylene Dichloride	a	P	F	-	P
Sodium Hydroxide		E	E	E	P
Sodium Hypochlorite		E	E	E	P
Sulfuric Acid	b	P	F	P	P
Toluene	a	P	P	P	E
Trichloroethylene	a	P	P	P	E
Tricresyl Phosphate	b	P	G	G	E

Chemical	Notes	Natural Rubber	Neoprene	Nitrile	Vinyl
Triethanolamine		G	E	E	E
Trinitrotoluene		P	F	F	P

Notes:

a Aromatic and halogenated hydrocarbons will attack all types of natural and most synthetic glove materials.

b Butyl rubber recommended for handling DMSO.

For more detailed information concerning glove material selection consult with the Chemical Hygiene Officer. It is imperative that the chemical resistance chart of the specific glove manufacturer being considered be consulted.

23.2 APPENDIX II - PERSONAL PROTECTIVE EQUIPMENT

Part B. Eye Protection Policy

BALL STATE UNIVERSITY

EYE PROTECTION POLICY

To minimize the risk of eye injury, BSU policy requires that all personnel, including visitors, wear eye protection at all times while in laboratories where hazardous chemicals are in use. This eye protection policy is necessary in order that the University comply with both Indiana and Federal law (e.g., Code of Federal Regulations, Title 29, Section 1910.133). Eye protection is required whether or not one is actually performing a "chemical operation", and visitors should not be permitted to enter a lab unless they wear appropriate eye protection. Groups that handle chemicals should provide a supply of safety glasses at the entrance of each laboratory for the use of BSU Facilities personnel and visitors.

1. Safety glasses must meet the American National Standards Institute standard Z87.1-1989 that specifies a minimum lens thickness (3 mm), certain impact resistance requirements, *etc*. Ordinary **prescription glasses** do not provide adequate protection against injury, and their use should be limited to providing minimal protection when you are present in the laboratory but not carrying out a chemical operation. **Safety glasses with side shields** also do not provide minimally acceptable protection. Although these safety glasses can provide satisfactory protection against injury from flying particles, they do not fit tightly against the face and offer little protection against splashes or sprays of chemicals. Other eye protection (goggles) is therefore required for all workers whenever a significant splash hazard exists (see below).

2. **Contact lenses** offer no significant protection against eye injury and cannot be substituted for safety glasses and goggles. Prudent safety practice prohibits the wearing of contact lenses in chemical laboratories in which chemicals are handled. If a worker's vision requires optical correction, regular spectacles should be worn underneath approved safety goggles at all times. Contact lenses worn by persons working in laboratories can increase injury from chemical splashes because the wearer may not be able to remove the lenses to permit thorough irrigation and a person giving first aid may not know that contact lenses are being worn or how to remove them. Many physicians believe that the substitution of contact lenses for spectacles in industrial workers is contraindicated in workers whose eyes may be exposed to dusts, molten metals, or irritant chemicals. Small foreign bodies, which normally are washed away by tears, sometimes become lodged beneath contact lenses, where they may cause injury to the cornea. Similarly, chemicals splashed into the eye may be trapped under a contact lens

and cause extensive corneal damage before the lens can be removed and the eye adequately irrigated. Furthermore, soft lenses can absorb solvent vapors even through face shields and, as a result, adhere to the eye. Since removal of a contact lens for urgent irrigations after injury is made so difficult by spasm of the eyelids, the contact lens wearer is in even greater need of protection than his/her counterpart who does not wear contact lenses, if the job carries high potential risk of eye injury. Contact lenses are not in themselves protective devices and in fact may increase the degree of injury to the eye.

3. **Goggles provide the minimal level of acceptable protection when working in a chemical laboratory**. Goggles should be worn when carrying out operations in which there is reasonable danger from splashing chemicals, flying particles, *etc*. For example, goggles are required when working with glassware under reduced or elevated pressures (e.g. sealed tube reactions), when handling potentially explosive compounds (particularly during distillations), and when employing glass apparatus in high-temperature operations. In some instances "safety shields" should be set up around experiments for additional protection. Since goggles offer little protection to the face and neck, **full-face shields** should be worn when conducting particularly hazardous laboratory operations. In addition, the use of laser or ultraviolet light sources requires special glasses or goggles that have been approved.

4. Before each use, eye and face protection equipment is to be inspected for damage, (i.e. cracks, severe scratches, debris). If deficiencies are noted, the equipment should be cleaned, repaired or replaced before use.

5. This policy applies to ALL persons: faculty, staff, students, and visitors. It is the responsibility of the faculty member or the area supervisor to enforce the Department protective eyewear policy. Failure to do so may subject an individual to personal liability.

23.3 APPENDIX III - TABLE 1. CHEMICAL COMPATIBILITY STORAGE

Stanford University Compatible Storage Group Classification System

Should be used in conjunction with specific storage conditions taken from the manufacturer's label and MSDS.

STORAGE GROUPS

Store chemicals in separate secondary containment and cabinets
Find Storage Group information in Chemtracker:
https://chemtracker.stanford.edu/chemsafety

A	Compatible Organic Bases
B	Compatible Pyrophoric & Water Reactive Materials
C	Compatible Inorganic Bases
D	Compatible Organic Acids
E	Compatible Oxidizers including Peroxides
F	Compatible Inorganic Acids not including Oxidizers or Combustible
G	Not Intrinsically Reactive or Flammable or Combustible
J*	Poison Compressed Gases
K*	Compatible Explosive or other highly Unstable Material
L	Non-Reactive Flammable and Combustible, including solvents
X*	Incompatible with ALL other storage groups

***Storage Groups J, K and X: Contact EH&S @ 3-0448**
For specific storage - consult manufacturer's MSDS

If space does not allow Storage Groups to be kept in separate cabinets the following scheme can be used with extra care taken to provide stable, uncrowded, and carefully monitored conditions.

Storage Group X must be segregated from all other chemicals.

Storage Group B is not compatible with any other storage group.

Last updated 04/17/09

April 6, 2010

Recommended Storage Groups for Common Chemicals

CHEMICAL	Group
1-Butanol or 2-	L
1-Propanol	L
2-Mercaptoethanol	L
Acetic Acid, Glacial (flammable)	D
Acetic Anhydride	L
Acetone	L
Acetonitrile	L
Acetaldehyde	L
Acrolein	L
Acrylamide	G
Agarose	G
Ammonium Acetate	G
Ammonium Chloride	G
Ammonium Formate	G
Ammonium Hydroxide	C
Ammonium Nitrate	E
Ammonium Persulfate	E
Ammonium Sulfate	G
Ammonium Sulfide	L
Benzene	L
BIS & BIS-Acrylamide	G
BIS TRIS	A
Borax	G
Boric Acid	G
Calcium Chloride	G
Chloroform	G
Chromerge	E
Citric Acid	D
Coomassie Blue	G
Dextrose	G
Dichloromethane	G
Diethylamine (flammable)	A
Diethyl Pyrocarbonate	L
Dimethyl Popop	G
Dimethyl Sulfoxide (DMSO)	L
Drierite	G
EcoLume, UniverSOL, BetaMax, CytoScint, Scintisafe, Econo-Safe, Ecoscint, Opti-fluor	L
EDTA (in solution G)	D
Ethanol	L
Ethanolamine	A
Ethers	L
Ethidium Bromide	G
Ethyl Acetate	L
Ethylene Glycol	L
Ficoll	G
Formaldehyde	L
Formamide	L
Formic Acid (88%)	D
Geopen	G
Glutaraldehyde	G
Glycerol	L
Glycine	G
Guanidine Hydrochloride	G
Guanidine Thiocyanate	C
Halothane, Isoflurane	G
HEPES	G
Hexanes	L
Hydrochloric Acid	F
Hydrogen Peroxide, 90%	E
Hydrogen Peroxide, <5%	G
Imidazole	A
Isobutyl Alcohol	L
Isopentane	L
Isopropanol	L
Magnesium Chloride	G
Magnesium Sulfate	G
Maleic Acid	D
Methanol	L
N-Methyl-2-Pyrrolidone	L
N,N Dimethylformamide	L
Nitric Acid	E
P-Dioxane	L
Paraformaldehyde	L
Perchloric Acid	E
Periodic Acid	E
Permount	L
Phenol	L
Phosphoric Acid	F
Picric Acid dry (<10% H_2O)	K
Picric Acid moist (10-40% H_2O)	X
Picric Acid soln (1-4%)	X
Piperidine	A
Pipes, Free Acid	G
Potassium Acetate	G
Potassium Chloride	G
Potassium Cyanide	C
Potassium Hydroxide (KOH)	C
Potassium Phosphate	G
PPO	G
Propionic Acid	D
Propylene Oxide	L
Pump Oil	L
Pyridine	A
SDS (Sodium Lauryl Sulfate) (in solution G)	L
Sigmacote	L
Sodium Acetate	G
Sodium Azide	X
Sodium Bicarbonate	G
Sodium Bisulfate	G
Sodium Bisulfite	G
Sodium Borate	G
Sodium Borohydride	B
Sodium Carbonate, Anhydrous	G
Sodium Chlorate	E
Sodium Chloride (NaCl)	G
Sodium Citrate, Dihydrate	G
Sodium Dichromate, Dihydrate	E
Sodium Hydroxide (NaOH)	C
Sodium Hypochlorite	E
Sodium Hypochlorite solution (i.e. Bleach)	G
Sodium Phosphate	G
Sodium Sulfide, Anhydrous	B
Succinic Acid	D
Sucrose	G
Sulfuric Acid	F
Tannic Acid	D
TEMED	A
TES free acid	G
Tetracycline	G
Tetrahydrofuran	L
Trichloroacetic Acid	D
Toluene	L
Triethanolamine	A
TRIS	A
Triton X-100	G
Trizol	L
TWEEN 20	G
Urea	G
WD-40	L
Xylenes	L
Zinc Chloride	G

See other side for information about the Stanford Storage Group System. Storage Groups are continuously reviewed and updated as needed. If you have any questions or suggested changes, please contact the EH&S at 723-0448.

23.3 APPENDIX III - TABLE 2. INDIANA (INTERNATIONAL) FIRE CODE EXCERPTS
HAZARDOUS MATERIAL STORAGE (CONTROL AREAS)

TABLE 2: Maximum allowable quantity of Hazardous Materials per control area.

The maximum allowable quantity per control area shall be as specified in Tables 2703.1.1(1) through 2703.1.1(4). A "control area" is a space within a building where hazardous materials not exceeding these quantity limits are stored, used, dispensed, or handled.

TABLE 2703.1.1(1) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD[a, j, m, n, p]

Material	Hazard Class	Group when the maximum allowable quantity is exceeded	STORAGE Solid pounds (cubic feet)	STORAGE Liquid Gallons (pounds)
Combustible liquid[c,i]	II IIIA IIIB	H-2 or H-3 H-2 or H-3 Not Applicable	Not Applicable	120[d,e] 330[d,e] 13,200[e,f]
Combustible fiber	Loose Baled[o]	H-3	(100) (1,000)	Not Applicable
Cryogenic Flammable	Not Applicable	H-2	Not Applicable	45[d]
Consumer fireworks (Class C Common)	1.4G	H-3[d,e,l]	125[d,e,l]	Not Applicable
Cryogenic Oxidizing	Not Applicable	H-3	Not Applicable	45[d]
Explosives	Division 1.1 Division 1.2 Division 1.3 Division 1.4 Division 1.4G Division 1.5 Division 1.6	H-1 H-1 H-1 or H-2 H-3 H-3 H-1 H-1	1[e,g] 1[e,g] 5[e,g] 50[e,g] 125d,e,l 1[e,g] 1[d,e,g]	(1)[e,g] (1)[e,g] (5)[e,g] (50)[e,g] Not Applicable 1[e,g] Not Applicable
Flammable gas	Gaseous Liquefied	H-2	Not Applicable	Not Applicable 30[d,e]
Flammable liquids[e]	IA IB and IC	H-2 or H-3	Not Applicable	30[d,e] 120[d,e]
Combination Flammable liquid (IA, IB, IC)	Not Applicable	H-2 or H-3	Not Applicable	120[d,e,h]
Flammable solid	Not applicable	H-3	125[d,e]	Not Applicable

Material	Hazard Class	Group when the maximum allowable quantity is exceeded	STORAGE Solid pounds (cubic feet)	STORAGE Liquid Gallons (pounds)
Organic peroxide	UD I II III Iv V	H-1 H-2 H-3 H-3 Not Applicable Not Applicable	1[e,g] 5[d,e] 50[d,e] 125[d,e] Not Limited Not limited	(1)[e,g] (5)[d,e] (50)[d,e] (125)[d,e] Not Limited Not limited
Oxidizer	4 3[k] 2 1	H-1 H-2 or H-3 H-3 Not Applicable	1[g] 10[d,e] 250[d,e] 4,000[e,f]	(1)[g] (10)[d,e] (250)[d,e] (4,000)[e,f]
Oxidizing gas	Gaseous Liquified	H-3	Not Applicable	Not Applicable 15[d,e]
Pyrophoric	Not Applicable	H-2	4[e,g]	(4)[e,g]
Unstable (reactive)	4 3 2 1	H-1 H-1 or H-2 H-3 Not Applicable	1[e,g] 5[d,e] 50[d,e] Not limited	(1)[e,g] (5)[d,e] (50)[d,e] Not limited
Water reactive	3 2 1	H-2 H-3 Not applicable	5[d,e] 50[d,e] Not limited	(5)[d,e] (50)[d,e] Not limited

For SI: 1 cubic foot = 0.02832 m^3, 1 pound = 0.454 kg, 1 gallon = 3.785 L.

a. For use of control areas, see Section 2703.8.3.

b. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.

c. The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons. In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs, consumer or industrial products, and cosmetics containing not more than 50 percent by volume of water-miscible liquids with the remainder of the solutions not being flammable shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.Where Note e also applies, the increase for both notes shall be applied accumulatively.

e. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, day boxes, gas cabinets, exhausted enclosures or safety cans. Where Note d also applies, the increase for both notes shall be applied accumulatively.

f. Quantities shall not be limited in a building equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.

g. Allowed only in buildings equipped throughout with an approved automatic sprinkler system.

h. Containing not more than the maximum allowable quantity per control area of Class IA, Class IB or Class IC flammable liquids.

i. Inside a building, the maximum capacity of a combustible liquid storage system that is connected to a fuel-oil piping system shall be 660 gallons provided such system complies with this code.

j. Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.

k. A maximum quantity of 200 pounds of solid or 20 gallons of liquid Class 3 oxidizers is allowed when such materials are necessary for maintenance purposes, operation or sanitation of equipment when the storage containers and the manner of storage are approved.
l. Net weight of pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks including packaging shall be used.
[m. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 2703.1.2.
n. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 2703.11, see Table 2703.11.1.
o. Densely-packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.

TABLE 2 (cont.): 2703.1.1(2) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIAL POSING A HEALTH HAZARD[a,b,c,j]

MATERIAL	STORAGE[d]		
	Solid pounds[e, f]	Liquid gallons (pounds)[e, f]	Gas cubic feet at NTP[e]
Corrosive	5,000	500	810[f, g]
Highly toxic	10	(10)[i]	20[h]
Toxic	500	(500)[i]	810[f]

For SI: 1 cubic foot = 0.02832 m^3, 1 pound = 0.454 kg, 1 gallon = 3.785 L.
a. For use of control areas, see Section 2703.8.3.
b. In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs consumer or industrial products, and cosmetics, containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.
c. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 2703.11, see Table 2703.11.1.
d. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
e. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.Where Note f also applies, the increase for both notes shall be applied accumulatively.
f. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, or exhausted enclosures. Where Note e also applies, the increase for both notes shall be applied accumulatively.
g. A single cylinder containing 150 pounds or less of anhydrous ammonia in a single control area in a nonsprinklered building shall be considered a maximum allowable quantity. Two cylinders, each containing 150 pounds or less in a single control area shall be considered a maximum allowable quantity provided the building is equipped throughout with an automatic sprinkler system in accordance with Section 903.3.1.1.
[h. Allowed only when stored in approved exhausted gas cabinets or exhausted enclosures.
i. Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.
j. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 2703.1.2.]

2703.8.3.2 Percentage of maximum allowable quantities.

The percentage of maximum allowable quantities of hazardous materials per control area allowed at each floor level within a building shall be in accordance with Table 2703.8.3.2.

TABLE 2 (cont.) 2703.8.3.2 DESIGN AND NUMBER OF CONTROL AREAS

FLOOR LEVEL		PERCENTAGE OF THE MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA[a]	NUMBER OF CONTROL AREAS PER FLOOR	FIRE-RESISTANCE RATING FOR FIRE BARRIERS IN HOURS[b]
Above grade plane	Higher than 9 7-9 6 5 4 3 2 1	5 5 12.5 12.5 12.5 50 75 100	1 2 2 2 2 2 3 4	2 2 2 2 2 1 1 1
Below grade plane	1 2 Lower than 2	75 50 Not Allowed	3 2 Not Allowed	1 1 Not Allowed

a. Percentages shall be of the maximum allowable quantity per control area shown in Tables 2703.1.1(1) and 2703.1.1(2), with all increases allowed in the footnotes to those tables.
b. Fire barriers shall include walls and floors as necessary to provide separation from other portions of the building.

23.3 APPENDIX III - TABLE 3. Solvent Flammability Properties

Chemical	Flash Point (°F)	Ignition Temp (°F)	Flammable Limits Lower	Flammable Limits Upper	Specific Gravity Water=1	Vapor Density Air=1	Boiling Point (°F)	Water Soluble	Notes	Hazard Rating Health	Hazard Rating Flammability	Hazard Rating Reactivity
Acetaldehyde CH_3CHO Ethanal	-36	347	4.0	60	0.8	1.5	70	Yes	polymerizes	2	4	2
Acetone CH_3COCH_3 2-Propanone	0	869	2.6	12.8	0.8	2	134	Yes		1	3	0
Acrolein CH_2CHCHO Acrylic Aldehyde	-15	455	2.8	31	0.8	1.9	125	Yes		3	3	2
Allylamine $CH_2CHCH_2NH_2$ 2-Propenylamine	-20	705	2.2	22	0.8	2	128	Yes		3	3	1
Amyl Acetate $CH_3COOC_5H_{11}$ 1-Pentanol Acetate	77	680	1.1	7.5	0.9	4.5	300	Slight		1	3	0
Benzene C_6H_6 Benzol	12	1040	1.3	7.1	0.9	2.8	176	No		2	3	0
Butadiene Monoxide $CH_2CHCHOCH_2$ Vinylethylene Oxide	-58				0.9	2.4	151			2	3	2

Chemical	Flash Point (°F)	Ignition Temp (°F)	Flammable Limits Lower	Flammable Limits Upper	Specific Gravity Water=1	Vapor Density Air=1	Boiling Point (°F)	Water Soluble	Notes	Hazard Rating Health	Hazard Rating Flammability	Hazard Rating Reactivity
Butyl Alcohol $CH_3(CH_2)_2CH_2OH$ /Butanol	84	689	1.4	11.2	0.8	2.6	243	Yes		1	3	0
Butyl Chloride C_4H_9Cl 1-Chlorobutane	15	860	1.8	10.1	0.9	3.2	170	No		2	3	0
Carbon Disulfide CS_2	-22	194	1.3	50	1.3	2.6	115	No		2	3	0
Collodion Solution of Nitrated Cellulose in Ether Alcohol	0									1	4	0
Cyclohexane C_6H_{12}	-4	473	1.3	8	0.8	2.9	179	No		1	3	0
Denatured Alcohol Government Formula CD-5 CD-5A CD-10 SD-1 SD-2B SD-3A SD-13A SD-17 SD-23A SD-30 SD-39B SD-39C SD-40M	60 60 60 49 57 56 59 19 60 35 59 60 59 59	750			0.8	1.6	175	Yes		0	3	0
Dibutyl Ether $(C_4H_9)_2O$ Butyl Ether	77	383	1.5	7.6	0.8	4.5	286	No		2	3	0
Dichloroethylene ClCHCHCl	43		9.7	12.8	1.3	3.4	141	No		2	3	2

Chemical	Flash Point (°F)	Ignition Temp (°F)	Flammable Limits Lower	Flammable Limits Upper	Specific Gravity Water=1	Vapor Density Air=1	Boiling Point (°F)	Water Soluble	Notes	Hazard Rating Health	Hazard Rating Flammability	Hazard Rating Reactivity	Chemical	Flash Point (°F)	Ignition Temp (°F)
Diethylamine $(C_2H_5)_2NH$	0	594	1.8	10.1	0.7	2.5	134	Yes					2	3	0
Dimethyl Butane $(CH_3)_3CCH_2CH_3$ Neohexane	-54	797	1.2	7.0	0.6	3.0	122	No					1	3	0
Dimethyl Pentane $CH_3CH(CH_3)CH(CH_3)CH_2CH_3$	20	635	1.1	6.7	0.7	3.5	194	No					0	3	0
ρ-Dioxane	54	356	2.0	22	1.0	3.0	214	Yes					2	3	0
Divinyl Ether $(CH_2CH)_2O$ Vinyl Ether	-22	680	1.7	27	0.8	2.4	102	No					2	3	2
Ethyl Acetate $CH_3COOC_2H_5$ Ethyl Ethanoate	24	800	2.2	11	0.9	3.0	171	Slight					1	3	0
Ethyl Alcohol C_2H_5OH Ethanol In Water 96% 95% 80% 70% 60% 50% 40% 30% 20% 10% 5%	55 62 63 68 70 72 75 79 85 97 120 144	689	3.3	19	0.8	1.6	173	Yes					0	3	0
Ethylamine $C_2H_5NH_2$ 70% Aqueous Solution	0	725	3.5	14	0.8	1.6	62	Yes					3	4	0

Chemical	Flash Point (°F)	Ignition Temp (°F)	Flammable Limits Lower	Flammable Limits Upper	Specific Gravity Water=1	Vapor Density Air=1	Boiling Point (°F)	Water Soluble	Notes	Hazard Rating Health	Hazard Rating Flammability	Hazard Rating Reactivity	Chemical	Flash Point (°F)	Ignition Temp (°F)
Ethyl Chloride C_2H_5Cl	-58	966	3.8	15.4	0.9	2.2	54	No					2	4	0
Ethylene Oxide CH_2OCH_2	0	804	3.6	100	0.9	1.5	51	Yes					2	4	3
Ethyl Ether $C_2H_5OC_2H_5$	-49	320	1.9	36	0.7	2.6	95	Slight					2	4	0
Gasoline	-36	853	1.4	7.6	0.8	3-4	100	No					1	3	0
Hexadiene $CH_3CHCHCH_2CHCH_2$	-6		2	6	0.7	2.8	151	No					0	3	0
Hexane $CH_3(CH_2)_4CH_3$	-7	437	1.1	7.5	0.7	3.0	156	No					1	3	0
Isopropyl Alcohol $(CH_3)_2CHOH$	53	750	2	12	0.8	2.1	181	Yes					1	3	0
Kerosene	100	410	0.7	5	<1		400	No	Varies by state				0	2	0
Methyl Alcohol CH_3OH	52	725	6.7	36	0.8	1.1	147	Yes					1	3	0
Methyl Cyclohexane	25	482	1.2	6.7	0.8	3.4	214	No					2	3	0
Methyl Ethyl Ether $CH_3OC_2H_5$	-35	374	2	10.1	0.7	2.1	51	Yes					2	4	0
Methyl Ethyl Ketone $C_2H_5COCH_3$	21	960	1.8	10	0.8	2.5	176	Yes					1	3	0
Naptha	28	450	0.9	6	<1		212	No	Depends on manufac-turer				1	3	0
Nitroethane $C_2H_5NO_2$	82	778	3.4		1.1	2.6	237	Slight					1	3	3

Chemical	Flash Point (°F)	Ignition Temp (°F)	Flammable Limits Lower	Flammable Limits Upper	Specific Gravity Water=1	Vapor Density Air=1	Boiling Point (°F)	Water Soluble	Notes	Hazard Rating Health	Hazard Rating Flammability	Hazard Rating Reactivity	Chemical	Flash Point (°F)	Ignition Temp (°F)
Paraldehyde $(CH_3CHO)_3$	96	460	1.3		1.0	4.5	255	Slight					2	3	1
Pentane $CH_3(CH_2)_3CH_3$	-40	500	1.5	7.8	.06	2.5	97	No					1	4	0
Petroleum Ether	0	550	1.1	5.9	0.6	2.5	95	No					1	4	0
Propanal CH_3CH_2CHO	15		2.9	17	0.8	2	120	Slight					2	3	1
Propylene Oxide	-35		2.8	37	0.9	2	95	Yes					2	4	2
Toluene $C_6H_5CH_3$	40	896	1.2	7.1	0.9	3.1	231	No					2	3	0
Turpentine	95	488	0.8		<1		300	No					1	3	0
Vinyl Ethyl Ether $CH_2CHOC_2H_5$	-50	395	1.7	28	0.8	2.5	96	No					2	4	2
Xylene $C_6H_4(CH_3)_2$	90	869	1	6	0.9	3.7	292	No					2	3	0

23.3 APPENDIX III - TABLE 4. Corrosive Chemicals

A Partial, Illustrative, List of Corrosive Chemicals

Acids:	Acetic	Chromic
	Chloroacetic	Cresylic
	Formic	Hydrochloric
	Hydrofluoric	Hydoiodic
	Perchloric	Periodic
	Phosphoric	Nitric
	Sulfuric	
Bases:	Ammonium hydroxide	Barium carbonate
	Barium hydroxide	Calcium hydroxide
	Calcium Oxide	Potassium carbonate
	Potassium hydroxide	Sodium Carbonate
	Sodium hydroxide	Trisodium phosphate
Others:	Bromine	Glutaraldehyde

23.3 APPENDIX III - TABLE 5. Water Reactive Chemicals

Partial List of Water Reactive Chemicals

Alkali metals, such as Na, Li, K

Alkali metal hydrides, such as LiH, CaH_2, $LiAlH_4$, $NaBH_4$, alkali metal amides, such as $NaNH_2$

Metal alkyls, such as lithium and aluminum alkyls

Grignard reagents, RMgX

Halides of nonmetals, such as BCl_3, BF_3, PCl_3, PCl_5, $SiCl_4$, S_2, Cl_2

Inorganic acid halides, such as $POCl_3$, $SOCl_2$, SO_2, Cl_2

Anhydrous metal halides, such as $AlCl_3$, $TiCl_4$, $ZrCl_4$, $SnCl_4$

Phosphorus pentoxide

Calcium carbide

Organic acid halides and anhydrides of low molecular weight, such as acetylchloride and acetic anhydride

23.3 APPENDIX III - TABLE 6. Pyrophoric Chemicals

Partial List of Pyrophoric Chemicals

Grignard reagents, RMgX

Metal alkyls and aryls, such as RLi, RNa, R_3Al, R_2Zn

Metal carbonyls, such as $Ni(CO)_4$, $Fe(CO)_5$, $Co_2(CO)_8$

Alkali metals such as Na, K

Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr

Metal hydrides, such as NaH, $LiAlH_4$

Nonmetal hydrides, such as B_2H_6 and other boranes, PH_3, AsH_3

Nonmetal alkyls, such as R_3B, R_3P, R_3As

Phosphorus (white)

23.3 APPENDIX III - TABLE 7. Strong Oxidizers

A Partial List of Strongly Oxidizing Chemicals

Ammonium perchlorate
Ammonium permanganate
Barium peroxide
Bromine
Calcium chlorate
Calcium hypochlorite
Chlorine trifluoride
Chromium anhydride
Chromic acid
Dibenzoyl peroxide
Fluorine
Hydrogen peroxide
Magnesium peroxide
Nitrogen trioxide
Perchloric acid
Potassium bromate
Potassium chlorate
Potassium peroxide
Propyl nitrate
Sodium chlorate
Sodium chlorite
Sodium perchlorate
Sodium peroxide

Source: CRC Handbook of Laboratory Safety, 3rd edition.

23.3 APPENDIX III - TABLE 8. Peroxide Forming Chemicals

Common Peroxide Forming Chemicals

List A: Severe Peroxide Hazard on Storage with Exposure to Air

Discard within 3 months

Diisopropyl ether (isopropyl ether)
Divinylacetylene (DVA)
Vinylidene Chloride
Potassium amide
Sodium amide (sodamide)
Potassium metal

List B: Peroxide Hazard on Concentration

Do not distill or evaporate without first testing for the presence of peroxides.
Discard or test for peroxides after 6 months

Acetaldehyde diethyl acetal (acetal)
Cumene (isopropyl benzene)
Cyclohexene
Cyclopentene
Decalin (decahydronaphthalene)
Diacetylene (butadiene)
Diethyl ether (ether)
Diethylene glycol dimethyl ether (diglyme)
Dioxane
Ethylene glycol dimethyl ether (glyme)
Ethylene glycol ether acetates
Ethylene glycol monoethers (cellosolves)
Furan
Methylacetylene
Methylcyclopentane
Tetrahydrofuran (THF)
Tetralin (tetrahydronapthalene)
Vinyl ethers

List C: Hazard of Rapid Polymerization Initiated by Internally Formed Peroxides

Normal Liquids
Discard or test for peroxides after 6 months

Chloroprene (2-chloro-1, 3-butadiene)
Styrene
Vinyl acetate
Vinyl pyridine

Normal Gases
Discard after 12 months

Butadiene
Tetrafluroethylene (TFE)
Vinyl acetylene (MVA)
Vinyl chloride

23.3 APPENDIX III - TABLE 9. Common Gas Properties

Data For Common Gases

Substances with Threshold Limit Values of 50 PPM or less should only be used in a properly operating chemical fume hood.

Gas (state in cylinder)	Threshold Limit Values, ppm[1] C=Ceiling limit	Flammability Limits in Air % by Vol[2]	Major Hazards
Acetylene (Dissolved)	Not established (nontoxic, produces anesthetic effects)	2.5-81.0	Flammable; asphyxiant
Ammonia (Liquid)	25	15-28	Toxic
Argon	Not established (nontoxic)	None	Asphyxiant
Boron trifluoride	1 C	None	Toxic; causes burns
1,3-Butadiene (Liquid)	2	2-11.5	Flammable; skin irritant; suspect carcinogen
Butane (Liquid)	800 (nontoxic, produces anesthetic effects)	1.9-8.5	Flammable, narcosis
Carbon dioxide (Liquid)	5000 C=30,000	None	Asphyxiant
Carbon monoxide	25	12.5-74.0	Toxic; chemical asphyxiant
Chlorine (Liquid)	0.5 C=1.0	None	Irritant; causes burns; corrosive
Ethane (Liquid)	Not established (nontoxic, produces anesthetic effects)	3.0-12.5	Flammable; asphyxiant
Ethylene	Not established (nontoxic, produces anesthetic effects)	3.1-32.0	Flammable; asphyxiant
Ethylene oxide (Liquid pure)	1 ppm	3.0-100.0	Flammable; toxic; causes burns when trapped by clothing; affects multiple organ, suspect carcinogen
Helium	Not established (nontoxic)	None	Asphyxiant
Gas (state in cylinder)	Threshold Limit Values, ppm[1] C=Ceiling limit	Flammability Limits in Air % by Vol[2]	Major Hazards
Hydrogen	Not established	4.0-75.0	Flammable; asphyxiant
Hydrogen bromide (Liquid)	C=3.0	None	Toxic; causes burns; corrosive
Hydrogen chloride (Liquid)	C=5.0	None	Toxic; causes burns; corrosive

Gas (state in cylinder)	Threshold Limit Values, ppm[1] C=Ceiling limit	Flammability Limits in Air % by Vol[2]	Major Hazards
Hydrogen fluoride (Liquid)	C=3.0	None	Toxic; causes severe slow healing burns; corrosive
Hydrogen sulfide (Liquid)	10 C=15	4.3-45.0	Toxic; flammable; irritant
Methane	Not established	5.3-14.0	Flammable; asphyxiant
Methyl bromide (Liquid)	1	13.5-14.5	Toxic; causes burns
Methyl chloride (Liquid)	50 C=100	10.7-17.4	Toxic; flammable
Methyl mercaptan (Liquid)	0.5	Unknown	Irritant; flammable
Nitrogen (nontoxic)	Not established	None	Asphyxiant
Nitrogen dioxide (Liquid)	3 C=5.0	None	Toxic; corrosive
Oxygen	Nontoxic	None	Highly reactive, oxidizer
Phosgene (Liquid)	0.1	None	Toxic
Propane (Liquid)	Not established (nontoxic, produces anesthetic effects)	2.2-9.5	Flammable; asphyxiant
Sulfur dioxide (Liquid)	2 C=5.0	None	Toxic; causes burns
Vinyl chloride	1	4.0-22.0	Flammable; causes burns, human carcinogen

[1] Threshold Limit Values (2000) ACGIH, Cincinnati, Ohio [2] Zabetakis, M. G. Flammability "Characteristics of Combustible Gases and Vapors" Bulletin 627, U.S. Bureau of Mines, U.S. Gov't Printing Office, WASH. D.C.

23.3 APPENDIX III - TABLE 10. Particularly Hazardous Substances

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen: Known	Human Carcinogen: Probable	Reproductive Hazard: Female	Reproductive Hazard: Male	Reproductive Hazard: Fetal	Reactive
	Nickel compounds	☐	☑	☐	☐	☐	☐	☐
	Chromium [VI] Compunds	☐	☑	☐	☐	☐	☐	☐
	Cadmium compounds	☐	☑	☐	☐	☐	☐	☐
	Chlorophenols (polychlorophenols)	☐	☐	☑	☐	☐	☐	☐
	Hexachlorocyclohexanes	☐	☐	☑	☐	☐	☐	☐
	Lead compounds, inorganic	☐	☐	☑	☑	☑	☑	☐
	Methyl and other organic mercury compounds	☑	☐	☑	☐	☐	☑	☐
	Polychlorinated biphenyls (PCBs) - all forms	☐	☐	☑	☑	☑	☑	☐
	Organolithium compounds	☐	☐	☐	☐	☐	☐	☑
	Botulinum Toxins	☑	☐	☐	☐	☐	☐	☐
	Clostridium perfringens, epsilon toxin	☑	☐	☐	☐	☐	☐	☐
	Conotoxins	☑	☐	☐	☐	☐	☐	☐
	Ricin isolates	☑	☐	☐	☐	☐	☐	☐
	Saxitoxins	☑	☐	☐	☐	☐	☐	☐
	Staphylococcal enterotoxins	☑	☐	☐	☐	☐	☐	☐
	Tetrodotoxins	☑	☐	☐	☐	☐	☐	☐
	Tricothecene mycotoxins	☑	☐	☐	☐	☐	☐	☐
50–00–0	Formaldehyde (Formalin) (Paraformaldeyde)	☑	☑	☐	☐	☐	☐	☐
50–06–6	Phenobarbital	☐	☐	☑	☐	☐	☐	☐
50–07–7	Mitomycin C	☐	☐	☑	☐	☐	☐	☐
50–18–0	Cyclophosphamide	☐	☑	☐	☐	☐	☑	☐
50–29–3	DDT [p,p'-DDT]	☐	☐	☑	☐	☐	☐	☐
50–32–8	Benzo[a]pyrene	☐	☑	☐	☐	☐	☐	☐
50–35–1	Thalidomide	☐	☐	☐	☐	☐	☑	☐
50–55–5	Reserpine	☐	☐	☑	☐	☐	☐	☐
51–21–8	5-Fluorouracil	☐	☐	☐	☐	☐	☑	☐
51–28–5	Dinitrophenol	☐	☐	☐	☐	☐	☐	☑

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
51–52–5	Propylthiouracil	☐	☐	☑	☐	☐	☑	☐
51–75–2	HN2 (nitrogen mustard-2)	☐	☐	☑	☐	☐	☑	☐
51–79–6	Ethyl carbamate (Urethane)	☐	☐	☑	☐	☐	☐	☐
52–24–4	Thiotepa	☐	☑	☐	☐	☐	☐	☐
52–67–5	Valine, 3-mercapto-, D-	☐	☐	☐	☐	☐	☑	☐
53–70–3	Dibenz [a,h]anthracene	☐	☐	☑	☐	☐	☐	☐
53–96–3	2-acetylaminofluorene	☐	☑	☐	☐	☐	☐	☐
54–62–6	Aminopterin	☐	☐	☐	☐	☐	☑	☐
55–18–5	N-Nitrosodiethylamine	☐	☐	☑	☐	☐	☐	☐
55–63–0	Nitrogycerine	☐	☐	☐	☐	☐	☐	☑
55–86–7	Nitrogen Mustard Hydrochloride	☐	☐	☑	☐	☐	☐	☐
55–98–1	1,4-Butanediol dimethanesulfonate (Busulfan; Myleran)	☐	☑	☐	☑	☑	☑	☐
56–04–2	Methylthiouracil	☐	☐	☑	☐	☐	☐	☐
56–23–5	Carbon tetrachloride	☐	☐	☑	☐	☐	☐	☐
56–53–1	Diethylstilboestrol	☐	☑	☐	☐	☐	☑	☐
56–55–3	Benz[a]anthracene	☐	☐	☑	☐	☐	☐	☐
56–75–7	Chloramphenicol	☐	☐	☑	☐	☐	☐	☐
57–14–7	1,1-Dimethylhydrazine	☑	☐	☑	☐	☐	☐	☐
57–41–0	Phenytoin	☐	☐	☑	☐	☐	☑	☐
57–57–8	beta-propiolactone	☐	☑	☐	☐	☐	☐	☐
57–74–9	Chlordane	☐	☐	☑	☐	☐	☐	☐
57–83–0	Progesterone	☐	☐	☑	☐	☐	☐	☐
58–18–4	Methyltestosterone	☐	☐	☐	☐	☐	☑	☐
58–89–9	Lindane	☐	☐	☑	☐	☐	☐	☐
59–05–2	Methotrexate	☐	☐	☐	☑	☐	☑	☐
59–89–2	N-Nitrosomorpholine	☐	☐	☑	☐	☐	☐	☐
60–09–3	para-Aminoazobenzene	☐	☐	☑	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen: Known	Human Carcinogen: Probable	Reproductive Hazard: Female	Reproductive Hazard: Male	Reproductive Hazard: Fetal	Reactive
60–11–7	4-Dimethylaminoazo-benzene	☐	☑	☐	☐	☐	☐	☐
60–29–7	Diethyl ether	☐	☐	☐	☐	☐	☐	☑
60–34–4	Methyl hydrazine	☑	☐	☐	☐	☐	☐	☐
60–35–5	Acetamide	☐	☐	☑	☐	☐	☐	☐
60–56–0	Methiamazole	☐	☐	☐	☐	☐	☑	☐
61–57–4	Niridazole	☐	☐	☑	☐	☐	☐	☐
61–82–5	Amitrole	☐	☐	☑	☐	☐	☐	☐
62–44–2	Phenacetin	☐	☐	☑	☐	☐	☐	☐
62–50–0	Ethyl methanesulfonate	☐	☐	☑	☐	☐	☐	☐
62–53–3	Aniline	☐	☐	☐	☐	☐	☑	☐
62–55–5	Thioacetamide	☐	☐	☑	☐	☐	☐	☐
62–56–6	Thiourea	☐	☐	☑	☐	☐	☐	☐
62–73–7	Dichlorvos	☐	☐	☑	☐	☐	☐	☐
62–75–9	N-nitrosodimethylamine	☐	☑	☐	☐	☐	☐	☐
63–92–3	Phenoxybenzamine hydrochloride	☐	☐	☑	☐	☐	☐	☐
64–67–5	Diethyl sulfate	☐	☐	☑	☐	☐	☐	☐
66–27–3	Methyl methanesulfonate	☐	☐	☑	☐	☐	☐	☐
66–75–1	Uracil mustard	☐	☐	☑	☐	☐	☐	☐
66–76–2	Dicumarol	☐	☐	☐	☐	☐	☑	☐
67–20–9	Nitrofurantoin	☐	☐	☐	☐	☑	☐	☐
67–66–3	Chloroform [Methane, trichloro-]	☐	☐	☑	☐	☐	☐	☐
67–72–1	Hexachloroethane	☐	☐	☑	☐	☐	☐	☐
68–22–4	Norethisterone	☐	☐	☑	☐	☐	☐	☐
70–25–7	N-Methyl-N′-nitro-N-nitrosoguanidine (MNNG)	☐	☐	☑	☐	☐	☐	☑
71–43–2	Benzene	☐	☑	☐	☐	☐	☐	☐
71–58–9	Medroxyprogesterone acetate	☐	☐	☑	☐	☐	☐	☐
72–57–1	Trypan blue	☐	☐	☑	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen: Known	Human Carcinogen: Probable	Reproductive Hazard: Female	Reproductive Hazard: Male	Reproductive Hazard: Fetal	Reactive
74–83–9	Methyl bromide	☑	☐	☐	☐	☐	☐	☐
74–86–2	Acetylene	☐	☐	☐	☐	☐	☐	☑
74–89–5	Methylamine	☑	☐	☐	☐	☐	☐	☐
74–90–8	Hydrogen cyanide (gas)	☑	☐	☐	☐	☐	☐	☐
74–93–1	Methyl mercaptan	☑	☐	☐	☐	☐	☐	☐
75–01–4	Vinyl chloride	☐	☑	☐	☐	☐	☐	☐
75–02–5	Vinyl fluoride	☐	☐	☑	☐	☐	☐	☐
75–07–0	Acetaldehyde	☑	☐	☑	☐	☐	☐	☐
75–09–2	Methylene Chloride (dichloromethane)	☐	☑	☐	☐	☐	☑	☐
75–15–0	Carbon disulfide	☑	☐	☐	☑	☑	☑	☐
75–20–7	Calcium carbide	☐	☐	☐	☐	☐	☐	☑
75–21–8	Ethylene Oxide	☑	☑	☐	☑	☐	☐	☑
75–27–4	Bromodichloromethane	☐	☐	☑	☐	☐	☐	☐
75–35–4	Vinylidene chloride	☐	☐	☐	☐	☐	☐	☑
75–44–5	Phosgene	☑	☐	☐	☐	☐	☐	☐
75–52–5	Nitromethane	☐	☐	☑	☐	☐	☐	☑
75–55–8	Propyleneimine (Aziridine, 2- methyl-)	☐	☐	☑	☐	☐	☐	☐
75–56–9	Propylene Oxide	☑	☐	☑	☐	☐	☐	☐
75–74–1	Tetramethyl lead	☑	☐	☐	☐	☐	☐	☐
75–77–4	Trimethylchlorosilane	☑	☐	☐	☐	☐	☐	☐
75–78–5	Dimethyldichlorosilane	☑	☐	☐	☐	☐	☐	☐
75–79–6	Methyltrichlorosilane	☑	☐	☐	☐	☐	☐	☐
75–86–5	Acetone cyanohydrin	☑	☐	☐	☐	☐	☐	☐
75–91–2	t-Butyl hydroperoxide	☐	☐	☐	☐	☐	☐	☑
76–06–2	Chloropicrin	☑	☐	☐	☐	☐	☐	☐
76–44–8	Heptachlor	☐	☐	☑	☐	☐	☐	☐
77–09–8	Phenolphthalein	☐	☐	☑	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
77–47–4	Hexachlorocyclopentadiene	☑	☐	☐	☐	☐	☐	☐
77–73–6	Dicyclopentadiene	☐	☐	☐	☐	☐	☐	☑
77–78–1	Dimethyl Sulfate	☑	☐	☑	☐	☐	☐	☐
78–11–5	Erythritol tetranitrate (PETN)	☐	☐	☐	☐	☐	☐	☑
78–53–5	o,o-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate	☐	☑	☐	☐	☐	☐	☐
78–79–5	Isoprene	☐	☐	☑	☐	☐	☐	☐
78–82–0	Isobutyronitrile	☑	☐	☐	☐	☐	☐	☐
78–85–3	Methacrylaldehyde	☑	☐	☐	☐	☐	☐	☐
78–94–4	Methyl vinyl ketone	☑	☐	☐	☐	☐	☐	☑
78–95–5	Chloroacetone, stabilized	☑	☐	☐	☐	☐	☐	☐
79–01–6	Trichloroethylene	☐	☐	☑	☐	☐	☐	☐
79–04–9	Chloroacetyl Chloride	☑	☐	☐	☐	☐	☐	☐
79–06–1	Acrylamide	☐	☐	☑	☐	☐	☐	☐
79–10–7	Acrylic acid	☑	☐	☐	☐	☐	☐	☐
79–21–0	Peracetic Acid	☑	☐	☐	☐	☐	☐	☑
79–22–1	Methyl chloroformate	☑	☐	☐	☐	☐	☐	☐
79–43–6	Dichloroacetic acid	☐	☐	☑	☐	☐	☐	☐
79–44–7	Dimethylcarbamoyl chloride	☐	☐	☑	☐	☐	☐	☐
79–46–9	2-Nitropropane	☐	☐	☑	☐	☐	☐	☐
80–15–9	Cumene Hydroperoxide	☑	☐	☐	☐	☐	☐	☑
80–43–3	Cumene peroxide	☐	☐	☐	☐	☐	☐	☑
81–49–2	1-Amino-2,4-dibromoanthraquinone	☐	☐	☑	☐	☐	☐	☐
81–81–2	Coumarin, 3-(alpha-acetonylbenzyl)-4-hydroxy-	☐	☐	☐	☐	☐	☑	☐
82–28–0	1-Amino-2-methylanthraquinone	☐	☐	☑	☐	☐	☐	☐
82–71–3	Trinitroresorcinol	☐	☐	☐	☐	☐	☐	☑
87–31–0	Diazodinitrophenol	☐	☐	☐	☐	☐	☐	☑
87–62–7	2,6-Dimethylaniline (2,6-Xylidine)	☐	☐	☑	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
87–68–3	Hexachlorobutadiene	☑	☐	☐	☐	☐	☐	☐
88–06–2	2,4,6-Trichlorophenol	☐	☐	☑	☐	☐	☐	☐
88–88–0	Picryl chloride	☐	☐	☐	☐	☐	☐	☑
88–89–1	Picric acid (trinitrophenol)	☐	☐	☐	☐	☐	☐	☑
90–04–0	ortho-Anisidine	☐	☐	☑	☐	☐	☐	☐
90–94–8	Michler's ketone (4,4'-bis(dimethylamino)benzophenone)	☐	☐	☑	☐	☐	☐	☐
91–17–8	Decahydronaphthalene	☐	☐	☐	☐	☐	☐	☑
91–20–3	Naphthalene	☐	☐	☑	☐	☐	☐	☐
91–23–6	2-Nitroanisole	☐	☐	☑	☐	☐	☐	☐
91–59–8	2-Naphthylamine	☐	☑	☐	☐	☐	☐	☐
91–94–1	3,3'-Dichlorobenzidine and salts	☐	☑	☐	☐	☐	☐	☐
92–67–1	4-Aminobiphenyl	☐	☑	☐	☐	☐	☐	☐
92–87–5	Benzidine	☐	☑	☐	☐	☐	☐	☐
93–15–2	Methyleugenol	☐	☐	☑	☐	☐	☐	☐
94–36–0	Benzoyl peroxide	☐	☐	☐	☐	☐	☐	☑
94–58–6	Dihydrosafrole	☐	☐	☑	☐	☐	☐	☐
94–59–7	Safrole	☐	☐	☑	☐	☐	☐	☐
95–06–7	Sulfallate	☐	☐	☑	☐	☐	☐	☐
95–53–4	ortho-Toluidine	☐	☑	☐	☐	☐	☐	☐
95–69–2	4-Chloro-ortho-toluidine	☐	☐	☑	☐	☐	☐	☐
95–80–7	2,4-Diaminotoluene	☐	☐	☑	☐	☐	☐	☐
95–83–0	4-Chloro-ortho-phenylenediamine	☐	☐	☑	☐	☐	☐	☐
96–09–3	Styrene-7,8-oxide	☐	☐	☑	☐	☐	☐	☐
96–12–8	1,2-Dibromo-3-chloropropane	☐	☑	☐	☐	☑	☐	☐
96–13–9	2,3-Dibromo-1-propanol	☐	☐	☑	☐	☐	☐	☐
96–18–4	1,2,3-Trichloropropane	☐	☐	☑	☐	☐	☐	☐
96–45–7	Ethylene Thiourea	☐	☐	☑	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
96–91–3	Picramic acid	☐	☐	☐	☐	☐	☐	☑
97–56–3	ortho-Aminoazotoluene	☐	☐	☑	☐	☐	☐	☐
98–07–7	benzotrichloride	☐	☐	☑	☐	☐	☐	☐
98–87–3	benzal chloride	☐	☐	☑	☐	☐	☐	☐
98–88–4	Benzoyl chloride	☑	☐	☑	☐	☐	☐	☐
98–95–3	Nitrobenzene	☐	☐	☑	☐	☑	☐	☐
99–35–4	Trinitrobenzene	☐	☐	☐	☐	☐	☐	☑
99–66–1	Valproate (Valproic acid)	☐	☐	☐	☐	☐	☑	☐
100–40–3	4-Vinylcyclohexene	☐	☐	☑	☐	☐	☐	☐
100–41–4	Ethylbenzene	☐	☐	☑	☐	☐	☐	☐
100–42–5	Styrene	☐	☐	☑	☐	☐	☐	☑
100–44–7	Benzyl Chloride	☑	☐	☑	☐	☐	☐	☐
100–66–3	Anisole	☐	☐	☐	☐	☐	☐	☑
100–75–4	N-Nitrosopiperidine	☐	☐	☑	☐	☐	☐	☐
101–14–4	4,4´-Methylenebis(2-chloroaniline)	☐	☑	☐	☐	☐	☐	☐
101–61–1	Michler's base (4,4'-methylenebis(N,N-dimethyl)benzenamine)	☐	☐	☑	☐	☐	☐	☐
101–68–8	4,4'-Methylenediphenyl diisocyanate	☑	☐	☐	☐	☐	☐	☐
101–77–9	Methylenedianiline	☐	☑	☐	☐	☐	☐	☐
101–80–4	4,4'-Oxydianiline	☐	☐	☑	☐	☐	☐	☐
101–90–6	Diglycidyl resorcinol ether	☐	☐	☑	☐	☐	☐	☐
103–50–4	Dibenzyl ether	☐	☐	☐	☐	☐	☐	☑
103–71–9	Phenyl isocyanate	☑	☐	☐	☐	☐	☐	☐
105–57–7	Acetal	☐	☐	☐	☐	☐	☐	☑
105–74–8	Dodecanoyl peroxide	☐	☐	☐	☐	☐	☐	☑
106–46–7	para-Dichlorobenzene	☐	☐	☑	☐	☐	☐	☐
106–47–8	para-Chloroaniline	☐	☐	☑	☐	☐	☐	☐
106–87–6	4-Vinylcyclohexene diepoxide	☐	☐	☑	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen: Known	Human Carcinogen: Probable	Reproductive Hazard: Female	Reproductive Hazard: Male	Reproductive Hazard: Fetal	Reactive
106–88–7	1,2-Epoxybutane	☐	☐	☑	☐	☐	☐	☐
106–89–8	Epichlorohydrin	☑	☐	☑	☐	☐	☐	☐
106–93–4	1,2-Dibromoethane (Ethylene Dibromide)	☐	☐	☑	☐	☐	☐	☐
106–96–7	Bromopropyne (Propargyl bromide)	☐	☐	☐	☐	☐	☐	☑
106–99–0	1,3-Butadiene	☐	☑	☐	☐	☐	☐	☐
107–02–8	Acrolein (2-Propenal)	☑	☐	☐	☐	☐	☐	☐
107–06–2	1,2-Dichloroethane	☐	☐	☑	☐	☐	☐	☐
107–07–3	2-Chloroethanol	☑	☐	☐	☐	☐	☐	☐
107–13–1	Acrylonitrile (2-Propenenitrile)	☑	☑	☐	☐	☐	☐	☐
107–18–6	Allyl alcohol (2-Propen-l-ol)	☑	☐	☐	☐	☐	☐	☐
107–20–0	2-Chloroethanal	☑	☐	☐	☐	☐	☐	☐
107–30–2	Chloromethyl methyl ether	☑	☑	☐	☐	☐	☐	☐
107–44–8	Sarin	☑	☐	☐	☐	☐	☐	☐
108–05–4	Vinyl acetate monomer (Acetic acid ethenyl ester)	☐	☐	☑	☐	☐	☐	☑
108–10–1	Methyl iso-butyl ketone	☐	☐	☐	☐	☐	☐	☑
108–20–3	isopropyl ether	☐	☐	☐	☐	☐	☐	☑
108–23–6	Isopropylchloroformate	☑	☐	☐	☐	☐	☐	☐
108–88–3	Toluene	☐	☐	☐	☑	☐	☑	☐
108–95–2	Phenol	☑	☐	☐	☐	☐	☑	☐
109–53–5	vinyl iso butyl ether	☐	☐	☐	☐	☐	☐	☑
109–86–4	Ethylene glycol monomethyl ether	☐	☐	☐	☐	☐	☐	☑
109–92–2	Ethyl vinyl ether	☐	☐	☐	☐	☐	☐	☑
109–99–9	Tetrahydrofuran	☐	☐	☐	☐	☐	☐	☑
110–00–9	Furan	☐	☐	☑	☐	☐	☐	☑
110–22–5	Acetyl peroxide	☐	☐	☐	☐	☐	☐	☑
110–78–1	n-Propyl isocyanate	☑	☐	☐	☐	☐	☐	☐
111–36–4	n-Butyl isocyanate	☑	☐	☐	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
111–96–6	Diethylene glycol diemethyl ether	☐	☐	☐	☐	☐	☐	☑
115–02–6	Azaserine	☐	☐	☑	☐	☐	☐	☐
115–28–6	Chlorendic acid	☐	☐	☑	☐	☐	☐	☐
115–67–3	Paramethadione	☐	☐	☐	☐	☐	☑	☐
116–14–3	Tetrafluoroethylene	☐	☐	☑	☐	☐	☐	☐
117–10–2	Dantron (Chrysazin; 1,8-Dihydroxyanthraquinone)	☐	☐	☑	☐	☐	☐	☐
117–79–3	2-Aminoanthraquinone	☐	☐	☑	☐	☐	☐	☐
117–81–7	di(2-Ethylhexyl) Phthalate	☐	☐	☑	☐	☐	☐	☐
118–74–1	Hexachlorobenzene	☐	☐	☑	☐	☐	☐	☐
118–96–7	Trinitrotoluene (TNT)	☐	☐	☐	☐	☐	☐	☑
119–64–2	Tetralin	☐	☐	☐	☐	☐	☐	☑
119–90–4	3,3'-Dimethoxybenzidine (ortho-Dianisidine)	☐	☐	☑	☐	☐	☐	☐
119–93–7	3,3'-Dimethylbenzidine (ortho-Tolidine)	☐	☐	☑	☐	☐	☐	☐
120–71–8	para-Cresidine	☐	☐	☑	☐	☐	☐	☐
120–80–9	Catechol	☐	☐	☑	☐	☐	☐	☐
121–14–2	2,4-Dinitrotoluene	☐	☐	☑	☐	☐	☑	☐
121–82–4	Cyclotrimethylenetrinitramine (RDX) (Hexolite)	☐	☐	☐	☐	☐	☐	☑
122–60–1	Phenyl glycidyl ether (PGE)	☐	☐	☑	☐	☑	☐	☐
122–66–7	Hydrazobenzene	☐	☐	☑	☐	☐	☐	☐
123–91–1	1,4-Dioxane	☐	☐	☑	☐	☐	☐	☑
124–43–6	Urea Peroxide	☐	☐	☐	☐	☐	☐	☑
124–47–0	Urea nitrate	☐	☐	☐	☐	☐	☐	☑
126–07–8	Griseofulvin	☐	☐	☑	☐	☐	☐	☐
126–72–7	Tris(2,3-dibromopropyl) phosphate	☐	☐	☑	☐	☐	☐	☐
126–85–2	Nitrogen mustard N-oxide	☐	☐	☑	☐	☐	☐	☐
126–98–7	Methacrylonitrile (2- Propenenitrile, 2-methyl-)	☑	☐	☐	☐	☐	☐	☐
126–99–8	Chloroprene	☐	☐	☑	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
127–07–1	Hydroxyurea	☐	☐	☐	☐	☐	☑	☐
127–18–4	Tetrachloroethylene	☐	☐	☑	☐	☐	☐	☐
127–48–0	Trimethadione	☐	☐	☐	☐	☐	☑	☐
129–15–7	2-Methyl-1-nitroanthraquinone	☐	☐	☑	☐	☐	☐	☐
129–43–1	1-Hydroxyanthraquinone	☐	☐	☑	☐	☐	☐	☐
129–66–8	Trinitrobenzoic acid	☐	☐	☐	☐	☐	☐	☑
131–73–7	Dipicrylamine	☐	☐	☐	☐	☐	☐	☑
131–74–8	Ammonium picrate	☐	☐	☐	☐	☐	☐	☑
132–27–4	Sodium ortho-phenylphenate	☐	☐	☑	☐	☐	☐	☐
134–29–2	o-Anisidine Hydrochloride	☐	☐	☑	☐	☐	☐	☐
134–32–7	alpha-Napthylamine	☐	☑	☐	☐	☐	☐	☐
135–20–6	Cupferron	☐	☐	☑	☐	☐	☐	☐
136–35–6	Diazoaminobenzene	☐	☐	☑	☐	☐	☐	☐
136–40–3	Phenazopyridine hydrochloride	☐	☐	☑	☐	☐	☐	☐
139–13–9	Nitrilotriacetic acid	☐	☐	☑	☐	☐	☐	☐
139–65–1	4,4'-Thiodianiline	☐	☐	☑	☐	☐	☐	☐
140–57–8	Aramite®	☐	☐	☑	☐	☐	☐	☐
140–88–5	Ethyl acrylate	☐	☐	☑	☐	☐	☐	☐
141–90–2	Thiouracil	☐	☐	☑	☐	☐	☐	☐
142–96–1	n-Butyl Ether	☐	☐	☐	☐	☐	☐	☑
143–50–0	Chlordecone (Kepone)	☐	☐	☑	☐	☐	☐	☐
147–94–4	Cytarabine	☐	☐	☐	☐	☐	☑	☐
148–82–3	Melphalan	☐	☑	☐	☐	☐	☐	☐
151–56–4	Ethyleneimine (Aziridine)	☐	☑	☐	☐	☐	☐	☐
154–42–7	Thioguanine	☐	☐	☐	☐	☐	☑	☐
154–93–8	Bischloroethyl nitrosourea (BCNU)	☐	☐	☑	☐	☐	☐	☐
189–55–9	Dibenzo[a,i]pyrene	☐	☐	☑	☐	☐	☐	☐

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen: Known	Human Carcinogen: Probable	Reproductive Hazard: Female	Reproductive Hazard: Male	Reproductive Hazard: Fetal	Reactive
189–64–0	Dibenzo[a,h]pyrene	☐	☐	☑	☐	☐	☐	☐
191–30–0	Dibenzo[a,l]pyrene	☐	☐	☑	☐	☐	☐	☐
192–65–4	Dibenzo[a,e]pyrene	☐	☐	☑	☐	☐	☐	☐
193–39–5	Indeno[1,2,3-cd]pyrene	☐	☐	☑	☐	☐	☐	☐
194–59–2	7H-Dibenzo[c,g]carbazole	☐	☐	☑	☐	☐	☐	☐
195–19–7	Benzo[c]phenanthrene	☐	☐	☑	☐	☐	☐	☐
202–33–5	Benz[j]aceanthrylene	☐	☐	☑	☐	☐	☐	☐
205–82–3	Benzo[j]fluoranthene	☐	☐	☑	☐	☐	☐	☐
205–99–2	Benzo[b]fluoranthene	☐	☐	☑	☐	☐	☐	☐
207–08–9	Benzo[k]fluoranthene	☐	☐	☑	☐	☐	☐	☐
218–01–9	Chrysene	☐	☐	☑	☐	☐	☐	☐
224–42–0	Dibenz[a,j]acridine	☐	☐	☑	☐	☐	☐	☐
226–36–8	Dibenz[a,h]acridine	☐	☐	☑	☐	☐	☐	☐
271–89–6	Benzofuran	☐	☐	☑	☐	☐	☐	☐
298–81–7	8-Methoxypsoralen (Methoxsalen) plus ultraviolet A radiation	☐	☑	☐	☐	☐	☐	☐
299–75–2	Treosulfan	☐	☑	☐	☐	☐	☐	☐
302–01–2	Hydrazine	☑	☐	☑	☐	☐	☐	☐
303–34–4	Lasiocarpine	☐	☐	☑	☐	☐	☐	☐
303–47–9	Ochratoxin A	☐	☐	☑	☐	☐	☐	☐
305–03–3	Chlorambucil	☐	☑	☐	☑	☑	☑	☐
315–22–0	Monocrotaline	☐	☐	☑	☐	☐	☐	☐
320–67–2	Azacitidine	☐	☐	☑	☐	☐	☐	☐
331–39–5	Caffeic acid	☐	☐	☑	☐	☐	☐	☐
353–42–4	Boron trifluoride	☐	☐	☐	☐	☐	☐	☑
366–70–1	Procarbazine hydrochloride	☐	☐	☑	☐	☐	☑	☐
434–07–1	Oxymetholone	☐	☐	☑	☐	☐	☐	☐
435–97–2	Phenprocoumon	☐	☐	☐	☐	☐	☑	☐

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen: Known	Human Carcinogen: Probable	Reproductive Hazard: Female	Reproductive Hazard: Male	Reproductive Hazard: Fetal	Reactive
443–48–1	Metronidazole	☐	☐	☑	☐	☐	☐	☐
446–86–6	Azathioprine	☐	☑	☐	☐	☐	☐	☐
460–19–5	Cyanogen	☑	☐	☐	☐	☐	☐	☐
463–51–4	Ketene	☑	☐	☐	☐	☐	☐	☐
463–58–1	Carbonyl sulfide	☑	☐	☐	☐	☐	☐	☐
463–71–8	Thiophosgene	☑	☐	☐	☐	☐	☐	☐
484–20–8	5-Methoxypsoralen	☐	☐	☑	☐	☐	☐	☐
489–98–5	Picramide (2,4,6-trinitrotoluene)	☐	☐	☐	☐	☐	☐	☑
492–80–8	Auramine	☐	☐	☑	☐	☐	☐	☐
494–03–1	N, N-Bis(2-chloroethyl)-2-naphthylamine (Chlornaphazine)	☐	☑	☐	☐	☐	☐	☐
505–60–2	Mustard gas (Sulfur mustard)	☐	☑	☐	☐	☐	☐	☐
506–68–3	Cyanogen bromide	☑	☐	☐	☐	☐	☐	☐
506–77–4	Cyanogen chloride	☑	☐	☐	☐	☐	☐	☐
507–40–4	tert-Butyl hypochlorite	☐	☐	☐	☐	☐	☐	☑
509–14–8	Tetranitromethane (Methane, tetranitro-)	☐	☐	☑	☐	☐	☐	☑
513–37–1	1-Chloro-2-methylpropene (Dimethylvinyl Chloride)	☐	☐	☑	☐	☐	☐	☐
531–76–0	Merphalan	☐	☐	☑	☐	☐	☐	☐
531–82–8	N-[4-(5-Nitro-2-furyl)-2-thiazolyl]acetamide	☐	☐	☑	☐	☐	☐	☐
540–73–8	Dimethylhydrazine, symmetrical	☑	☐	☑	☐	☐	☐	☐
541–41–3	Ethyl chloroformate	☑	☐	☐	☐	☐	☐	☐
542–75–6	1,3-Dichloropropene	☐	☐	☑	☐	☐	☐	☐
542–88–1	Chloromethyl ether (Methane, oxybis[chloro-])	☐	☑	☐	☐	☐	☐	☐
542–92–7	cyclopentadiene	☐	☐	☐	☐	☐	☐	☑
543–27–1	Isobutyl chloroformate	☑	☐	☐	☐	☐	☐	☐
544–97–8	Dimethylzinc	☐	☐	☐	☐	☐	☐	☑
555–54–4	Magnesium diphenyl	☐	☐	☐	☐	☐	☐	☑
555–84–0	1-[(5-Nitrofurfurylidene)amino]-2-imidazolidinone	☐	☐	☑	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
556–52–5	Glycidol	☐	☐	☑	☐	☐	☐	☐
556–88–7	Nitroguanidine (Picrite)	☐	☐	☐	☐	☐	☐	☑
556–89–8	Nitrourea	☐	☐	☐	☐	☐	☐	☑
557–20–0	Diethylzinc	☐	☐	☐	☐	☐	☐	☑
563–47–3	3-Chloro-2-methylpropene	☐	☐	☑	☐	☐	☐	☐
569–61–9	CI Basic Red 9	☐	☐	☑	☐	☐	☐	☐
584–84–9	Toluene-2,4-diisocyanate (unspecified isomer)	☑	☐	☐	☐	☐	☐	☐
592–34–7	n-Butyl chloroformate	☑	☐	☐	☐	☐	☐	☐
592–62–1	Methylazoxymethanol acetate	☐	☐	☑	☐	☐	☐	☐
593–60–2	Vinyl bromide	☐	☐	☑	☐	☐	☐	☐
593–74–8	Dimethyl mercury	☑	☐	☑	☐	☐	☑	☐
593–89–5	Methyldichloroarsine	☑	☐	☐	☐	☐	☐	☐
598–14–1	Ethyldichloroarsine	☑	☐	☐	☐	☐	☐	☐
602–87–9	5-Nitroacenaphthene	☐	☐	☑	☐	☐	☐	☐
604–75–1	Oxazepam	☐	☐	☑	☐	☐	☐	☐
606–20–2	2,6-Dinitrotoluene	☐	☐	☑	☐	☐	☑	☐
606–35–9	Trinitroanisole	☐	☐	☐	☐	☐	☐	☑
607–57–8	2-Nitrofluorene	☐	☐	☑	☐	☐	☐	☐
612–83–9	3,3´-Dichlorobenzidine Dihydrochloride	☐	☐	☑	☐	☐	☐	☐
613–35–4	N,N'-Diacetylbenzidine	☐	☐	☑	☐	☐	☐	☐
615–05–4	2,4-Diaminoanisole	☐	☐	☑	☐	☐	☐	☐
615–53–2	N-Methyl-N-nitrosourethane	☐	☐	☑	☐	☐	☐	☐
621–64–7	N-Nitrosodi-n-propylamine	☐	☐	☑	☐	☐	☐	☐
624–83–9	Methyl isocyanate	☑	☐	☐	☐	☐	☐	☐
627–44–1	Diethyl Mercury	☑	☐	☑	☐	☐	☑	☐
628–55–7	isobutyl ether	☐	☐	☐	☐	☐	☐	☑
628–85–3	Dipropyl Mercury	☑	☐	☑	☐	☐	☑	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
628–86–4	Mercury Fulminate	☐	☐	☐	☐	☐	☐	☑
628–96–6	Nitroglycol	☐	☐	☐	☐	☐	☐	☑
630–08–0	Carbon monoxide	☑	☐	☐	☑	☐	☑	☐
636–21–5	o-Toluidine Hydrochloride	☐	☐	☑	☐	☐	☐	☐
638–21–1	Phenylphosphine	☐	☐	☐	☐	☑	☐	☐
674–82–8	Diketene	☑	☐	☐	☐	☐	☐	☐
675–14–9	Cyanuric Fluoride	☑	☐	☐	☐	☐	☐	☐
676–97–1	Methyl phosphonic dichloride	☑	☐	☐	☐	☐	☐	☐
680–31–9	Hexamethylphosphoramide	☐	☐	☑	☐	☐	☐	☐
681–84–5	Tetramethyl orthosilicate	☑	☐	☐	☐	☐	☐	☐
684–16–2	Hexafluoroacetone	☑	☐	☐	☐	☑	☐	☐
684–93–5	N-Methyl-N-nitrosourea	☐	☐	☑	☐	☐	☐	☐
712–68–5	2-Amino-5-(5-nitro-2-furyl)-1,3,4-thiadiazole	☐	☐	☑	☐	☐	☐	☐
759–73–9	N-Ethyl-N-nitrosourea	☐	☐	☑	☐	☐	☐	☐
765–34–4	Glycidaldehyde	☐	☐	☑	☐	☐	☐	☐
794–93–4	Panfuran S	☐	☐	☑	☐	☐	☐	☐
817–09–4	Trichlormethine (Trimustine hydrochloride)	☐	☐	☑	☐	☐	☐	☐
831–52–7	Sodium picramate	☐	☐	☐	☐	☐	☐	☑
838–88–0	4,4'-Methylene bis(2-methylaniline)	☐	☐	☑	☐	☐	☐	☐
924–16–3	N-Nitrosodi-n-butylamine	☐	☐	☑	☐	☐	☐	☐
930–55–2	N-Nitrosopyrrolidine	☐	☐	☑	☐	☐	☐	☐
993–00–0	Methylchlorosilane	☑	☐	☐	☐	☐	☐	☐
998–40–3	Tributylphosphane	☐	☐	☐	☐	☐	☐	☑
1071–39–2	Diisopropyl Mercury	☑	☐	☑	☐	☐	☑	☐
1116–54–7	N-Nitrosodiethanolamine	☐	☐	☑	☐	☐	☐	☐
1120–71–4	1,3-Propane sultone	☐	☐	☑	☐	☐	☐	☐
1162–65–8	Aflatoxin B	☑	☐	☐	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
1303–00–0	Gallium arsenide	☐	☑	☐	☐	☐	☐	☐
1305–99–3	Calcium phosphide	☐	☐	☐	☐	☐	☐	☑
1309–64–4	Antimony trioxide	☐	☐	☑	☐	☐	☐	☐
1313–60–6	Sodium peroxide	☐	☐	☐	☐	☐	☐	☑
1314–20–1	Thorium Dioxide	☐	☑	☐	☐	☐	☐	☐
1314–62–1	Vanadium pentoxide	☐	☐	☑	☐	☐	☐	☐
1314–84–7	Zinc phosphide	☐	☐	☐	☐	☐	☐	☑
1321–12–6	Mononitrotoluene	☐	☐	☐	☐	☐	☐	☑
1332–21–4	Asbestos	☐	☑	☐	☐	☐	☐	☐
1333–86–4	Carbon black	☐	☐	☑	☐	☐	☐	☐
1337–81–1	vinyl pyridine	☐	☐	☐	☐	☐	☐	☑
1338–23–4	MEK peroxide (butanone peroxide)	☐	☐	☐	☐	☐	☐	☑
1393–62–0	Abrin	☑	☐	☐	☐	☐	☐	☐
1402–68–2	Aflatoxins	☑	☑	☐	☐	☐	☐	☐
1464–53–5	Diepoxybutane	☐	☐	☑	☐	☐	☐	☐
1609–86–5	tert-Butyl isocyanate	☑	☐	☐	☐	☐	☐	☐
1615–80–1	1,2-Diethylhydrazine	☐	☐	☑	☐	☐	☐	☐
1694–09–3	Benzyl violet 4B	☐	☐	☑	☐	☐	☐	☐
1746–01–6	2,3,7,8-Tetrachlorodibenzo-para-dioxin	☐	☑	☐	☐	☐	☐	☐
1836–75–5	Nitrofen	☐	☐	☑	☐	☐	☐	☐
1897–45–6	Chlorothalonil	☐	☐	☑	☐	☐	☐	☐
2068–78–2	Vincristine sulfate	☐	☐	☐	☐	☐	☑	☐
2238–07–5	Diglycidyl ether (DGE)	☐	☐	☐	☐	☑	☐	☐
2243–94–9	Trinitronaphthalene	☐	☐	☐	☐	☐	☐	☑
2270–40–8	Diacetoxyscirpenol	☑	☐	☐	☐	☐	☐	☐
2385–85–5	Mirex	☐	☐	☑	☐	☐	☐	☐
2425–06–1	Captafol	☐	☐	☑	☐	☐	☐	☐

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
2426–08–6	Glycidyl n-butyl ether	☐	☐	☐	☐	☐	☐	☑
2429–74–5	CI Direct Blue 15	☐	☐	☑	☐	☐	☐	☐
2475–45–8	Disperse Blue 1	☐	☐	☑	☐	☐	☐	☐
2487–90–3	Trimethoxysilane	☑	☐	☐	☐	☐	☐	☐
2623–22–5	Monoacetoxyscirpenol	☑	☐	☐	☐	☐	☐	☐
2646–17–5	Oil Orange SS	☐	☐	☑	☐	☐	☐	☐
2691–41–0	Cyclotetramethylenetetranitramine (HMX)	☐	☐	☐	☐	☐	☐	☑
2696–92–6	n-Propyl chloroformate (Nitrosyl chloride)	☑	☐	☐	☐	☐	☐	☐
2699–79–8	Sulfuryl fluoride	☑	☐	☐	☐	☐	☐	☐
2784–94–3	HC Blue No. 1	☐	☐	☑	☐	☐	☐	☐
2937–50–0	Allyl chloroformate	☑	☐	☐	☐	☐	☐	☐
2941–64–2	Ethyl chlorothioformate	☑	☐	☐	☐	☐	☐	☐
2973–10–6	Diisopropyl sulfate	☐	☐	☑	☐	☐	☐	☐
3068–88–0	b-Butyrolactone	☐	☐	☑	☐	☐	☐	☐
3165–93–3	p-Chloro-o-toluidine Hydrochloride	☐	☐	☑	☐	☐	☐	☐
3173–53–3	Cyclohexyl isocyanate	☑	☐	☐	☐	☐	☐	☐
3296–90–0	2,2-Bis(bromomethyl)propane-1,3-diol	☐	☐	☑	☐	☐	☐	☐
3564–09–8	Ponceau 3R	☐	☐	☑	☐	☐	☐	☐
3570–75–0	2-(2-Formylhydrazino)-4-(5-nitro-2-furyl)thiazole	☐	☐	☑	☐	☐	☐	☐
3688–53–7	AF-2 (2-(2-Furyl)-3-(5-nitro-2-furyl)acrylamide)	☐	☐	☑	☐	☐	☐	☐
3697–24–3	5-Methylchrysene	☐	☐	☑	☐	☐	☐	☐
3698–54–2	Tetranitroaniline	☐	☐	☐	☐	☐	☐	☑
3761–53–3	Ponceau MX	☐	☐	☑	☐	☐	☐	☐
3771–19–5	Nafenopin	☐	☐	☑	☐	☐	☐	☐
3795–88–8	5-(Morpholinomethyl)-3-[(5-nitrofurfurylidene)amino]-2-oxazolidinone	☐	☐	☑	☐	☐	☐	☐
4109–96–0	Dichlorosilane	☑	☐	☐	☐	☐	☐	☐
4170–30–3	Crotonaldehyde (2-Butenal)	☑	☐	☐	☐	☐	☐	☐

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
4342–03–4	Dacarbazine	☐	☐	☑	☐	☐	☐	☐
4368–28–9	Tetrodotoxin	☑	☐	☐	☐	☐	☐	☐
4549–40–0	N-Nitrosomethylvinylamine	☐	☐	☑	☐	☐	☐	☐
4732–14–3	Trinitrophenetol	☐	☐	☐	☐	☐	☐	☑
5522–43–0	1-Nitropyrene	☐	☐	☑	☐	☐	☐	☐
5714–22–7	Sulfur Pentafluoride	☑	☐	☐	☐	☐	☐	☐
6055–19–2	Cyclophosphamide	☐	☑	☐	☐	☐	☑	☐
6358–53–8	Citrus Red No. 2	☐	☐	☑	☐	☐	☐	☐
6379–69–7	Trichothecin	☑	☐	☐	☐	☐	☐	☐
6459–94–5	CI Acid Red 114	☐	☐	☑	☐	☐	☐	☐
6484–52–2	Ammonium nitrate	☐	☐	☐	☐	☐	☐	☑
6795–23–9	Aflatoxin M1	☑	☐	☑	☐	☐	☐	☐
6885–57–0	Aflatoxin M2	☑	☐	☐	☐	☐	☐	☐
7220–81–7	Aflatoxin B2	☑	☐	☐	☐	☐	☐	☐
7241–98–7	Aflatoxin G2	☑	☐	☐	☐	☐	☐	☐
7439–92–1	Lead	☐	☐	☑	☑	☑	☑	☐
7439–93–2	Lithium	☐	☐	☐	☐	☐	☐	☑
7439–95–4	Magnesium (powder)	☐	☐	☐	☐	☐	☐	☑
7440–02–0	Nickel, metallic	☐	☐	☑	☐	☐	☐	☐
7440–09–7	Potassium metal	☐	☐	☐	☐	☐	☐	☑
7440–17–7	Rubidium	☐	☐	☐	☐	☐	☐	☑
7440–23–5	Sodium metal	☐	☐	☐	☐	☐	☐	☑
7440–32–6	Titanium powder	☐	☐	☐	☐	☐	☐	☑
7440–38–2	Arsenic and compounds	☐	☑	☐	☐	☐	☐	☐
7440–41–7	Beryllium and beryllium compounds	☐	☑	☐	☐	☐	☐	☐
7440–43–9	Cadmium	☐	☑	☐	☐	☐	☐	☐
7440–46–2	Cesium	☐	☐	☐	☐	☐	☐	☑

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
7440–48–4	Cobalt	☐	☐	☑	☐	☐	☐	☐
7440–58–6	Hafnium powder	☐	☐	☐	☐	☐	☐	☑
7440–66–6	Zinc powder	☐	☐	☐	☐	☐	☐	☑
7440–67–7	Zirconium powder	☐	☐	☐	☐	☐	☐	☑
7446–34–6	Selenium Sulfide	☐	☐	☑	☐	☐	☐	☐
7446–70–0	Aluminum chloride	☐	☐	☐	☐	☐	☐	☑
7481–89–2	Zalcitabine	☐	☐	☑	☐	☐	☐	☐
7496–02–8	6-Nitrochrysene	☐	☐	☑	☐	☐	☐	☐
7550–45–0	Titanium tetrachloride	☑	☐	☐	☐	☐	☐	☐
7553–56–2	Iodine	☑	☐	☐	☐	☐	☐	☐
7580–67–8	Lithium hydride	☐	☐	☐	☐	☐	☐	☑
7601–89–0	Sodium perchlorate	☐	☐	☐	☐	☐	☐	☑
7601–90–3	Perchloric Acid	☑	☐	☐	☐	☐	☐	☑
7637–07–2	Boron trifluoride	☑	☐	☐	☐	☐	☐	☐
7646–69–7	Sodium hydride	☐	☐	☐	☐	☐	☐	☑
7647–01–0	Hydrogen chloride (gas)	☑	☐	☐	☐	☐	☐	☐
7647–19–0	Phosphorus pentafluoride	☑	☐	☐	☐	☐	☐	☐
7664–39–3	Hydrogen fluoride (gas and solutions)	☑	☐	☐	☐	☐	☐	☐
7664–41–7	Ammonia	☑	☐	☐	☐	☐	☐	☐
7664–93–9	Sulfuric acid	☐	☑	☐	☐	☐	☐	☐
7693–27–8	Magnesium hydride	☐	☐	☐	☐	☐	☐	☑
7697–37–2	Nitric acid	☐	☐	☐	☐	☐	☐	☑
7705–07–9	Titanium trichloride	☐	☐	☐	☐	☐	☐	☑
7719–09–7	Thionyl chloride	☐	☐	☐	☐	☐	☐	☑
7719–12–2	Phosphorus trichloride	☑	☐	☐	☐	☐	☐	☑
7722–84–1	Hydrogen peroxide solutions 35% and greater	☑	☐	☐	☐	☐	☐	☑
7723–14–0	Phosphorus white	☐	☐	☐	☐	☐	☐	☑

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
7724–38–1	Tetrodaminotoxin	☑	☐	☐	☐	☐	☐	☐
7724–39–2	Methoxytetrodotoxin	☑	☐	☐	☐	☐	☐	☐
7724–40–5	Ethoxytetrodotoxin	☑	☐	☐	☐	☐	☐	☐
7724–41–6	Deoxytetrodotoxin	☑	☐	☐	☐	☐	☐	☐
7726–95–6	Bromine	☑	☐	☐	☐	☐	☐	☐
7758–01–2	Potassium bromate	☐	☐	☑	☐	☐	☐	☐
7758–19–2	Sodium chlorite	☐	☐	☐	☐	☐	☐	☑
7775–09–9	Sodium chlorate	☐	☐	☐	☐	☐	☐	☑
7775–14–6	Sodium dithionite (Sodium hydrosulphite)	☐	☐	☐	☐	☐	☐	☑
7782–41–4	Fluorine	☑	☐	☐	☐	☐	☐	☐
7782–50–5	Chlorine	☑	☐	☐	☐	☐	☐	☐
7782–65–2	Germane	☑	☐	☐	☐	☐	☐	☐
7782–92–5	Sodamide	☐	☐	☐	☐	☐	☐	☑
7783–06–4	Hydrogen sulfide	☑	☐	☐	☐	☐	☐	☐
7783–07–5	Hydrogen selenide	☑	☐	☐	☐	☐	☐	☐
7783–41–7	Oxygen Difluoride (Fluorine Monoxide)	☑	☐	☐	☐	☐	☐	☐
7783–54–2	Nitrogen trifluoride	☐	☐	☐	☐	☐	☐	☑
7783–61–1	Silicon tetrafluoride	☑	☐	☐	☐	☐	☐	☐
7783–66–6	Iodine pentafluoride	☐	☐	☐	☐	☐	☐	☑
7783–79–1	Selenium hexafluoride	☑	☐	☐	☐	☐	☐	☐
7783–80–4	Tellurium hexafluoride	☑	☐	☐	☐	☐	☐	☐
7783–82–6	Tungsten hexafluoride	☑	☐	☐	☐	☐	☐	☐
7784–21–6	Aluminum hydride	☐	☐	☐	☐	☐	☐	☑
7784–34–1	Arsenic trichloride	☑	☐	☐	☐	☐	☐	☐
7784–42–1	Arsine	☑	☐	☐	☐	☐	☐	☐
7787–71–5	Bromine Trifluoride	☑	☐	☐	☐	☐	☐	☐
7789–09–5	Ammonium dichromate	☐	☐	☐	☐	☐	☐	☑

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
7789–30–2	Bromine pentafluoride	☑	☐	☐	☐	☐	☐	☐
7789–78–8	Calcium hydride	☐	☐	☐	☐	☐	☐	☑
7790–91–2	Chlorine trifluoride	☑	☐	☐	☐	☐	☐	☐
7790–94–5	Chlorosulfonic acid	☑	☐	☐	☐	☐	☐	☐
7790–98–9	Ammonium perchlorate	☐	☐	☐	☐	☐	☐	☑
7791–25–5	Sulfuryl chloride	☑	☐	☐	☐	☐	☐	☐
7803–51–2	Phosphine	☑	☐	☐	☐	☐	☐	☐
7803–52–3	Stibine	☑	☐	☐	☐	☐	☐	☐
8001–35–2	Toxaphen	☐	☐	☑	☐	☐	☐	☐
8001–58–9	Creosotes	☐	☐	☑	☐	☐	☐	☐
8006–19–7	Amatol (ammonoium nitrate/trinitrotoluene mix)	☐	☐	☐	☐	☐	☐	☑
8014–95–7	Oleum (Fuming Sulfuric acid)	☑	☐	☐	☐	☐	☐	☐
8052–42–4	Bitumens	☐	☐	☑	☐	☐	☐	☐
9000–07–1	Carrageenan	☐	☐	☑	☐	☐	☐	☐
9004–66–4	Iron-dextran complex	☐	☐	☑	☐	☐	☐	☐
9004–70–0	Nitrocellulose	☐	☐	☐	☐	☐	☐	☑
9009–86–3	Ricin	☑	☐	☐	☐	☐	☐	☐
9040–12–4	Ricins, D	☑	☐	☐	☐	☐	☐	☐
10025–87–3	Phosphorus oxychloride (Phosphoryl chloride)	☑	☐	☐	☐	☐	☐	☐
10026–04–7	Silicon tetrachloride	☐	☐	☐	☐	☐	☐	☑
10026–24–1	Cobalt sulfate	☐	☐	☑	☐	☐	☐	☐
10028–15–6	Ozone	☑	☐	☐	☐	☐	☐	☐
10035–10–6	Hydrogen bromide (gas)	☑	☐	☐	☐	☐	☐	☐
10043–92–2	Radon-222	☐	☑	☐	☐	☐	☐	☐
10048–13–2	Sterigmatocystin	☐	☐	☑	☐	☐	☐	☐
10049–04–4	Chlorine dioxide	☑	☐	☐	☐	☐	☐	☐
10102–43–9	Nitric oxide	☑	☐	☐	☐	☐	☐	☑

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
10102–44–0	Nitrogen Dioxide	☑	☐	☐	☐	☐	☐	☐
10124–37–5	Calcium nitrate	☐	☐	☐	☐	☐	☐	☑
10294–33–4	Boron tribromide	☑	☐	☐	☐	☐	☐	☐
10294–34–5	Boron Trichloride	☑	☐	☐	☐	☐	☐	☐
10540–29–1	Tamoxifen	☐	☑	☐	☐	☐	☐	☐
10544–72–6	Dinitrogen tetroxide	☑	☐	☐	☐	☐	☐	☐
10595–95–6	N-Nitrosomethylethylamine	☐	☐	☑	☐	☐	☐	☐
11017–04–2	Saxitoxin hydrate	☑	☐	☐	☐	☐	☐	☐
11028–71–0	Concanavalin A	☑	☐	☐	☐	☐	☐	☐
11056–06–7	Bleomycins	☐	☐	☑	☐	☐	☐	☐
11100–45–1	Staphylococcus enterotoxin B	☑	☐	☐	☐	☐	☐	☐
11135–81–2	Potassium sodium alloys, liquid	☐	☐	☐	☐	☐	☐	☑
12030–88–5	Potassium superoxide	☐	☐	☐	☐	☐	☐	☑
12034–12–7	Sodium superoxide	☐	☐	☐	☐	☐	☐	☑
12057–74–8	Magnesium phosphide	☐	☐	☐	☐	☐	☐	☑
12174–11–7	Palygorskite (attapulgite)	☐	☐	☑	☐	☐	☐	☐
12504–13–1	Strontium phosphide	☐	☐	☐	☐	☐	☐	☑
13010–47–4	1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU)	☐	☐	☑	☐	☐	☐	☐
13072–89–4	Anhydroepitetrodotoxin	☑	☐	☐	☐	☐	☐	☐
13256–22–9	N-Nitrososarcosine	☐	☐	☑	☐	☐	☐	☐
13285–84–2	Diacetylanhydrotetrodotoxin	☑	☐	☐	☐	☐	☐	☐
13424–46–9	Lead Azide	☐	☐	☐	☐	☐	☐	☑
13463–39–3	Nickel carbonyl	☑	☐	☐	☐	☐	☑	☐
13463–40–6	Iron, Pentacarbonyl	☑	☐	☐	☐	☐	☐	☐
13463–67–7	Titanium dioxide	☐	☐	☑	☐	☐	☐	☐
13637–63–3	Chlorine pentafluoride	☑	☐	☐	☐	☐	☐	☑
13647–35–3	Trilostane	☐	☐	☐	☐	☐	☑	☐

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
13762–51–1	Potassium borohydride	☐	☐	☐	☐	☐	☐	☑
13863–41–7	Bromine chloride	☑	☐	☐	☐	☐	☐	☐
13909–09–6	1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Semustine)	☐	☑	☐	☐	☐	☐	☐
14808–60–7	Crystalline Silica	☐	☑	☐	☐	☐	☐	☐
14901–08–7	Cycasin	☐	☐	☑	☐	☐	☐	☐
15245–44–0	Lead styphnate	☐	☐	☐	☐	☐	☐	☑
15475–56–6	Methotrexate sodium	☐	☐	☐	☑	☐	☑	☐
15663–27–1	Cisplatin	☐	☐	☑	☐	☐	☐	☐
15825–70–4	Mannitol hexanitrate (Nitromannite)	☐	☐	☐	☐	☐	☐	☑
16543–55–8	N'-Nitrosonornicotine (NNN)	☐	☑	☐	☐	☐	☐	☐
16842–03–8	Cobalt hydrocarbonyl	☑	☐	☐	☐	☐	☐	☐
16853–85–3	Lithium aluminum hydride	☐	☐	☐	☐	☐	☐	☑
16940–66–2	Sodium borohydride	☐	☐	☐	☐	☐	☐	☑
16949–15–8	Lithium borohydride	☐	☐	☐	☐	☐	☐	☑
16962–07–5	Aluminum borohydride	☐	☐	☐	☐	☐	☐	☑
17014–71–0	Potassium peroxide	☐	☐	☐	☐	☐	☐	☑
17462–58–7	sec-Butyl chloroformate	☑	☐	☐	☐	☐	☐	☐
17878–54–5	Aflatoxin B1, B2A	☑	☐	☐	☐	☐	☐	☐
18540–29–9	Chromium Hexavalent Compounds	☐	☑	☐	☐	☐	☐	☐
18660–81–6	Tetrodotoxin citrate	☑	☐	☐	☐	☐	☐	☐
18883–66–4	Streptozotocin	☐	☐	☑	☐	☐	☐	☐
19287–45–7	Diborane	☑	☐	☐	☐	☐	☐	☐
19624–22–7	Pentaborane	☑	☐	☐	☐	☐	☐	☑
20062–22–0	Hexanitrostilbene	☐	☐	☐	☐	☐	☐	☑
20421–10–7	Aflatoxin G(sub 2a)	☑	☐	☐	☐	☐	☐	☐
20770–41–6	Potassium phosphide	☐	☐	☐	☐	☐	☐	☑
20816–12–0	Osmium Tetroxide	☑	☐	☐	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
20830–81–3	Daunomycin	☐	☐	☑	☐	☐	☐	☐
20859–73–8	Aluminum phosphide	☐	☐	☐	☐	☐	☐	☑
21259–20–1	T2 toxin	☑	☐	☐	☐	☐	☐	☐
22398–80–7	Indium phosphide	☐	☐	☑	☐	☐	☐	☐
22506–53–2	3,9-Dinitrofluoranthene	☐	☐	☑	☐	☐	☐	☐
23214–92–8	Adriamycin	☐	☐	☑	☐	☐	☐	☐
23246–96–0	Riddelliine	☐	☐	☑	☐	☐	☐	☐
24167–76–8	Sodium phosphide	☐	☐	☐	☐	☐	☐	☑
25013–16–5	Butylated hydroxyanisole (BHA)	☐	☐	☑	☐	☐	☐	☐
25321–14–6	Dinitrotoluene	☐	☐	☑	☐	☐	☑	☑
25324–56–5	Stannic phosphide	☐	☐	☐	☐	☐	☐	☑
25962–77–0	trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)-vinyl]-1,3,4-oxadiazole	☐	☐	☑	☐	☐	☐	☐
26134–62–3	Lithium nitride	☐	☐	☐	☐	☐	☐	☑
26148–68–5	A-a-C (2-Amino-9H-pyrido[2,3-b]indole)	☐	☐	☑	☐	☐	☐	☐
26471–62–5	Toluene diisocyanate	☐	☐	☑	☐	☐	☐	☐
26628–22–8	Sodium azide (Hydrazoic acid)	☑	☐	☐	☐	☐	☐	☑
26934–87–2	Mycotoxin HT2	☑	☐	☐	☐	☐	☐	☐
26952–42–1	Trinitroaniline	☐	☐	☐	☐	☐	☐	☑
27208–37–3	Cyclopenta [cd] pyrene	☐	☐	☑	☐	☐	☐	☐
28289–54–5	MPTP (1-Methyl-4-phenyl-1,2,3,6-tetrahydropyridine)	☑	☐	☐	☐	☐	☐	☐
28434–86–8	3,3'-Dichloro-4,4'-diaminodiphenyl ether	☐	☐	☑	☐	☐	☐	☐
29611–03–8	Aflatoxin Ro	☑	☐	☐	☐	☐	☐	☐
29767–20–2	Teniposide	☐	☐	☑	☐	☐	☐	☐
30516–87–1	Zidovudine (AZT)	☐	☐	☑	☐	☐	☐	☐
30525–89–4	Paraformaldehyde	☑	☑	☐	☐	☐	☐	☐
30674–80–7	Methacryloyloxyethyl Isocyanate	☑	☐	☐	☐	☐	☐	☐
32215–02–4	AflatoxinP1	☑	☐	☐	☐	☐	☐	☐

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
33419–42–0	Etoposide	☐	☐	☑	☐	☐	☐	☐
35523–89–8	Saxitoxin	☑	☐	☐	☐	☐	☐	☐
35554–08–6	Saxitoxin hydrochloride	☑	☐	☐	☐	☐	☐	☐
35860–51–6	Dinitroresorcinol	☐	☐	☐	☐	☐	☐	☑
37337–57–8	Staphylococcus enterotoxin A	☑	☐	☐	☐	☐	☐	☐
39156–41–7	2,4-Diaminoanisole Sulfate	☐	☐	☑	☐	☐	☐	☐
42397–64–8	1,6-Dinitropyrene	☐	☐	☑	☐	☐	☐	☐
42397–65–9	1,8-Dinitropyrene	☐	☐	☑	☐	☐	☐	☐
42583–46–0	Aflatoxin B1 Epoxide	☑	☐	☐	☐	☐	☐	☐
51264–14–3	Amsacrine	☐	☐	☑	☐	☐	☐	☐
52819–96–2	Aflatoxin Q1	☑	☐	☐	☐	☐	☐	☐
53597–23–2	abrin A	☑	☐	☐	☐	☐	☐	☐
53597–24–3	Abrin C	☑	☐	☐	☐	☐	☐	☐
54413–15–9	Tritonal	☐	☐	☐	☐	☐	☐	☑
54749–90–5	Chlorozotocin	☐	☐	☑	☐	☐	☐	☐
55803–45–7	Saxitoxin p-bromobenzenesulfonate	☑	☐	☐	☐	☐	☐	☐
57835–92–4	4-Nitropyrene	☐	☐	☑	☐	☐	☐	☐
59122–46–2	Misoprostol	☐	☐	☐	☐	☐	☑	☐
59536–65–1	Polybrominated biphenyls	☐	☐	☑	☐	☐	☐	☐
59865–13–3	Cyclosporin A	☐	☑	☐	☐	☐	☐	☐
60153–49–3	3-(N-Nitrosomethylamino)propionitrile	☐	☐	☑	☐	☐	☐	☐
61740–00–9	Aflatoxin Ro'	☑	☐	☐	☐	☐	☐	☐
62450–06–0	Trp-P-1 (3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole)	☐	☐	☑	☐	☐	☐	☐
62450–07–1	Trp-P-2 (3-Amino-1-methyl-5H-pyrido [4,3-b]indole)	☐	☐	☑	☐	☐	☐	☐
64091–91–4	4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone	☐	☑	☐	☐	☐	☐	☐
65271–80–9	Mitoxantrone	☐	☐	☑	☐	☐	☐	☐
66419–04–3	Ricin D (isoleucine-chain reduced)	☑	☐	☐	☐	☐	☐	☐

Particularly Hazardous Substances

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CAS Number order

CAS Number	Chemical	Acutely Toxic	Human Carcinogen		Reproductive Hazard			Reactive
			Known	Probable	Female	Male	Fetal	
66733–21–9	Erionite	☐	☑	☐	☐	☐	☐	☐
67730–10–3	Glu-P-2 (2-Aminodipyrido[1,2-a:3',2'-d]imidazole)	☐	☐	☑	☐	☐	☐	☐
67730–11–4	Glu-P-1 (2-Amino-6-methyldipyrido[1,2-a:3',2'-d]imidazole)	☐	☐	☑	☐	☐	☐	☐
68006–83–7	MeA-a-C (2-Amino-3-methyl-9H-pyrido[2,3-b]indole)	☐	☐	☑	☐	☐	☐	☐
72514–84–2	Ricin D (alanine-chain protein moiety)	☑	☐	☐	☐	☐	☐	☐
75757–64–1	Shiga Toxin	☑	☐	☐	☐	☐	☐	☐
76180–96–6	2-Amino-3-methylimidazo[4,5-f]quinoline (IQ)	☐	☐	☑	☐	☐	☐	☐
76862–65–2	Conotoxin GI	☑	☐	☐	☐	☐	☐	☐
77094–11–2	MeIQ (2-Amino-3,4-dimethylimidazo[4,5-f]quinoline)	☐	☐	☑	☐	☐	☐	☐
77439–76–0	3-Chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone	☐	☐	☑	☐	☐	☐	☐
77500–04–0	MeIQx (2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline)	☐	☐	☑	☐	☐	☐	☐
79217–60–0	Ciclosporin	☐	☑	☐	☐	☐	☐	☐
81133–24–6	Conotoxin GIV	☑	☐	☐	☐	☐	☐	☐
82952–64–5	Trimetrexate glucuronate	☐	☐	☐	☐	☐	☑	☐
93384–43–1	Botulinum toxin A	☑	☐	☐	☐	☐	☐	☐
93384–44–2	Botulinum toxin B	☑	☐	☐	☐	☐	☐	☐
93384–46–4	Botulinum toxin F	☑	☐	☐	☐	☐	☐	☐
96638–28–7	Ricin A	☑	☐	☐	☐	☐	☐	☐
101043–37–2	Microcystin-LR	☐	☐	☑	☐	☐	☐	☐
102489–05–4	Aflatoxin 495	☑	☐	☐	☐	☐	☐	☐
105650–23–5	PhIP (2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine)	☐	☐	☑	☐	☐	☐	☐
105735–71–5	3,7-Dinitrofluoranthene	☐	☐	☑	☐	☐	☐	☐
116355–83–0	Fumonisin B1	☐	☐	☑	☐	☐	☐	☐
1056502–30–5	2-Amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (PhIP)	☐	☐	☑	☐	☐	☐	☐

23.3 APPENDIX III - TABLE 11. Class 4 Chemical Hazards

Examples of Chemicals Listed as Hazards under NFPA 49

Chemical Name	Health Rating	Flammability Rating	Reactivity Rating	Additional Hazards
3 - Bromopropyne	3	3	4	
Acetaldehyde	3	4	2	
Acetone Cyanohydrin, stabilized	4	2	2	
Acetylene	0	4	3	
Acrolein, inhibited	4	3	3	
Acrylonitrile, inhibited	4	3	2	
Allyl alcohol	4	3	1	
Allylamine	4	3	1	
Aluminum alkyls	3	4	3	water reactive
Aluminum phosphide	4	4	2	water reactive
Ammonium perchlorate	1	0	4	oxidizing
Antimony pentafluoride	4	0	1	
Arsenic pentafluoride	4	0	1	
Arsine	4	4	2	
Boron trifluoride	4	0	1	
Bromine pentafluoride	4	0	3	water reactive, oxidizing
Bromine trifluoride	4	0	3	water reactive, oxidizing
Butadienes, inhibited	2	4	2	
Butyllithium	3	4	2	water reactive
Carbon disulfide	3	4	0	
Carbon monoxide	3	4	0	
Chlorine	4	0	0	oxidizing

Chemical Name	Health Rating	Flammability Rating	Reactivity Rating	Additional Hazards
Chlorine trifluoride	4	0	3	water reactive, oxidizing
Chlorodinitrobenzenes	3	1	4	
Chloropicrin	4	0	3	
Chlorosulfonic acid	4	0	2	water reactive, oxidizing
Crotonaldehyde, stabilized	4	3	2	
Cyanogen bromide	4	0	1	
Cyanogen, liquified	4	4	2	
Diborane	4	4	3	water reactive
Dichlorodimethyl ether	4	3	1	
Dichlorosilane	4	4	2	water reactive
Diethyl ether	1	4	1	
Diethyl telluride	1	4	3	water reactive
Diethylaluminum chloride	3	4	3	water reactive
Diethylzinc	3	4	3	water reactive
Diketene, inhibited	4	2	2	
Dimethyl ether	1	4	1	
Dimethyl sulfate	4	2	0	
Dimethylamine, anhydrous	3	4	0	
Dimethylamine, solution	3	4	0	
Dimethylhydrazine, unsymetrical	4	3	1	
Dinitrobenzenes	3	1	4	
Ethyl methyl ether	1	4	4	
Ethyl nitrite solutions	3	4	4	
Ethylamine	3	4	0	
Ethylchloroformate	4	3	1	
Ethylene chlorohydrin	4	2	0	

Chemical Name	Health Rating	Flammability Rating	Reactivity Rating	Additional Hazards
Ethylene oxide	3	4	3	
Ethylene, compressed	1	4	2	
Ethylenimine, inhibited	4	3	3	
Fluorine, compressed	4	0	4	water reactive
Formaldehyde, flammable	3	4	0	
Formaldehyde, solutions	3	4	0	
Germane	4	4	3	water reactive
Hydrogen cyanide, anhydrous, stabilized	4	4	2	
Hydrogen cyanide, anhydrous, stabilized, absorbed in a porous inert material	4	4	2	
Hydrogen fluoride, anjydrous	4	0	1	
Hydrogen sulfide, liquified	4	4	0	
Hydrogen, refrigerated liquid	3	4	0	
Isoprene, inhibited	1	4	2	
Isopropylamine	3	4	0	
Methyl formate	2	4	0	
Methyl isocyanate	4	3	2	water reactive
Methyl mercaptan	4	4	0	
Methyl vinyl ketone	4	3	2	
Methylamine, anhydrous	3	4	0	
Methylamine, aqueous solution	3	4	0	
Methylhydrazine	4	3	2	
Natural gas, liquified	3	4	0	
Nickel carbonyl	4	3	3	
Nickel catalyst	2	4	1	

Chemical Name	Health Rating	Flammability Rating	Reactivity Rating	Additional Hazards
Nitric acid (> 40%)	4	0	0	oxidizing
Nitric acid, fuming	4	0	1	oxidizing
Nitromethane	1	3	4	
Pentaborane	4	4	2	
Peracetic acid (<40%)	3	2	4	oxidizing
Phenol, molten	4	2	0	
Phenol, solid	4	2	0	
Phenol, solutions	4	2	0	
Phosgene	4	0	1	
Phosphorus oxychloride	4	0	2	water reactive
Phosphorus trichloride	4	0	1	water reactive
Phosphorus, white, molten	4	4	2	
Phsophine	4	4	2	
Picric acid, wet, with not less than 10% water	3	4	4	
Propargyl alcohol	4	3	3	
Propylene oxide	3	4	2	
Silane	1	4	3	
Stibine	4	4	2	
Tetrafluoroethylene, inhibited	2	4	3	
Thionyl chloride	4	0	2	water reactive
Trichlorosilane	3	4	2	water reactive
Triethylaluminum	3	4	3	water reactive
Triisobutylaluminum	3	4	3	water reactive
Trimethoxysilane	3	4	2	
Trimethylamine	3	4	0	

Chemical Name	Health Rating	Flammability Rating	Reactivity Rating	Additional Hazards
Vinyl acetylene	2	4	3	
Vinyl chloride, inhibited	2	4	2	
Vinyl ether	2	4	2	
Vinylidene chloride, inhibited	4	4	2	

23.3 APPENDIX III - TABLE 12. Limits for Air Contaminants

29 CFR PART 1910 - OCCUPATIONAL SAFETY AND HEALTH STANDARDS

Subpart Z - Toxic and Hazardous Substances
TABLE Z-1 Limits for Air Contaminants.

NOTE: Because of the length of the table, explanatory Footnotes applicable to all substances are given below as well as at the end of the table. Footnotes specific only to a limited number of substances are also shown within the table.

Footnote (1)	The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit. They are to be determined from breathing-zone air samples.
Footnote (a)	Parts of vapor or gas per million parts of contaminated air by volume at 25 degrees C and 760 torr.
Footnote (b)	Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.
Footnote (c)	The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound measured as the metal, the CAS number for the metal is given - not CAS numbers for the individual compounds.
Footnote (d)	The final benzene standard in 1910.1028 applies to all occupational exposures to benzene except in some circumstances the distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures; for the excepted subsegments, the benzene limits in Table Z-2 apply. See 1910.1028 for specific circumstances.
Footnote (e)	This 8-hour TWA applies to respirable dust as measured by a vertical elutriator cotton dust sampler or equivalent instrument. The time-weighted average applies to the cotton waste processing operations of waste recycling (sorting, blending, cleaning and willowing) and garnetting. See also 1910.1043 for cotton dust limits applicable to other sectors.
Footnote (f)	All inert or nuisance dusts, whether mineral, inorganic, or organic, not listed specifically by substance name are covered by the Particulates Not Otherwise Regulated (PNOR) limit which is the same as the inert or nuisance dust limit of Table Z-3.
Footnote (2)	See Table Z-2.
Footnote (3)	See Table Z-3
Footnote (4)	Varies with compound.

TABLE Z-1

Substance	CAS No. (c)	ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Acetaldehyde	75-07-0	200	360	
Acetic acid	64-19-7	10	25	
Acetic anhydride	108-24-7	5	20	
Acetone	67-64-1	1000	2400	
Acetonitrile	75-05-8	40	70	
2-Acetylaminofluorene; see 1910.1014	53-96-3			
Acetylene dichloride; see 1,2-Dichloroethylene				
Acetylene tetrabromide	79-27-6	1	14	
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-06-1		0.3	X
Acrylonitrile; see 1910.1045	107-13-1			
Aldrin	309-00-2		0.25	X
Allyl alcohol	107-18-6	2	5	X
Allyl chloride	107-05-1	1	3	
Allyl glycidyl ether (AGE)	106-92-3	(C)10	(C)45	
Allyl propyl disulfide	2179-59-1	2	12	
alpha-Alumina	1344-28-1			
Total dust			15	
Respirable fraction			5	
Aluminum Metal (as Al)	7429-90-5			
Total dust			15	
Respirable fraction			5	
4-Aminodiphenyl; see 1910.1011	92-67-1			
2-Aminoethanol; see Ethanolamine				
2-Aminopyridine	504-29-0	0.5	2	
Ammonia	7664-41-7	50	35	
Ammonium sulfamate	7773-06-0			
Total dust			15	
Respirable fraction			5	
n-Amyl acetate	628-63-7	100	525	
sec-Amyl acetate	626-38-0	125	650	
Aniline and homologs	62-53-3	5	19	X
Anisidine (o-,p-isomers)	29191-52-4		0.5	X
Antimony and compounds (as Sb)	7440-36-0		0.5	
ANTU (alpha Naphthylthiourea)	86-88-4		0.3	
Arsenic, inorganic compounds (as As); see 1910.1018	7440-38-2			
Arsenic, organic compounds (as As)	7440-38-2		0.5	
Arsine	7784-42-1	0.05	0.2	

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Asbestos; see 1910.1001			(4)	
Azinphos-methyl	86-50-0		0.2	X
Barium, soluble compounds (as Ba)	7440-39-3		0.5	
Barium sulfate	7727-43-7			
Total dust			15	
Respirable fraction			5	
Benomyl	17804-35-2			
Total dust			15	
Respirable fraction			5	
Benzene; See 1910.1028 See Table Z-2 for the limits applicable in the operations or sectors excluded in 1910.1028(d)	71-43-2			
Benzidine; See 1910.1010	92-87-5			
p-Benzoquinone; see Quinone.				
Benzo(a)pyrene; see Coal tar pitch volatiles				
Benzoyl peroxide	94-36-0		5	
Benzyl chloride	100-44-7	1	5	
Beryllium and beryllium compounds (as Be)	7440-41-7		(2)	
Biphenyl; see Diphenyl				
Bismuth telluride, Undoped	1304-82-1			
Total dust			15	
Respirable fraction			5	
Boron oxide	1303-86-2			
Total dust			15	
Boron trifluoride	7637-07-2	(C)1	(C)3	
Bromine	7726-95-6	0.1	0.7	
Bromoform	75-25-2	0.5	5	X
Substance	**CAS No. (c)**	**Ppm (a)(1)**	**mg/m³ (b)(1)**	**Skin designation**
Butadiene (1,3-Butadiene)	106-99-0	1000	2200	
Butanethiol; see Butyl mercaptan				
2-Butanone (Methyl ethyl ketone)	78-93-3	200	590	
2-Butoxyethanol	111-76-2	50	240	X
n-Butyl-acetate	123-86-4	150	710	
sec-Butyl acetate	105-46-4	200	950	
tert-Butyl-acetate	540-88-5	200	950	
n-Butyl alcohol	71-36-3	100	300	
sec-Butyl alcohol	78-92-2	150	450	
tert-Butyl alcohol	75-65-0	100	300	
Butylamine	109-73-9	(C)5	(C)15	X
tert-Butyl chromate (as CrO(3))	1189-85-1		(C)0.1	X

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
n-Butyl glycidyl ether (BGE)	2426-08-6	50	270	
Butyl mercaptan	109-79-5	10	35	
p-tert-Butyltoluene	98-51-1	10	60	
Cadmium (as Cd); see 1910.1027	7440-43-9			
Calcium Carbonate	1317-65-3			
Total dust			15	
Respirable fraction			5	
Calcium hydroxide	1305-62-0			
Total dust			15	
Respirable fraction			5	
Calcium oxide	1305-78-8		5	
Calcium silicate				1344-95-2
Total dust			15	
Respirable fraction			5	
Calcium sulfate	7778-18-9			
Total dust			15	
Respirable fraction			5	
Camphor, synthetic	76-22-2		2	
Carbaryl (Sevin)	63-25-2		5	
Carbon black	1333-86-4		3.5	
Carbon dioxide	124-38-9	5000	9000	
Carbon disulfide	75-15-0		(2)	
Carbon monoxide	630-08-0	50	55	
Carbon tetrachloride	56-23-5		(2)	
Cellulose	9004-34-6			
Total dust			15	
Respirable fraction			5	
Chlordane	57-74-9		0.5	X
Chlorinated camphene	8001-35-2		0.5	X
Chlorinated diphenyl oxide	55720-99-5		0.5	
Chlorine	7782-50-5	(C)1	(C)3	
Chlorine dioxide	10049-04-4	0.1	0.3	
Chlorine trifluoride	7790-91-2	(C)0.1	(C)0.4	
Chloroacetaldehyde	107-20-0	(C)1	(C)3	
a-Chloroacetophenone (Phenacyl chloride)	532-27-4	0.05	0.3	
Chlorobenzene	108-90-7	75	350	
o-Chlorobenzylidene malononitrile	2698-41-1	0.05	0.4	
Chlorobromomethane	74-97-5	200	1050	
2-Chloro-1,3-butadiene; See beta-Chloroprene				
Chlorodiphenyl (42% Chlorine)(PCB)	53469-21-9		1	X
Chlorodiphenyl (54% Chlorine)(PCB)	11097-69-1		0.5	X
1-Chloro-2, 3-epoxypropane; See Epichlorohydrin				

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
2-Chloroethanol; See Ethylene chlorohydrin				
Chloroethylene; See Vinyl chloride				
Chloroform (Trichloromethane)	67-66-3	(C)50	(C)240	
bis(Chloromethyl) ether; see 1910.1008	542-88-1			
Chloromethyl methyl ether; see 1910.1006	107-30-2			
1-Chloro-1-nitropropane	600-25-9	20	100	
Chloropicrin	76-06-2	0.1	0.7	
beta-Chloroprene	126-99-8	25	90	X
2-Chloro-6 (trichloromethyl) pyridine	1929-82-4			
Total dust			15	
Respirable fraction			5	
Chromic acid and chromates (as CrO(3))	(4)		(2)	
Chromium (II) compounds (as Cr)	7440-47-3		0.5	
Chromium (III) compounds (as Cr)	7440-47-3		0.5	
Chromium metal and insol. salts (as Cr)	7440-47-3		1	
Chrysene; see Coal tar pitch volatiles				
Clopidol	2971-90-6			
Total dust			15	
Respirable fraction			5	
Coal dust (less than 5% SiO(2)),				
respirable fraction			(3)	
Coal dust (greater than or equal to 5% SiO(2)),				
respirable fraction			(3)	
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65966-93-2		0.2	
Cobalt metal, dust, and fume (as Co)	7440-48-4		0.1	
Coke oven emissions; see 1910.1029				
Copper	7440-50-8			
Fume (as Cu)			0.1	
Dusts and mists (as Cu)			1	
Cotton dust (e), see 1910.1043			1	
Crag herbicide (Sesone)	136-78-7			
Total dust			15	
Respirable fraction			5	
Cresol, all isomers	1319-77-3	5	22	X
Crotonaldehyde	123-73-9	2	6	
	4170-30-3			
Cumene	98-82-8	50	245	X
Cyanides (as CN)	(4)		5	
Cyclohexane	110-82-7	300	1050	
Cyclohexanol	108-93-0	50	200	
Cyclohexanone	108-94-1	50	200	

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Cyclohexene	110-83-8	300	1015	
Cyclopentadiene	542-92-7	75	200	
2,4-D (Dichlorophenoxyacetic acid)	94-75-7		10	
Decaborane	17702-41-9	0.05	0.3	X
Demeton (Systox)	8065-48-3		0.1	X
Diacetone alcohol (4-Hydroxy-4-methyl-2-pentanone)	123-42-2	50	240	
1,2-Diaminoethane; see Ethylenediamine				
Diazomethane	334-88-3	0.2	0.4	
Diborane	19287-45-7	0.1	0.1	
1,2-Dibromo-3-chloropropane (CBCP); see 1910.1044	96-12-8			
1,2-Dibromoethane; see Ethylene dibromide				
Dibutyl phosphate	107-66-4	1	5	
Dibutyl phthalate	84-74-2		5	
o-Dichlorobenzene	95-50-1	(C)50	(C)300	
p-Dichlorobenzene	106-46-7	75	450	
3,3'-Dichlorobenzidine; see 1910.1007	91-94-1			
Dichlorodifluoromethane	75-71-8	1000	4950	
1,3-Dichloro-5, 5-dimethyl hydantoin	118-52-5		0.2	
Dichlorodiphenyltrichloroethane (DDT)	50-29-3		1	X
1,1-Dichloroethane	75-34-3	100	400	
1,2-Dichloroethane; see Ethylene dichloride				
1,2-Dichloroethylene	540-59-0	200	790	
Dichloroethyl ether	111-44-4	(C)15	(C)90	X
Dichloromethane; see Methylene chloride				
Dichloromonofluoromethane	75-43-4	1000	4200	
1,1-Dichloro-1-nitroethane	594-72-9	(C)10	(C)60	
1,2-Dichloropropane; see Propylene dichloride				
Dichlorotetrafluoroethane	76-14-2	1000	7000	
Dichlorvos (DDVP)	62-73-7		1	X
Dicyclopentadienyl iron	102-54-5			
Total dust			15	
Respirable fraction			5	
Dieldrin	60-57-1		0.25	X
Diethylamine	109-89-7	25	75	
2-Diethylaminoethanol	100-37-8	10	50	X
Diethyl ether; see Ethyl ether				
Difluorodibromomethane	75-61-6	100	860	
Diglycidyl ether (DGE)	2238-07-5	(C)0.5	(C)2.8	
Dihydroxybenzene; see Hydroquinone				
Diisobutyl ketone	108-83-8	50	290	
Diisopropylamine	108-18-9	5	20	X
4-Dimethylaminoazobenzene; see 1910.1015	60-11-7			

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Dimethoxymethane; see Methylal				
Dimethyl acetamide	127-19-5	10	35	X
Dimethylamine	124-40-3	10	18	
Dimethylaminobenzene; see Xylidine				
Dimethylaniline (N,N-Dimethylaniline)	121-69-7	5	25	X
Dimethylbenzene; see Xylene				
Dimethyl-1,2-dibromo-2,2-dichloroethylphosphate	300-76-5		3	
Dimethylformamide	68-12-2	10	30	X
2,6-Dimethyl-4-heptanone; see Diisobutyl ketone				
1,1-Dimethylhydrazine	57-14-7	0.5	1	X
Dimethylphthalate	131-11-3		5	
Dimethyl sulfate	77-78-1	1	5	X
Dinitrobenzene (all isomers)			1	X
(ortho)	528-29-0			
(meta)	99-65-0			
Dinitro-o-cresol	534-52-1		0.2	X
Dinitrotoluene	25321-14-6		1.5	X
Dioxane (Diethylene dioxide)	123-91-1	100	360	X
Diphenyl (Biphenyl)	92-52-4	0.2	1	
Diphenylmethane diisocyanate;				
see Methylene bisphenyl isocyanate				
Dipropylene glycol methyl ether	34590-94-8	100	600	X
Di-sec octyl phthalate (Di-(2-ethylhexyl) phthalate)	117-81-7		5	
Emery	12415-34-8			
Total dust			15	
Respirable fraction			5	
Endosulfan	115-29-7		0.1	X
Endrin	72-20-8		0.1	X
Epichlorohydrin	106-89-8	5	19	X
EPN	2104-64-5		0.5	X
1,2-Epoxypropane; see Propylene oxide				
2,3-Epoxy-1-propanol; see Glycidol				
Ethanethiol; see Ethyl mercaptan				
Ethanolamine	141-43-5	3	6	
2-Ethoxyethanol (Cellosolve)	110-80-5	200	740	X
2-Ethoxyethyl acetate (Cellosolve acetate)	111-15-9	100	540	X
Ethyl acetate	141-78-6	400	1400	
Ethyl acrylate	140-88-5	25	100	X
Ethyl alcohol (Ethanol)	64-17-5	1000	1900	
Ethylamine	75-04-7	10	18	
Ethyl amyl ketone (5-Methyl-3-heptanone)	541-85-5	25	130	

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Ethyl benzene	100-41-4	100	435	
Ethyl bromide	74-96-4	200	890	
Ethyl butyl ketone (3-Heptanone)	106-35-4	50	230	
Ethyl chloride	75-00-3	1000	2600	
Ethyl ether	60-29-7	400	1200	
Ethyl formate	109-94-4	100	300	
Ethyl mercaptan	75-08-1	(C)10	(C)25	
Ethyl silicate	78-10-4	100	850	
Ethylene chlorohydrin	107-07-3	5	16	X
Ethylenediamine	107-15-3	10	25	
Ethylene dibromide	106-93-4		(2)	
Ethylene dichloride (1,2-Dichloroethane)	107-06-2		(2)	
Ethylene glycol dinitrate	628-96-6	(C)0.2	(C)1	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate				
Ethyleneimine; See 1910.1012				
Ethylene oxide; see 1910.1047	75-21-8			
Ethylidene chloride; see 1,1-Dichlorethane				
N-Ethylmorpholine	100-74-3	20	94	X
Ferbam	14484-64-1			
Total dust			15	
Ferrovanadium dust	12604-58-9		1	
Fluorides (as F)	(4)		2.5	
Fluorine	7782-41-4	0.1	0.2	
Fluorotrichloromethane (Trichloro-fluoromethane)	75-69-4	1000	5600	
Formaldehyde; see 1910.1048	50-00-0			
Formic acid	64-18-6	5	9	
Furfural	98-01-1	5	20	X
Furfuryl alcohol	98-00-0	50	200	
Grain dust (oat, wheat, barley)			10	
Glycerin (mist)	56-81-5			
Total dust			15	
Respirable fraction			5	
Glycidol	556-52-5	50	150	
Glycol monoethyl ether; see 2-Ethoxyethanol				
Graphite, natural respirable dust	7782-42-5		(3)	
Graphite, synthetic				
Total dust			15	
Respirable Fraction			5	
Guthion; see Azinphos methyl				
Gypsum	13397-24-5			
Total dust			15	

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Respirable fraction			5	
Hafnium	7440-58-6		0.5	
Heptachlor	76-44-8		0.5	X
Heptane (n-Heptane)	142-82-5	500	2000	
Hexachloroethane	67-72-1	1	10	X
Hexachloronaphthalene	1335-87-1		0.2	X
n-Hexane	110-54-3	500		1800
2-Hexanone (Methyl n-butyl ketone)	591-78-6	100	410	
Hexone (Methyl isobutyl ketone)	108-10-1	100	410	
sec-Hexyl acetate	108-84-9	50	300	
Hydrazine	302-01-2	1	1.3	X
Hydrogen bromide	10035-10-6	3	10	
Hydrogen chloride	7647-01-0	(C)5	(C)7	
Hydrogen cyanide	74-90-8	10	11	X
Hydrogen fluoride (as F)	7664-39-3		(2)	
Hydrogen peroxide	7722-84-1	1	1.4	
Hydrogen selenide (as Se)	7783-07-5	0.05	0.2	
Hydrogen sulfide	7783-06-4		(2)	
Hydroquinone	123-31-9		2	
Iodine	7553-56-2	(C)0.1	(C)1	
Iron oxide fume	1309-37-1		10	
Isomyl acetate	123-92-2	100	525	
Isomyl alcohol (primary and secondary)	123-51-3	100	360	
Isobutyl acetate	110-19-0	150	700	
Isobutyl alcohol	78-83-1	100	300	
Isophorone	78-59-1	25	140	
Isopropyl acetate	108-21-4	250	950	
Isopropyl alcohol	67-63-0	400	980	
Isopropylamine	75-31-0	5	12	
Isopropyl ether	108-20-3	500	2100	
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240	
Kaolin	1332-58-7			
Total dust			15	
Respirable fraction			5	
Ketene	463-51-4	0.5	0.9	
Lead inorganic (as Pb); see 1910.1025	7439-92-1			
Limestone	1317-65-3			
Total dust			15	
Respirable fraction			5	
Lindane	58-89-9		0.5	X
Lithium hydride	7580-67-8		0.025	

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
L.P.G. (Liquified petroleum gas)	68476-85-7	1000	1800	
Magnesite	546-93-0			
Total dust			15	
Respirable fraction			5	
Magnesium oxide fume	1309-48-4			
Total Particulate			15	
Malathion	121-75-5		15	X
Total dust				
Maleic anhydride	108-31-6	0.25	1	
Manganese compounds (as Mn)	7439-96-5		(C)5	
Manganese fume (as Mn)	7439-96-5		(C)5	
Marble	1317-65-3			
Total dust			15	
Respirable fraction			5	
Mercury (aryl and inorganic)(as Hg)	7439-97-6		(2)	
Mercury (organo) alkyl compounds (as Hg)	7439-97-6		(2)	
Mercury (vapor) (as Hg)	7439-97-6		(2)	
Mesityl oxide	141-79-7	25	100	
Methanethiol; see Methyl mercaptan				
Methoxychlor	72-43-5			
Total dust			15	
2-Methoxyethanol; (Methyl cellosolve)	109-86-4	25	80	X
2- Methoxyethyl acetate (Methyl cellosolve acetate)	110-49-6	25	120	X
Methyl acetate	79-20-9	200	610	
Methyl acetylene (Propyne)	74-99-7	1000	1650	
Methyl acetylene propadiene mixture (MAPP)		1000	1800	
Methyl acrylate	96-33-3	10	35	X
Methylal (Dimethoxy-methane)	109-87-5	1000	3100	
Methyl alcohol	67-56-1	200	260	
Methylamine	74-89-5	10	12	
Methyl amyl alcohol; see Methyl Isobutyl carbinol				
Methyl n-amyl ketone	110-43-0	100	465	
Methyl bromide	74-83-9	(C)20	(C)80	X
Methyl butyl ketone; see 2-Hexanone				
Methyl cellosolve; see 2-Methoxyethanol				
Methyl cellosolve acetate; see 2-Methoxyethyl acetate				
Methyl chloride	74-87-3		(2)	
Methyl chloroform (1,1,1-Trichloro-ethane)	71-55-6	350	1900	
Methylcyclohexane	108-87-2	500	2000	
Methylcyclohexanol	25639-42-3	100	470	
o-Methylcyclohexanone	583-60-8	100	460	X
Methylene chloride	75-09-2		(2)	
Methyl ethyl ketone (MEK); see 2-Butanone				

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Methyl formate	107-31-3	100	250	
Methyl hydrazine (Monomethyl hydrazine)	60-34-4	(C)0.2	(C)0.35	X
Methyl iodide	74-88-4	5	28	X
Methyl isoamyl ketone	110-12-3	100	475	
Methyl isobutyl carbinol	108-11-2	25	100	X
Methyl isobutyl ketone; see Hexone				
Methyl isocyanate	624-83-9	0.02	0.05	X
Methyl mercaptan	74-93-1	(C)10	(C)20	
Methyl methacrylate	80-62-6	100	410	
Methyl propyl ketone; see 2-Pentanone				
alpha-Methyl styrene	98-83-9	(C)100	(C)480	
Methylene bisphenyl isocyanate (MDI)	101-68-8	(C)0.02	(C)0.2	
Mica; see Silicates				
Molybdenum (as Mo)	7439-98-7			
Soluble compounds			5	
Insoluble Compounds				
Total dust			15	
Monomethyl aniline	100-61-8	2	9	X
Monomethyl hydrazine; see Methyl hydrazine				
Morpholine	110-91-8	20	70	X
Naphtha (Coal tar)	8030-30-6	100	400	
Naphthalene	91-20-3	10	50	
alpha-Naphthylamine; see 1910.1004	134-32-7			
beta-Naphthylamine; see 1910.1009	91-59-8			
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007	
Nickel, metal and insoluble compounds (as Ni)	7440-02-0		1	
Nickel, soluble compounds (as Ni)	7440-02-0		1	
Nicotine	54-11-5		0.5	X
Nitric acid	7697-37-2	2	5	
Nitric oxide	10102-43-9	25	30	
p-Nitroaniline	100-01-6	1	6	X
Nitrobenzene	98-95-3	1	5	X
p-Nitrochlorobenzene	100-00-5		1	X
4-Nitrodiphenyl; see 1910.1003	92-93-3			
Nitroethane	79-24-3	100	310	
Nitrogen dioxide	10102-44-0	(C)5	(C)9	
Nitrogen trifluoride	7783-54-2	10	29	
Nitroglycerin	55-63-0	(C)0.2	(C)2	X
Nitromethane	75-52-5	100	250	
1-Nitropropane	108-03-2	25	90	
2-Nitropropane	79-46-9	25	90	

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
N-Nitrosodimethylamine; see 1910.1016				
Nitrotoluene (all isomers)		5	30	X
o-isomer	88-72-2			
m-isomer	99-08-1			
p-isomer				
Nitrotrichloromethane; see Chloropicrin				
Octachloronaphthalene	2234-13-1		0.1	X
Octane	111-65-9	500	2350	
Oil mist, mineral	8012-95-1		5	
Osmium tetroxide (as Os)	20816-12-0		0.002	
Oxalic acid	144-62-7		1	
Oxygen difluoride	7783-41-7	0.05	0.1	
Ozone	10028-15-6	0.1	0.2	
Paraquat, respirable dust	4685-14-7		0.5	X
	1910-42-5			
	2074-50-2			
Parathion	56-38-2		0.1	X
Particulates not otherwise regulated (PNOR)(f)				
Total dust			15	
Respirable fraction			5	
PCB; see Chlorodiphenyl (42% and 54% chlorine)				
Pentaborane	19624-22-7	0.005	0.01	
Pentachloronaphthalene	1321-64-8		0.5	X
Pentachlorophenol	87-86-5		0.5	X
Pentaerythritol	115-77-5			
Total dust			15	
Respirable fraction			5	
Pentane	109-66-0	1000	2950	
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700	
Perchloroethylene (Tetrachloroethylene)	127-18-4		(2)	
Perchloromethyl mercaptan	594-42-3	0.1	0.8	
Perchloryl fluoride	7616-94-6	3	13.5	
Perlite	93763-70-3			
Total dust			15	
Respirable fraction			5	
Petroleum distillates (Naphtha)(Rubber Solvent)		500	2000	
Phenol	108-95-2	5	19	X
p-Phenylene diamine	106-50-3		0.1	X
Phenyl ether, vapor	101-84-8	1	7	
Phenyl ether-biphenyl mixture, vapor		1	7	
Phenylethylene; see Styrene				
Phenyl glycidyl ether (PGE)	122-60-1	10	60	

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Phenylhydrazine	100-63-0	5	22	X
Phosdrin (Mevinphos)	7786-34-7		0.1	X
Phosgene (Carbonyl chloride)	75-44-5	0.1	0.4	
Phosphine	7803-51-2	0.3	0.4	
Phosphoric acid	7664-38-2		1	
Phosphorus (yellow)	7723-14-0		0.1	
Phosphorus pentachloride	10026-13-8		1	
Phosphorus pentasulfide	1314-80-3		1	
Phosphorus trichloride	7719-12-2	0.5	3	
Phthalic anhydride	85-44-9	2	12	
Picloram	1918-02-1			
Total dust			15	
Respirable fraction			5	
Picric acid	88-89-1		0.1	X
Pindone (2-Pivalyl-1,3-indandione)	83-26-1		0.1	
Plaster of paris	26499-65-0			
Total dust			15	
Respirable fraction			5	
Platinum (as Pt) Metal Soluble Salts	7440-06-4		0.002	
Portland cement	65997-15-1			
Total dust			15	
Respirable fraction			5	
Propane	74-98-6	1000	1800	
beta-Propriolactone; see 1910.1013	57-57-8			
n-Propyl acetate	109-60-4	200	840	
n-Propyl alcohol	71-23-8	200	500	
n-Propyl nitrate	627-13-4	25	110	
Propylene dichloride	78-87-5	75	350	
Propylene imine	75-55-8	2	5	X
Propylene oxide	75-56-9	100	240	
Propyne; see Methyl acetylene				
Pyrethrum	8003-34-7		5	
Pyridine	110-86-1	5	15	
Quinone	106-51-4	0.1	0.4	
RDX: see Cyclonite				
Rhodium (as Rh), metal fume	7440-16-6		0.1	
and insoluble compounds				
Rhodium (as Rh), soluble compounds	7440-16-6		0.001	
Ronnel	299-84-3		15	
Rotenone	83-79-4		5	
Rouge				

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Total dust			15	
Respirable fraction			5	
Selenium compounds (as Se)	7782-49-2		0.2	
Selenium hexafluoride (as Se)	7783-79-1	0.05	0.4	
Silica, amorphous, precipitated and gel	112926-00-8		(3)	
Silica, amorpous, diatomaceous earth,				
containing less than 1% crystalline silica	61790-53-2		(3)	
Silica, crystalline cristobalite, respirable dust	14464-46-1		(3)	
Silica, crystalline quartz, respirable dust	14808-60-7		(3)	
Silica, crystalline tripoli (as quartz), respirable dust	1317-95-9		(3)	
Silica, crystalline tridymite, respirable dust	15468-32-3		(3)	
Silica, fused, respirable dust	60676-86-0		(3)	
Silicates (less than 1% crystalline silica)				
Mica (respirable dust)	12001-26-2		(3)	
Soapstone, total dust			(3)	
Soapstone, respirable dust			(3)	
Talc (containing asbestos): use asbestos limit:				
see 29 CFR 1910.1001			(3)	
Talc (containing no asbestos), respirable dust Tremolite, asbestiform; see 1910.1001	14807-96-6		(3)	
Silicon	7440-21-3			
Total dust			15	
Respirable fraction			5	
Silicon carbide	409-21-2			
Total dust			15	
Respirable fraction			5	
Silver, metal and soluble compounds (as Ag)	7440-22-4		0.01	
Soapstone; see Silicates				
Sodium fluoroacetate	62-74-8		0.05	X
Sodium hydroxide	1310-73-2		2	
Starch	9005-25-8			
Total dust			15	
Respirable fraction			5	
Stibine	7803-52-3	0.1	0.5	
Stoddard solvent	8052-41-3	500	2900	
Strychnine	57-24-9		0.15	
Styrene	100-42-5		(2)	
Sucrose	57-50-1			
Total dust			15	
Respirable fraction			5	
Sulfur dioxide	7446-09-5	5	13	
Sulfur hexafluoride	2551-62-4	1000	6000	

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Sulfuric acid	7664-93-9		1	
Sulfur monochloride	10025-67-9	1	6	
Sulfur pentafluoride	5714-22-7	0.025	0.25	
Sulfuryl fluoride	2699-79-8	5	20	
Systox; see Demeton				
2,4,5-T (2,4,5-tri-chlorophenoxyacetic acid)	93-76-5		10	
Talc; see Silicates				
Tantalum, metal and oxide dust	7440-25-7		5	
TEDP (Sulfotep)	3689-24-5		0.2	X
Tellurium and compounds (as Te)	13494-80-9		0.1	
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2	
Temephos	3383-96-8			
Total dust			15	
Respirable fraction			5	
TEPP (Tetraethyl pyrophosphaate)	107-49-3		0.05	X
Terphenylis	26140-60-3	(C)1	(C)9	
1,1,1,2-Tetrachloro-2,2-difluoroethane	76-11-9	500	4170	
1,1,2,2-Tetrachloro-1,2-difluoroethane	76-12-0	500	4170	
1,1,2,2-Tetrachloro-ethane	79-34-5	5	35	X
Tetrachoroethylene; see Perchloroethylene				
Tetrachloromethane; see Carbon tetrachloride				
Tetrachloronaphthalene	1335-88-2		2	X
Tetraethyl lead (as Pb)	78-00-2		0.075	X
Tetrahydrofuran	109-99-9	200	590	
Tetramethyl lead, (as Pb)	75-74-1		0.075	X
Tetramethyl succinonitrile	3333-52-6	0.5	3	X
Tetranitromethane	509-14-8	1	8	
Tetryl (2,4,6-Trinitro-phenylmethyl-nitramine)	479-45-8		1.5	X
Thallium, soluble compounds (as Tl)	7440-28-0		0.1	X
4,4'-Thiobis (6-tert, Butyl-m-cresol)	96-69-5			
Total dust			15	
Respirable fraction			5	
Thiram	137-26-8		5	
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5		2	
Tin, organic compounds (as Sn)	7440-31-5		0.1	
Titanium dioxide	13463-67-7			
Total dust			15	
Toluene	108-88-3		(2)	
Toluene-2,4-diisocyanate (TDI)	584-84-9	(C)0.02	(C)0.14	
o-Toluidine	95-53-4	5	22	X
Toxaphene; see Chlorinated camphene				

Substance	CAS No. (c)	Ppm (a)(1)	mg/m³ (b)(1)	Skin designation
Tremolite; see Silicates				
Tributyl phosphate	126-73-8		5	
1,1,1-Trichloroethane; see Methyl chloroform				
1,1,2-Trichloroethane	79-00-5	10	45	X
Trichloroethylene	79-01-6		(2)	
Trichloromethane; see Chloroform				
Trichloronaphthalene	1321-65-9		5	X
1,2,3-Trichloropropane	96-18-4	50	300	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1000	7600	
Triethylamine	121-44-8	25	100	
Trifluorobromomethane	75-63-8	1000	6100	
2,4,6-Trinitrophenyl; see Picric acid				
2,4,6-Trinitrophenyl-methyl nitramine; see Tetryl				
2,4,6-Trinitrotoluene (TNT)	118-96-7		1.5	X
Triorthocresyl phosphate	78-30-8		0.1	
Triphenyl phosphate	115-86-6		3	
Turpentine	8006-64-2	100	560	
Uranium (as U)	7440-61-1			
Soluble compounds			0.05	
Insoluble compounds			0.05	
Vanadium	1314-62-1			
Respirable dust (as V(2)O(5))			(C)0.5	
Fume (as V(2)O(5))			(C)0.1	
Vegetable oil mist				
Total dust			15	
Respirable fraction			5	
Vinyl benzene; see Styrene				
Vinyl chloride; see 1910.1017	75-01-4			
Vinyl cyanide; see Acrylonitrile				
Vinyl toluene	25013-15-4	100	480	
Warfarin	81-81-2		0.1	
Xylenes (o-, m-, p-isomers)	1330-20-7	100	435	
Xylidine	1300-73-8	5	25	X
Yttrium	7440-65-5		1	
Zinc chloride fume	7646-85-7		1	
Zinc oxide fume	1314-13-2		5	
Zinc oxide	1314-13-2			
Total dust			15	
Respirable fraction			5	
Zinc stearate	557-05-1			
Total dust			15	
Respirable fraction			5	
Zirconium compounds (as Zr)	7440-67-7		5	

23.3, APPENDIX III, TABLE 16 (CONTINUED)

Table Z2 - Limits for Air Contaminants

Compound		8 Hour TWA	Ceiling Conc.	Max. Peak Conc.	
				Conc.	Duration
Benzene	Z37.40-1969	10 ppm	25 ppm	50 ppm	10 min
Berylium and Berylium Compounds	Z37.29-1970	2 μg/m^3	5 μg/m^3	25 μg/m^3	30 min.
Cadmium Fume Dust	Z37.5-1970	 100 μg/m^3 200 μg/m^3	 300 μg/m^3 600 μg/m^3	 _____	 _____
Carbon Disulfide	Z37.3-1968	20 ppm	30 ppm	100 ppm	30 min.
Carbon Tetrachloride	Z37.17-1967	10 ppm	25 ppm	200 ppm	5 min. in 4 hr. per.
Chromic acid and Chromates	Z37.7-1971		100 μg/m^3		
Ethylene Dibromide	Z37.31-1970	20 ppm	30 ppm	50 ppm	5 min.
Ethylene Dichloride	Z37.21-1969	50 ppm	100 ppm	200 ppm	5 min. in 3 hr. per.
Fluoride (as dust)	Z37.28-1969	2,500 μg/m^3			
Hydrogen Fluoride	Z37.28-1969	3 ppm			
Hydrogen Sulfide	Z37.2-1966		20 ppm	50 ppm	10 min. if no add. Exposure
Mercury	Z37.8-1971		100 μg/m^3		
Methyl Chloride	Z37.18-1969	100 ppm	200 ppm	300 ppm	5 min. in 3 hr. per.
Methylene Chloride	Z37.23-1969	500 ppm	1,000 ppm	2,000 ppm	5 min. in 2 hr. per.
Alkyl Mercury	Z37.30-1969	10 μg/m^3	40 μg/m^3		
Styrene	Z37.15-1969	100 ppm	200 ppm	600 ppm	5 min. in 3 hr. per.
Tetrachloroethylene	Z37.22-1967	100 ppm	200 ppm	300 ppm	5 min. in 3 hr. per.
Toluene	Z37.12-1967	200 ppm	300 ppm	500 ppm	10 min.
Trichloroethylene	Z37.19-1967	100 ppm	200 ppm	300 ppm	5 min. in 2 hr. per

23.3, APPENDIX III, TABLE 16 (CONTINUED)

Table Z3 - Limits for Air Contaminants.

Compound	Millions of Particles per cubic foot of air	mg/ m^3
Silica:		
Crystaline		
Quartz (Respirable)		10 / (%SiO_2 + 2)
Quartz (Total Dust)		30 / (%SiO_2 + 2)
Cristobalite		1/2 Value Calc. for Quartz
Tridymite		1/2 Value Calc. for Quartz
Amorphous (incl. natural diatamaceous earth)		80 /(%SiO_2)
Silicates (Less than 1% Crystaline)		
Mica	20	
Soapstone	20	
Talc (non-asbestos)	20	
Portland Cement	50	
Graphite (Natural)	15	
Coal Dust -- Respirable		
Less than 5% SiO_2		2.4 / (%SiO_2 + 2)
Greater than 5% SiO_2		10 / (%SiO_2 + 2)
Inert or Nuisance Dust		
Respirable	15	5
Total Dust	50	15

24.0 DEPARTMENT POLICIES RELATING TO THE CHP

Policy 1: Vacating Laboratory ("Check-Out" Policy)

The intention of the *Chemical Hygiene Plan* is to reduce exposure to hazardous chemicals in the laboratory. Materials left by departing laboratory workers (including investigators, faculty, professors, or graduate students) can provide an unexpected and unnecessary source of exposure if proper clean-up, disposal, storage and transfer of responsibility for hazardous materials is not accomplished.

Students, graduate students, and post-doctoral fellows are to be responsible for cleaning their laboratory area and apparatus, for storing chemicals and materials appropriately, and for disposing of waste materials correctly before leaving the Department.

Laboratory Supervisors or Department Chairs shall be responsible to certify prior to termination of a Laboratory employee or academic staff that the following conditions have been met.

1. Laboratory area has been cleaned and glassware, apparatus and chemicals have stored properly.
2. All laboratory employee generated chemicals have been properly identified and labeled.
3. All wastes and hazardous materials have been either disposed, marked for such disposal, put in proper storage pending disposal, or the responsibility for the wastes has been transferred to a continuing laboratory employee.
4. All safety responsibilities have been reassigned to continuing laboratory employees and notification has been made to the Chemical Hygiene Officer.

Signatures of the exiting individual and supervisor will be required on the Check-Out Form which is provided on the next page.

Environmental Health and Safety
North Service Building
tlrussell@bsu.edu
765-285-2807

LABORATORY CHECK-OUT FORM

Name of Exiting Researcher (print): _____

Supervisor / Department Chair: _____

Room(s)/Building(s): _____

Work / Research Performed: _____

Please initial the items completed in left column, mark NA for items that do not apply:

1	**Waste –** a request for pick-up of unwanted hazardous materials has been submitted to EHS and all waste containers labeled with completed LAB WASTE labels.
2	**Chemical Containers –** all other chemical containers used by me have been properly labeled and stored.
3	**Excess** - Department notified of any excess or orphan chemicals for re-distribution or assessment.
4	**Research Products –** research samples and prepared solutions have been transferred to: _____. An inventory of transferred or disposed materials completed.
5	**Biological materials –** biological materials (samples, organisms, tissues, fluids, cell lines, etc.) have been decontaminated and disposed of or the biological materials inventory is up to date including storage locations.
6	**Radioactive materials users –** RSO has been notified of departure so radioactive materials can be disposed/transferred and the laboratory decommissioned.
7	**Controlled Substance Registrants** - EHS has been notified of departure so controlled substances can be disposed / transferred and the laboratory decommissioned.
8	**X-Ray Equipment and TEM/SEM users –** EHS notified of change in personnel for training or dosimetry purposes.
9	**Lab Door Sign –** Revised to reflect new or temporary contact and remaining hazards
10	**Workspace –** Workspace and equipment has been cleaned/decontaminated/disinfected. Please indicate (checkmark) that the following locations have been checked and all samples and prepared solutions have been properly discarded or transferred to _____: ☐ lab benches ☐ refrigerators/freezers ☐ cell culture room ☐ Explosion proof freezer/refrigerator ☐ fume and / or biosafety cabinet ☐ walk-in-cold room and/or freezers ☐ shelves, storage areas ☐ ultralow (-80°) freezer(s)
11	**Equipment –** Identify any unwanted or unusable laboratory equipment for excess or re-use elsewhere
12	**Other** routine or safety-related duties I am responsible for:
13	**Personal –** all personal items and effects have been removed
14	**Keys –** all keys or access cards have been located and returned to Department Chair or Key Control

Comments: _____

_____

Signature of Exiting Researcher: _____ **Date:** _____

Verified By: _____ **Title:** _____

24.0 DEPARTMENT POLICIES RELATING TO THE CHP (CONTINUED)

Policy 2: Safety Enforcement Policy

Introduction

The various Departments utilizing laboratories, including the Chairperson, faculty and staff, recognize that we must comply with a variety of State and Federal mandates including those issued by the Environmental Protection Agency (EPA), the Occupational Health and Safety Administration (OSHA), the Indiana Department of Environmental Management (IDEM), and the State of Indiana (Administrative, Building and Fire Codes). Each employee of the Department, therefore, has an obligation to understand and comply with applicable environmental, health and safety regulations as well as those policies established by the University.

This means that all faculty, emeritus faculty, staff, graduate students, visitors, and guests must:

Observe health and safety related signs, warning signals and directions;

Review the Department's emergency procedures;

Have an awareness of potential work hazards;

Be aware of the identity, characteristics, and hazards of chemicals in the area of use;

Take appropriate health and safety training;

Follow all standard operating procedures and precautions;

Warn coworkers about defective equipment and notify appropriate personnel;

Use personal protective equipment and safety engineering equipment appropriate to their work;

Stop work that poses imminent danger to health and safety and notify appropriate personnel;

Participate in required inspection and monitoring activities; and,

Report unsafe conditions to a supervisor, the Laboratory or Department Safety Officer or the Chemical Hygiene Officer.

All Laboratory Supervisors, Principal Investigators and Managers are responsible for the safe operation of their laboratories, other staff, and students. They must:

Train employees to identify and mitigate potential hazards;

Maintain and update a chemical inventory as required;

Develop and implement procedures and practices as required by the Department Chemical Hygiene and Hazard Communication Plans;

Analyze work procedures for hazard identification and correction;

Promote regular self-assessment inspections to review and correct deficiencies;

Implement measures to eliminate or control workplace hazards;

Encourage prompt employee reporting of health and safety problems without fear of reprisal; and,

Stop any work that poses imminent danger;

The Chairperson with the Safety Officer must:

Within the resources available, ensure that all environmental, health and safety obligations are fulfilled; and,

Communicate the importance of establishing a high priority for health, safety and a concern for the environment.

Instill a "Culture of Safety" as part of routine laboratory activities and as part of the educational curriculum for students.

Inspections

The Department Chairperson, the Laboratory Manager, Safety Officer, the Chemical Hygiene Officer, and all members of any Department Safety Committee will have authority to:

- *Conduct random and/or periodic inspections anywhere within the Department laboratory and support systems to monitor compliance;*
- *Issue verbal and written warnings based on above inspections. The written warnings will be addressed to the individual in violation of the policies, with copies to the individual's upervisor and any Safety Committee; and,*
- *Stop or curtail any work or process that is immediately or imminently dangerous to life and health and lock the laboratory until the danger can be resolved.*

Compliance and Enforcement Mechanisms

Violations of accepted policies may be discovered by casual observation, investigations of spills, exposure incidents, or injuries, inspection by a member of the Department or the Chemical Hygiene Officer, through an inspection by the State Fire Marshall or University Environmental Health and Safety Office, a routine IOSHA inspection, or due to a formal complaint.

The compliance program requires that PIs/Laboratory Supervisors and other responsible parties take appropriate and effective corrective action upon receipt of written notification of inspection findings, exposure investigations, chemical/biological/radiological spills or releases, or injuries. Critical deficiencies are required to be corrected within 48-hours; non-critical deficiencies must be corrected within 30-days. Failure to take corrective actions within the required timeframe will result in a repeat deficiency finding and an escalation of the notification to the Department Chair. Depending on the severity of the deficiency, the CHO, in consultation with the Department Chair, may temporarily suspend or monitor research or educational activities until the violation is corrected. In some cases, the PI, Department, or Laboratory Supervisor may be required to provide a corrective action plan to the Laboratory Safety Committee prior to resumption of research activities.

Students, other than student employees such as interns, graduate students, teaching assistants, or research assistants, are not employees or directly subject to OSHA requirements. They are, however, accountable and subject to regulations of the EPA, IDEM, CDC, Indiana State Department of Health, Homeland Security, Drug Enforcement Agency, and many other authorities.

It is the responsibility of the various Departments, faculty, instructors, staff, and principal investigators to ensure compliance by students with the content of this Chemical Hygiene Plan and related procedures and policies developed by Ball State University.

24.0 DEPARTMENT POLICIES RELATING TO THE CHP (CONTINUED)

Policy 3

Disposal Policy for Materials of Uncertain Composition ("Chemical Unknowns")

Disposal of hazardous waste is dangerous and expensive even when the contents of the waste are identified. Fortunately, most of the chemical waste produced by the various Departments is readily identifiable. However, when the contents of a waste container, reagent bottle, reaction flask or gas cylinder are not identified, the process for disposal is much more dangerous, expensive and difficult. Without mitigating information, all unknown materials have to be treated as if they were potentially lethal and hazardous. In all cases, chemical unknowns cannot be disposed of until a general profile of the unknown has been generated. Even then, the cost of disposal is a premium. Additionally, there is a constant threat of personal injury or death to the individuals required to handle these potentially dangerous materials. No price tag can be attached to an avoidable personal injury.

The obvious goal is to reduce the number of "unknowns" to as close to zero as possible by following the *BSU Chemical Hygiene Plan* and the *BSU Waste Management Guide*. Labeling all chemical containing glassware; disposing of all old, outdated and questionable chemicals and samples; recycling unneeded chemical reagents; maintaining separate waste containers for different classes of chemical wastes; and keeping a running log of the amounts and quantities of all wastes placed into disposal containers will reduce the number of unknowns and should be considered standard laboratory practice. This policy details the procedures that should be followed when an "unknown" is discovered and a request for disposal is to be generated.

Procedure

It is the responsibility of the generator to identify each "unknown" as completely as possible before submitting an "unknown" to the Environmental Health and Safety Office. The generator is defined as the Principal Investigator (PI), Laboratory Manager, or Safety Officer initiating the disposal request. The three steps to be followed by the generator are:

1. Complete an UNKNOWN PROFILE FORM, available from the EHS Office and shown on the following page.

2. Attach the sheet to the material being submitted for disposal.

3. Call the Environmental Health and Safety Office at (28)5-2807.

Instructions for Completing the UNKNOWN PROFILE FORM

1. Container Identification Number
   The Generator will supply a Container Identification Number which should include the Generator's surname, the year and a number unique to the container submitted. This number should be included on all information attached.

2. Generator Knowledge

If the Lab Supervisor has adequate knowledge of the material, then "Generator Knowledge" can be a substitute for analytical tests and can greatly simplify the process of dealing with the "unknown". Provide a physical description to include the appearance, odor and quantity of the unknown; the source and/or history of the unknown; and, especially, a listing of potential elements for inorganic waste or compounds for organic waste, even if the percentages or absolute amounts are not known. The presence of specific hazard classes should be indicated with a "**Y**" when known. If the presence of a material is likely (but not certain), indicate with a "**?**". When compounds or classes of compounds are known to be absent, a "**N**" should be placed in the appropriate blank

3. Analytical Tests
   In the absence of generator knowledge, the results of screening tests should be provided by the Laboratory Supervisor to provide an indication of the major components present. Suggested screening tests include a determination of the pH and a general qualitative analysis. If radioactive contamination is suspected, the Office of Radiation Safety must be contacted to schedule an accurate test for Alpha and Beta emissions. Specific additional tests that will assist the Safety Office in the disposing the materials are strongly recommended, but are at the discretion of the Laboratory Supervisor. Use of Departmental instrumentation to test unknowns in preparation for disposal will not be charged to the Laboratory Supervisor.

4. Signature
   Each sample must be accompanied by a signature of the PI or Laboratory Supervisor or designated individual certifying the above information is the best "Good Faith Effort" to describe and identify the unknown.

Notice

Individuals who dispose of hazardous wastes in an inappropriate manner will face disciplinary action as outlined in the Departmental Enforcement Policy.

Unknown Profile Form

Submit to the Environmental Health and Safety Office
BSU Facilities Planning and Management

I. Container Identification Number (Name/Year/#) _____
Generator (Laboratory or Shop) _____

Contact Name (If different than Laboratory Supervisor) _____

Contact Telephone Number _____ Email _____Building/ Room Number _____

II. Generator Knowledge

Source of Material ____ Lab Clean Out ____ Reagent ___ _Lab Waste ___ Unknown ___ Other _____

Physical Description ___ Solid ___ Liquid ___ Gas ___ Mulit-phasic (describe): _____

Color _____ Container type: _____

Odor _____ Quantity: _____

Potential Contents: (Y = Present, ? = Possible, N = Known Absent)

General Classification

_____ __ Organic Only _____ Inorganic Only _____ Mixture

Potential Hazard Classes (* Critical Information for Disposal)

___ Strong Acids*	___ Strong Bases*	___ Mercury*	___ Flammable*
___ Radioactive*	___ Peroxides*	___ Cyanide	___ Air Reactive
___ Water Reactive	___ Oxidizer	___ Picrates	___ Pyrophoric
___ Heavy Metals	___ Perchlorates	___ Sulfide	___ Biological

III. Analytical Tests Performed

pH: _____ volatility: _____
Qualitative Analysis (attach results)_____
_____
Additional Tests Performed (attach results)
_____
_____
_____

IV. Generator (Print)
_____Title_____

Signature _____ **Date** _____

CHAPTER 25.0 DEPARTMENT FORMS RELATING TO THE CHP

Form 1A-- Laboratory Self-Inspection Forms (for Lab Manager Use)

Form 1B -- Formal Laboratory Inspection Form (used by CHO/EHS)

Ball State University **Environmental Health and Safety Office** **Laboratory Self-Inspection Form (CHP 1A)**	BALL STATE UNIVERSITY

It is the aim of the Laboratory Safety and Security Committee and Environmental Health & Safety Office (EHS) to work cooperatively with Principal Investigators, faculty, and laboratory workers to achieve compliance with University safety policies, the Chemical Hygiene Plan and governmental regulations. Unsatisfactory items and laboratory safety violations will be handled, following the steps outlined in the Chemical Hygiene Plan. **Issues that represent an immediate or imminent hazard to University Personnel, risk to the environment, or potential to cause damage to University facilities are classified at Category 1 Deficiencies (pink background) and must be rectified immediately.**

Department:	**Date:**
Building and Room Number:	
Inspector(s):	

A. Administrative

Inspection Item	**S**	**UNS**	**N/A**	**Comments**
Access to Material Safety Data Sheets in Lab? *Personnel must have access to updated MSDS in the laboratories. MSDS may be managed as printed hard copies in an organized fashion such as a binder. MSDS may also be maintained through a bookmarked Internet site or as an electronic file. A functioning computer with internet access and a functioning printer must be available in the laboratory. All laboratory personnel must know where and how to access the material safety datasheets (MSDS) for the hazardous materials they use in their operations. Laboratories are strongly urged to print the MSDS sheets for their chemicals from the manufacturer that produced them and keep them in a clearly marked three ring binder in the laboratory on a bookshelf or other organized fashion where they will be visible to all researchers. These printed MSDS must be updated and current. If a laboratory chooses to use electronic access, internet bookmarks, desktop icons or shortcuts must be used on the computer or posted in a conspicuous location to facilitate easy access. These electronic copies must be updated and current. Provisions are needed for dealing with long-term interruptions to power, the network, or the server which would make electronic versions unavailable.*				
Hand washing sink, Hand Soap and Paper Towels Available to Assure Proper Decontamination? *On leaving the designated area or the laboratory area, remove protective apparel and thoroughly decontaminate or dispose of contaminated items. Thoroughly wash hands and forearms with soap and water.*				
No Smoking, Eating, Drinking? *Smoking, Eating, Drinking, and the application of cosmetics are prohibited in all University laboratories.*				
Unauthorized Occupants? *Laboratory workers must limit access by unauthorized occupants and challenge or report any suspicious activity or people to the University Police. Children should not be allowed in the laboratory.*				

Inspection Item	S	UNS	N/A	Comments
Lab Secured? *Assure that the laboratory is locked when no one is present in the laboratory.*				
Laboratory door (entrance) sign(s) posted, accurate, and up to date. *Is the laboratory hazard sign accurate? Are emergency contacts and phone numbers posted up to date?*				
Laboratory-specific Chemical Hygiene Plan available *(or Page 2 of CHP with Emergency Information and locations of SDSs and safety equipment in this lab?*				
Chemical Inventory Available? *An up to date chemical inventory must be maintained or the web-based ChemTracker in use.*				
Biological Material Inventory Available? *A biological material inventory must be maintained, in the laboratory and technical information or pathogen safety data sheets available for any infectious agents.*				
Right-To-Know/Chemical Hygiene Plan and Task Specific Training? *All members of the lab must have Right-to-Know and Chemical Hygiene/Safety training. Electronic management of training records is encouraged. Laboratory personnel must receive task and chemical specific training on all processes, chemicals, equipments and hazards in the laboratory.*				
Job Hazard Analysis or Written Safety Procedures? *Written procedures are required for all hazardous operations and use of hazardous chemicals. These written procedures should discuss the hazards involved in the operation and ways to mitigate the hazard. The written procedures should dictate the types of personal protective equipment, fume hood use and other safety practices. They should be revised whenever there is a change in procedure or a new procedure added.*				
Lab Doors and Windows Closed? *Lab doors should remain closed at all times to assure optimum laboratory ventilation. Keeping lab doors closed also minimizes odors and helps prevent the spread of smoke in the event of a fire.*				
Emergency Training? *Laboratory members should know the procedures to follow for a laboratory accident; i.e. use an emergency phone or dial 5-1111 or 911 for help, location of first aid kits, eye washes, accident reporting procedures. Researchers need to develop procedures to make operations safe should a ventilation or power failure occur. Lab members should know where the emergency gathering point is located.*				
B. Electrical				
General Condition? Check for frayed power cords, unsafe electrical operations, open/exposed wires, grounding plugs removed, etc. *Adequate electrical service is necessary in the lab to avoid the use of unsafe practices such as permanent use of extension cords. Electrical equipment must be maintained in good condition.*				
Use of Extension Cords? *Extension cords are allowed for temporary use provided the gauge of the cord is adequate for the load applied. Contact BSU Work Control for additional guidance. Check to be sure the extension cord is three pronged and that no cords are frayed. Multi-plug devices are allowed provided they are UL listed with a built-in circuit breaker and used in accordance with the manufacturer's intended use.*				

Inspection Item	S	UNS	N/A	Comments
Breaker/Circuit Identification? *Circuit breakers that service laboratory equipment should be identified as such. Contact BSU Work Control for assistance.*				
Ground Fault Protection? *Outlets located near sinks (within three feet) or other sources of water should be on a ground fault circuit or otherwise ground fault protected. Contact Work Control for assistance.*				
C. General Safety				
Housekeeping, Surplus Equipment and Egress? *Housekeeping must be maintained so that the aisles are clear to allow for emergency egress. A minimum of 36" of clear aisle space in required throughout the lab. Could a person exit the lab quickly without tripping over objects? Materials, chemicals and debris should not be stored on the floor or in the path of egress. Excess or surplus equipment and supplies should be disposed of or relocated to a storage location.*				
Hot Surfaces/Equipment? *Hot surfaces or equipment should be posted with an appropriate warning sign or have a mechanism to indicate that the surface is hot.*				
Safety Shower/Eye Wash? *Safety showers and eyewash units should be located in the lab or nearby (within 10 seconds) and accessible at all times. Eyewash must be in the laboratory if corrosive materials are used. They should bear a tag indicating an inspection within the last year by the EHS Office. Eyewash units should be tested and flushed weekly by lab occupants wherever possible.*				
Refrigerators/Freezers? *Laboratory refrigerators and freezers must not be used to store of food or drink for human consumption. Refrigerators and freezers used to store flammable, combustible and corrosive chemicals must be approved and certified. Units must be signed or labeled.*				
Needles/Syringes Secured? *Needles and/or syringes must be kept secured at all times. This means kept in a locked drawer or cabinet or in a locked laboratory and under surveillance of lab personnel when the lab is unlocked. Do not leave uncapped needles in fume hoods or on laboratory benches. Rigid biohazard containers must be available and used for sharps disposal.*				
Tripping/Slipping Hazards? *Floors should be in good repair, i.e. no tripping hazards caused by cracks, holes, protrusions, missing tiles, ethernet cords, wires, hoses, tubing, etc. Chemicals must not be stored unprotected on floors.*				
Potable Water Protection? *Hoses connected to sink faucets should not extend below the plane of the sink surface or back flow preventers should be installed.*				
First Aid Kits? *There should be a first aid kit available in case of minor injuries. It should remain stocked and be accessible during the hours of operation of the lab.*				

Inspection Item	S	UNS	N/A	Comments
Emergency Lights? *Is there adequate emergency lighting? If there is a unit in the area, depress the test button to determine if the light is operational. Any problems should be reported to BSU Work Control.*				
Ice Machines/Microwave Ovens (Labeled)? *Laboratory microwaves or ice machines must not be used with food or drink for human consumption. Make sure they are signed appropriately.*				
D. Fire Safety Concerns				
Detectors/Sprinklers? *If there are smoke/heat detectors, audio/visual devices or sprinklers in the lab, make sure that nothing is stored near them that would interfere with their intended operation. No storage within 18 inches of sprinkler heads. Visually check for physical damage or leaks. Report any deficiencies to Work Control.*				
Combustible Storage, such as excess boxes, shipping containers, paperwork? *Check for excess storage of combustibles or combustibles near any hot surfaces or equipment. Maintain at least 18 inches from hot surfaces or equipment.*				
Special Concerns? *If drying operations are performed in the lab, are there procedures written for safe operation; i.e. are lab personnel instructed not to use combustible trays for holding materials to be dried? Limit the use of Bunsen burners. Develop written safety procedures for all heating operations and train lab workers.*				
Fire Extinguishers? *Fire extinguishers should be located nearby and accessible from the hallway. They are inspected monthly by EHS. Check to make sure the extinguisher is present, charged, and un damaged.*				
E. Chemical Concerns				
Storage by Hazard and Chemical Storage? *Chemicals need to be stored by hazard class, i.e. Reactives, Flammables, Poisons, Oxidizers, Inorganic Acids, Organic Acids, Caustic Materials, etc. Organic acid should not be stored with inorganic acids. Carcinogenic chemicals, acutely toxic chemicals and reproductive toxics should be used only in designated areas. Pay close attention to special storage requirements such as refrigeration, desiccated, inerted, etc. Liquids must not be stored above eye level and should be stored in the appropriate cabinet in secondary containment. Open shelving units should have a lip. Chemicals must not be stored on the floor*				
Flammables/Combustibles? *Flammables and combustible materials should be stored in flammable storage cabinets wherever possible and always kept away from ignition sources. Lab safe or explosion proof refrigerators and freezers are required when flammables and combustible chemicals must be stored at refrigerated temperatures. Regular/residential refrigerators and freezers should bear the caution statement prohibiting storage of these materials.*				

Inspection Item	S	UNS	N/A	Comments
Peroxide formers, such as ethyl ether and tetrahydrofuran, dated when the material was received and when opened. Material is stored past the manufacturer's expiration date. *Date all peroxidizables upon receipt and upon opening. Unless an inhibitor has been added by the manufacturer, materials should be properly disposed of after 18 months from the date of receipt or 3 months from the date of opening. If an inhibitor is added, dispose of the material based on the manufacturer's expiration date.*				
Excessive Quantities? *Quantities of chemicals kept in the lab should not be excessive. Outdated chemicals should be disposed of using proper disposal methods outlined in the BSU Waste Management Guide. Placement or storage of chemical containers on floors, in fume hoods, working counters, etc., is indicative of excess chemicals in the laboratory.*				
Container Labels? *All chemical containers must be labeled and the labels must be securely affixed to the container. Reaction flasks, samples and other lab containers must be labeled as well. EHS recommends that the preparer's name, the date prepared and the basic hazard also are listed. Abbreviations or trade names should not be used to label containers, unless the container is too small to fit the full name. Common chemical or IUPAC nomenclature should be used whenever possible.*				
Chemical Spill Kits? *Chemical spill kits must be readily available and, where necessary, contain absorbents or neutralizing agents for particularly offensive materials (e.g., formaldehyde, hydrofluoric acid).*				
Any materials which are reproductive toxins, highly toxic or carcinogenic require a Standard Operating Procedure. See the BSU Chemical Hygiene Plan. *All work with chemicals that are Highly Toxic, Carcinogenic materials, Reproductive toxins, or highly hazardous work such as explosive materials, pyrophoric materials or vacuum and pressure operations require a Standard Operating Procedure – these are Particularly Hazardous Substances.*				
Lab limits the use of mercury thermometers and metallic mercury ? *Laboratories should eliminate the use of metallic mercury. Replace all mercury thermometers with digital or alcohol thermometers. Eliminate metallic mercury monometers and sphygmomanometers (blood pressure units). Contact EHS for proper disposal and recycling of the units and equipment.*				
F. Waste Management				
Quantity of Waste Accumulated? *Waste should be removed from a laboratory in a timely manner. Do not store more than 55 gallons of waste materials in a lab. Full waste containers must be removed promptly. See the BSU Waste Management Guide. Contact EHS at 5-2807 if you need assistance or removal of wastes.*				
Properly Labeled? *Abbreviations or trade names must not be used to identify contents. Common chemical or IUPAC nomenclature must be used. Label every constituent added to the container, especially with heavy metals in the parts per million ranges. Unknowns are forbidden and will be disposed of at the department's expense.*				

Inspection Item	S	UNS	N/A	Comments
Properly Stored/Secured? *Liquid waste must be stored in a secondary container, segregated by chemical compatibility. Do not fill liquid waste containers over 90% full. Solid waste should be kept in a properly labeled sturdy cardboard box lined with a heavy plastic bag. Waste containers (both liquid and solid) must be capped or sealed at all times unless material is actually being added. Biowaste boxes must be constructed properly with packing tape and lined with red bags.*				
Proper Waste Containers Available? *Waste containers must be compatible with contents. All liquid waste must be in a LDPE Nalgene type container or a Justrite container segregated by chemical compatibility. Chemical solid waste must be stored in a sturdy cardboard box lined with a heavy plastic bag. Biowaste and sharps must be stored in rigid or approved containers.*				
Evidence of Improper Waste Disposal? *Normal trash cans or recycle bins should not contain inappropriate materials; i.e. used PPE or materials that can be construed as chemical or biological waste. Sinks should be free of stains and waste containers should not be stored in close proximity to sinks unless they are in secondary containers. Clean broken laboratory glass is to be collected in "glass only" boxes, closed up and taken to the outside dumpster by lab personnel. Chemical bottles must be triple rinsed and the labels defaced prior to disposal or recycling. All other chemically contaminated glassware must be disposed of as hazardous waste. All biological waste must be disposed of properly in biowaste boxes or sharps containers and autoclaved as necessary.*				
Lab personnel have received chemical waste disposal training? *All personnel who work with chemicals or have the potential to generate, or are generating, chemical waste must attend chemical waste training annually. Contact EHS for more information.*				
G. Physical and Environmental Concerns				
Moving Parts Guarded? *All belts, blades or other moving parts on equipment should be guarded or otherwise protected.*				
Shields Used? *Shields should be used when conducting experiments that could explode or if there is the possibility of a flying projectile or object.*				
Equipment Clean and Operable? *All lab equipment should be clean and in good working order. Damaged/out of service equipment must be tagged and removed from the lab for proper disposal or repair.*				
Noise Levels? *Operations or equipment that produces noise at a level of concern require hearing protection.*				
Sharp Edges, Points? *Check for sharp edges or points sticking out on equipment, furniture etc. that could cause an injury.*				
Laboratory Environmental Conditions – Wet Floors, Temperature Concerns, Wet/Stained Ceiling Tiles, Mold *Call Facilities Work Control or the EHS Office to report issues with the temperature, wet/stained ceiling tiles and mold. Use matting in areas where the floors periodically get wet such as in front of -80 Freezers.*				

Inspection Item	S	UNS	N/A	Comments
Oil mist filters installed on oil filled vacuum pumps? Oil mist filters maintained properly? No oil on the floor, in the exhaust lines or no other indications of a leak or issue. *Vacuum pumps exhaust oil mist and toxic materials, depending on the specific operation, into the laboratory or laboratory exhaust. The oil mist collects on equipment, the floor and in the horizontal runs of the laboratory exhaust ductwork. The oil mist is a health hazard which can be magnified if organic solvents and other toxic materials are used with the vacuum pump systems. Install a manufacturer's recommended oil mist filter on the vacuum pump exhaust. Maintain the oil mist filter based on the manufacturer recommendations. Some mist filters require the replacement of a filter matrix; others simply require the collected oil to be drained.*				
High overhead storage safe and secured. A rated/proper ladder available to retrieve overhead storage Overhead storage should be minimized. Liquids and heavy equipment/materials should not be stored overhead. Shelving must be rated for the weight. A ladder or other rated and safe mechanism must be in place to remove the equipment safely from the overhead storage.				
H. Personal Protective Equipment				
Proper Lab Attire, Personal Protective Equipment (PPE) Available? *In general, proper lab attire must consist of safety glasses, lab coats, gloves, pants/dresses that come below the knees and closed-toe shoes. Efforts must be made to minimize all exposed skin. Sandals, short skirts or shorts and sleeveless shirts are not appropriate for the lab. Face shields, splash goggles, hot mitts, cryogenic gloves, and specialized PPE should be available. PPE should not be worn in non-lab areas.*				
Safety Glasses or Goggles Being Worn? *Eye protection is mandatory in all University laboratories except laboratories used exclusively for computers. (See Policy in the BSU CHP)*				
I. Ventilation and Engineering Controls				
Fume Hood Operation and local exhaust – Check Before Use! *The lab manager, instructor, or researcher should make sure the fume hood(s) or local exhaust systems are operating properly before use. Check the automatic alarms or flow indicators. Make sure the sash is at proper height and, the baffles are properly set based on the vapor density of the chemicals to be used. Verify the fume hood is operating properly by holding a ribbon or tissue (Kimwipe) below the sash and observing flow. Ensure lab doors are closed and personnel traffic past the hood is eliminated.*				
Proper Use of Fume Hood? *Fume hood work should be performed approximately six inches into the hood, i.e. not right at the front edge. The sashes should be positioned to produce the flow rate indicated on the certification sticker. They should not be used for storage of chemicals. Large equipment must be raised about 2 inches off the fume hood deck. Only chemicals, materials and supplies for the current experiment or operation should be in the fume hood. Fume hoods must be kept clean and should be decontaminated on a periodic basis.*				
Fume Hoods Available? *If operations in the lab involve materials which present an inhalation exposure hazard, a fume hood, exhaust trunks or biosafety cabinet must be available for use. These operations include, but are not limited to, work with carcinogens, reproductive toxins, acutely toxic materials, flammable liquids, materials with high vapor pressures, dusts, mists, volatile materials, soldering operations, welding operations, or with any chemical that has an occupational exposure value.*				

Inspection Item	S	UNS	N/A	Comments
Fume Hood Certified? *Fume hoods and exhaust trunks are inspected by the EHS for proper operation twice per year. An inspection tag should be present to verify this.*				
Biosafety Cabinets? *All Biosafety Cabinets must be inspected and certified by an EHS contractor annually. Chemicals should not be used in cabinets. Bunsen burners should not be used in biosafety cabinets. Biosafety cabinets should be positioned away from doorways and supply/exhaust vents; this will disrupt the laminar flow.*				
J. Compressed Gases				
Proper Storage? *Gas cylinders should not be stored in laboratories unless they are being used for the current operation. Empty cylinders should be moved out as soon as possible. Some gas companies will accept their cylinders back empty or partially full. These companies should be used to minimize chemical waste. Do not store a gas cylinder between a user and an exit. Compressed gases with a health hazard rating of 3 or 4 must be stored in a rated ventilated gas cabinet. Compressed gases with a fire hazard of 4 (hydrogen, for example) require a second means of egress form a laboratory or must be stored in a rated ventilated gas cabinet. Contact EHS for additional assistance with compressed gas safety.*				
Proper Labeling? *Gas cylinders must be labeled with the contents. Unknown gas cylinders are very hazardous and expensive to dispose of.*				
Cylinders Capped or Restrained properly? *Caps should be kept on the cylinders when not in use. Cylinders need to be individually restrained by chains or bars at approximately two-thirds height from the floor. The cylinder must be of good quality and firmly attached to a structural member. Bench clamps should be avoided and only used if a gas cylinder bracket cannot be permanently mounted.*				
Proper Lines and Regulators? *Gas supply lines need to be compatible with the gas being used. All gas cylinders must have an appropriate regulator. Do not use thread tape on the regulator/cylinder connection. The suppliers can provide information about proper line material. Regulators should be replaced or recertified on a regular basis. Contact the gas supplier with questions.*				
Lab personnel trained on compressed gases and gas cylinder safety? *Laboratory personnel must receive task and chemical specific training on all processes, chemicals, equipments and hazards in the laboratory and Standard Operating Procedures should be available.*				
K. Additional Comments				

L. Corrective Actions

Items marked as unsatisfactory will be reported to the Safety Committee Chair, Department Chair, and to the responsible PI. Category 1 Deficiencies must be rectified immediately. Category 2 Deficiencies should be rectified in 30 days or sent to the Department Chair for action. Deficiencies were communicated to:

Name:	Signature: _____	Date:

Status of Deficiencies:	All Items Rectified:	Steps to Rectify Items Established	Entered into the Chemical Hygiene Compliance Process

Date Items will be Rectified:

Corrective Action Comments:

A follow-up inspection to determine if agreed upon steps to rectify outstanding issues were implemented was completed:

By:	Date:

Unsatisfactory items:	Were Properly Addressed	Are Still in the Process of Being Addressed	Were Not Properly Addressed, Laboratory Entered into the Chemical Hygiene Compliance Process

Followup Inspection:

By:_____ Title: _____ Department: _____

Date:_____

Form 1B – Formal Laboratory Inspection Form

Ball State University Laboratory Safety Inspection Form			
Bldg/Room(s):		***Today's Date:***	
Lab Supervisor/ PI Name:		***Inspector Name:***	
Title:		***Inspector Title:***	
Department:		***Department:***	
Phone/E-mail:		***Phone/E-mail:***	

Refer to the ***Instructions for the Laboratory Safety Inspection Form*** for a more detailed description as to what to look for when checking each item.

S=Satisfactory **U=Unsatisfactory** **N=Not Applicable**

GENERAL SAFETY					**COMMENTS**
		S	**U**	**N**	
Door Signs					
1	Key lab personnel are identified.				
2	Hazard, access, and chemical information sections are completed.				
3	Information is current and applicable to the lab.				
General Laboratory Conditions					
1	Ventilation – air exchange adequate (4-12 per hour)				
2	Air flow is negative relative to corridor (lab is negative pressure)				
3	General conditions – temperature, humidity, CO, CO_2, VOCs				
4	Ceiling tiles are in place and/or ceiling in good condition.				
5	Surfaces – peeling paint, moisture, mold, ACBM				
6	Hand washing facilities adequate – soap, towels, waste containers				
7	Refrigerator/Freezers/microwaves posted *Not for Food Use / Not for Flammable Storage* (unless so designed)				
8	Potable water protected – no submerged inlets; backflow concerns				
Security					
9	Doors locked, lab secured whenever not occupied				
10	No unauthorized persons or unaccompanied visitors to the premises				
Housekeeping					
11	Lab door(s) and windows closed and able to be secured.				
12	View through door's window is unobstructed.				
13	Lab is clean, orderly, free of slip/trip or other hazards				
14	Aisles and exits are unobstructed.				
15	Work areas are uncluttered.				
16	Storage areas are uncluttered.				
17	No evidence of food or drink storage or consumption in lab				
18	Surfaces are clean and contaminant and dust-free				
19	Combustible materials minimized and stored properly				
20	Sink and floor drains are protected from chemical/biological spills				
Equipment and Furnishings					
21	Furniture is appropriately sturdy and in good condition.				
22	Furniture can be easily decontaminated.				
23	Equipment is unobstructed.				
24	Guards and other safety features are in place.				
25	Equipment is secured or on a stable surface.				
26	Auto shut-offs are on equipment.				
ELECTRICAL SAFETY					
1	Emergency cut-off switches are accessible.				
2	Electrical panels are accessible.				
Electrical Outlets					

Electrical Safety (continued)		S	U	N	
3	Outlets are not overloaded.				
4	GFCI outlets are present.				
Electrical Cords					
5	Electrical cords are clear of aisles, sinks and heat sources.				
6	Electrical cords are in good condition.				
Extension Cords					
7	Extension cords are used temporarily (less than 90 days).				
8	Extension cords are of 3-wire design, with ground plug intact.				
EMERGENCY EQUIPMENT AND SAFETY					
1	Emergency shutoffs for gas and utilities present and accessible				
2	Fire alarm pull stations are unobstructed.				
3	Stocked first aid kit is available.				
4	Stocked spill clean-up kit is available with correct absorbents.				
5	Extinguishers are correct type for the hazards present.				
6	Extinguishers are mounted to the wall or in extinguisher cabinet.				
7	Extinguisher visually apparent and access is unobstructed.				
8	Personnel trained in Extinguisher Use				
9	Safety Shower/Eyewash is unobstructed – within 50 feet.				
10	Safety Shower/Eyewash location identified by a highly visible sign.				
11	Eyewash is flushed weekly by lab staff.				
CHEMICAL SAFETY					
Flammables and Hazardous Materials					
1	Flammable liquids separated from oxidizers				
2	Flammable materials outside of safety cabinets kept to minimum (<10-gallons) and preferrably in safety cans.				
3	Spark-producing equipment is kept away from flammables.				
4	House vacuum is protected by traps/filters.				
5	Hazardous Material quantities conform to Fire Code exemptions				
6	Flammable and corrosive materials stored in safety cabinets				
Chemical Hygiene Plan (CHP) Compliance					
7	Current CHP is available in hard copy or electronic format.				
8	Lab-specific safety information (including SOPS) is included.				
9	Safety Data Sheets (SDSs) are available.				
10	Lab personnel and students are trained on the CHP, SOPs, SDSs, and emergency procedures.				
11	Chemical inventory is current and available or ChemTracker used.				
Personal Protective Equipment					
12	Eye/face protection is worn while in the lab.				
	Training provided in PPE use and limitations				
13	Lab coats or aprons are worn.				
14	Appropriate gloves are worn.				
15	Required respirator wearers have entered BSU Respiratory Protection Program – medical fitness, training, and fit-testing.				
	Voluntary respirator users contact EHS for information/training				
16	Specialized equipment provided (thermal, splash goggles, etc)				
Chemical Storage					
17	Chemicals are stored per compatibility.				
18	Outdated (>10 years), off-spec, or legacy chemicals not present				
19	Chemicals are stored in cabinets or stable shelving.				
20	Chemicals are stored in proper containers.				
21	Chemicals not stored on floors or unsafe shelving (no lips, weak)				
Chemical Containers					

Chemical Safety (continued)		S	U	N	
22	Containers are in good condition and compatible with contents.				
23	Primary container labels remain and legible				
24	Secondary containers properly labeled – identity & hazard warnings				
25	Containers are closed when not in use.				
26	Secondary containment used for liquids near drains / incompatibles.				
Particularly Hazardous Substances (carcinogens, reproductive toxins, high acute toxins)					
27	Identified, SOP created, training, designated areas established				
Gas Cylinders					
28	Gas cylinders are securely fastened to prevent tipping.				
29	Gas cylinder contents identified – labeled and capped when empty				
Peroxidizable Chemicals					
30	Peroxidizables are dated when opened/tested every six months				
Mercury Devices					
31	Mercury-containing devices have been replaced or removed.				
Chemical Fume Hoods					
32	Chemical fume hoods inspection label current				
33	Air flow into the hood is unobstructed.				
34	Alarms or flow gauges functioning properly				
35	Located to prevent turbulence (doors, vents, traffic, etc.)				
BIOLOGICAL SAFETY					
1	Functional sink is in laboratory space.				
2	Exterior windows are sealed shut				
3	Bio-safety cabinet(s)have been certified within the last year.				
4	Lab space can be easily decontaminated.				
5	Appropriate disinfectant and SOPs for material available in lab.				
6	Bench tops are made of an impervious material.				
7	Bench tops are resistant to chemicals and moderate heat.				
8	Biological Safety Cabinets certified annually. No flammables/toxics				
Biohazard Waste Containers (sharps and infectious waste)					
9	Containers are able to be closed – no more than ¾ full.				
10	Containers display the biohazard symbol.				
11	Containers are appropriate for transport to autoclave.				
12	Containers are closed when not in use.				
13	Sharps Disposal Containers are present– no more than ¾ full. .				
14	SOP, media or test sets and records of autoclave testing				
LABORATORY PRACTICES					
1	No evidence of food presence, eating, or drinking in the lab.				
2	Hands washed at appropriate times and when leaving laboratory				
3	Lab personnel/students wearing proper clothing – long pants/sleeves, closed shoes, no loose hair or jewelry				
4	Proper PPE available and being used properly for all tasks				
5	Lab personnel/students properly trained in the use of PPE				
6	Personnel/students trained in general lab safety				
7	Personnel/students know location of SDSs, SOPs for procedures				
8	Safe work practices observed by students and lab personnel				
9	Chemicals transported with secondary containment				
10	Laboratory PPE not worn outside of laboratory				
11	Cleaning/decontamination of work surfaces/equipment as needed				

Laboratory Practices (continued)		S	U	N	
12	Fume hoods and biosafety cabinets used properly				
WASTE MANAGEMENT					
1	All *LAB WASTE* containers labelled as such and label completed				
2	No *LAB WASTE* containers at or approaching 6 months from *start of accumulation* date				
3	Waste containers kept closed and compatible with contents				
4	Lab staff/students trained in BSU *Lab Waste Management Plan*				
5	Broken glass bench or floor container available				
6	Empty containers rinsed before disposal – triple rinsed with suitable solvent if acute or toxic material				
7	Aerosol cans completely emptied before disposal				
8	No injurious or infective materials disposed in regular trash				
OTHER REGULATORY PROGRAMS – Note or refer to appropriate Officer					
Radioactive Materials (NRC License) – refer to BSU Radiation Safety Officer (5-8066)					
1	All areas/containers with radioactive materials are identified with signs/labels.				
2	Material is secured when lab is unattended.				
3	Material is identified and shielded in the laboratory				
Lasers –refer to Laser Safety Officer (5-2807)					
4	Class IIIB or IV lasers are registered.				
5	SOPs for Class 3b and 4 laser use				
6	Operators trained in SOP and ANSI Laser Safety Standard				
X-Ray Equipment – refer to X-Ray Equipment Radiation Officer (5-2807)					
7	XRFs, TEMS, SEMS, etc. are registered,				
8	Dosimetry and records provided where needed				
9	Manufacturer or in-house training documented for all operators				
Controlled Substances – refer to Coordinator (5-2807)					
10	Researcher/Teaching Registration and Licenses (ISBP and DEA)				
11	*Scheduled Material* is secured – access limited to authorized users				
12	Required records and inventory maintained				
13	*Listed* DEA substances cleared through EHS Office and documented				
Hazardous Materials Shipping and Receiving – refer to Coordinator (5-2807)					
14	Persons shipping or receiving hazardous materials DOT trained				
15	Training and shipping records (manifests, shipping papers) available				
Plant Pest and Noxious Weed Control Program					
16	Compliance with USDS Animal & Plant Health Inspection Service Permit, shipping, and record-keeping				

Immediate Corrective Actions Needed:

Form 2-Operations Requiring Prior Approval

Operations Requiring Prior Approval

Using and storing certain chemicals may require prior approval. *Particularly Hazardous Chemicals* as defined in **Chapter 18.0** is one example.

The intent of this document is to ensure that the hazards associated with these compounds are thoroughly understood AND that every reasonable precaution is taken to protect the health and safety of those involved.

Use the Back of the sheet and/or attachments as necessary.

Name of Responsible Party_____ Date _____

Location of Operation _____

Types of materials requiring prior approval and amounts _____
_____
_____

Describe the available personal safety devices and engineering controls that will be used to minimize hazards while using and storing these materials i.e. fume hoods, glove hoods, exhaust systems, vacuum systems, etc.: _____
_____
_____
_____
_____
_____
_____
Print: _____ Title: _____
Approved _____ Date _____

Form 3-Job Hazard Assessment and PPE Recommendation

Job Hazard Assessment And
Personal Protective Equipment (PPE) Recommendation

All laboratory supervisors must survey the work areas and activities under their control to determine: what hazards exist, steps to take to minimize those hazards, and what PPE may be required.

Instructions: Identify the workplace location and the general nature of the task. Conduct a walkthrough survey of the workplace and list the task or job functions or pieces of equipment that are hazardous and/or require PPE. Consult the Safety Officer/CHO for assistance. Sign and date this assessment. Keep this form with your other safety and training records.

Please note: When determining if a potential hazard exists, consideration should also be given to the following: (1) history of injuries or illnesses related to the workplace or job; (2) history of employee complaints or concerns; and, (3) employees perception of hazards

Location _____ **Task Name** _____

Specific Tasks or Steps or Pieces of Equipment	Potential Hazard(s)	Methods to Reduce Hazard and Specific PPE Required
Attach additional sheets as necessary		

I, _____ , certify that the above location has been evaluated for potential hazards and the appropriate PPE, and that training has been performed.

Signature of Assessor_____

Title _____Date_____

25.0 DEPARTMENT FORMS RELATING TO THE CHP (CONTINUED)

Form 4- Training and Awareness Form (Sample)

Chemical Hygiene Awareness Training Certification

Training Date:_____Building and Room_____
Training or Topic:_____
Trainer and/or the training media used:_____
_____
Content or Outline of Topics Covered:_____
_____
_____
_____

Attendees:

Name (please print)	***Signature***

Make additional copies as necessary. Training records should be maintained for 3 years.

Training record affirmed by: _____ Title: _____

25.0 DEPARTMENT FORMS RELATING TO THE CHP (CONTINUED)

Form 5- Incident Report (Sample)

Incident Type:	***Page***	***of***	***Incident No.:***
Reported by:	***Office/Address:***	***Phone / email:***	
Date/Time of Incident:	***Date/Time Reported:***	***How Reported:***	
Exact Location of Incident:			
Person(s) Involved:	***Building/Room:***	***Phone / email:***	
Nature of Problem to be Investigated: ***Received by:***			
Findings and Response:			
Recommendation and/or Follow up:			
Investigator Signature / Printed name:	***Date:***	***Status:*** ☐ ***Active*** ☐ ***Suspended*** ☐ ***Cleared***	
Copies to: Name/Dept.:			

Form 6-Chemical Inventory

DEPARTMENT		CHEMICAL INVENTORY FORM BALL STATE UNIVERSITY MUNCIE, INDIANA 47306 (Screenshot of pdf-fillable form being developed and to be made available for completion and direct submittal)	ROOM NUMBER
PRINCIPAL INVESTIGATOR/LAB SUPERVISOR	BSU (email)		BUILDING
OFFICE PHONE NUMBER	LAB PHONE NUMBER		DATE (MM/DD/YYYY) / UPDATED ON: (MM/DD/YYYY)

CHEMICAL NAME (Common Name)	CAS NUMBER	MANUFACTURER (Company)	MSDS ON FILE?		QUANTITY			N.F.P.A. RATING (http://www.hazmat.msu.edu:591/nfpa/)				PHYSICAL OR HEALTH HAZARD	PARTIC. HAZARDOUS SUBSTANCE	
			Yes	No	Container Size (L, lbs)	Number of Containers	Total Quantity (L, g, kg, lbs)	H	F	R	S		Yes	No
EXAMPLE: *BENZENE (CHROMASOLV)*	*71-43-2*	*ALDRICH*	*X*		*1 L*	*3*	*3 L*	*2*	*3*	*0*	*-*	*Flammable, Toxic, Carcinogen, Reproductive Toxin*	*X*	

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Submit/Email to EH&S

[Note: a new PDF-fillable form is being developed to allow direct web submittal]

Completed forms should be filed or referenced in chapter 29 of this Plan

26.0 STANDARD OPERATING PROCEDURES

26.1 GENERIC SOPs

SOP 1: Standard Operating Procedure for Flammable Liquids

SOP 2: Standard Operating Procedure for Corrosive Chemicals

SOP 3: Standard Operating Procedure for Water Reactive Chemicals

SOP 4: Standard Operating Procedure for Pyrophoric Chemicals

SOP 5: Standard Operating Procedure for Reactive Liquids

SOP 6: Standard Operating Procedure for Reactive Solids

SOP 7: Standard Operating Procedure for Compressed Gases

SOP 8: Standard Operating Procedure for Oxidizing Chemicals

SOP 9: Standard Operating Procedure for Carcinogens

SOP 10: Standard Operating Procedure for Reproductive Toxins

SOP 11: Standard Operating Procedure for Acutely Toxic Chemicals

SOP 12: Standard Operating Procedure for Acutely Toxic Gases

SOP 13: Standard Operating Procedure for Handling Acid Solutions

Flammable Liquids

Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the Principal Investigator.

Flammable liquids are chemicals that have a flash point below 100^{o}F (38.7^{o} C) and a vapor pressure that does not exceed 40 psig at 100^{o}F.

Securing of gas cylinders

Not applicable

Decontamination procedures

Personnel: Wash hands and arms with soap and water immediately following any skin contact with flammable liquids.

Designated area

Not applicable

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed. The procedures should address as a minimum the following:

- Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)
- The location of all safety equipment (showers, spill cleanup supplies, eye wash, fire extinguishers, etc.)
- The method used to alert personnel in nearby areas of potential hazards
- Special first aid treatment required by the type of corrosive material(s) handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling flammable liquids. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to flammable liquids suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

When possible experiments involving greater than 500 mL of flammable liquids should be carried out in a fume hood.

Glove (dry) box

Not applicable

Gloves

Gloves should be worn when handling flammable liquids. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact EHS for advice on chemical resistant glove selection when direct or

prolonged contact with hazardous chemicals is anticipated.

Hazard assessment

Hazard assessment for work involving flammable liquids should thoroughly address the issues of proper use and handling, fire safety, chemical toxicity, storage, and spill response.

OEHS Notification

Not applicable

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling flammable liquids. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of flammable liquids which pose this risk should occur in a fume hood with the sash in the lowest effective position. Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the flammable liquids are used.

Signs and labels

Containers: All flammable liquids must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable. The containers should also bear a “flammable liquid” label.

Special storage

The storage of flammable and combustible liquids in a laboratory, shop or building area must be kept to the minimum needed for research and/or operations. If more than 5 gallons of flammables are present outside of safety cans per 100 square feet of area, a flammable-liquids storage cabinet is required. Flammable-liquids storage cabinets are not intended for the storage of highly toxic materials, acids, bases, compressed gases or pyrolytic chemicals.

Where feasible (if the quality of the solvent will not be adversely affected) transfer flammable liquids from glass bottles into metal safety cans.

Special ventilation

Manipulation of flammable liquids outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to flammable liquids in the laboratory and are the preferred ventilation control device. Always attempt to handle large quantities of flammable liquids in a fume hood. If your study does not permit the handing of large quantities of flammable liquids in your fume hood, contact the Office of Environmental Health and Safety to review the adequacy of all special ventilation.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any flammable liquids. Spill supplies for flammable liquids are designed to control the liquid portion of the spill and minimize the production of flammable vapors. Never use paper towels on large spills of flammable liquids because it exacerbates vapor production.

In the event of a spill all personnel in the area should be alerted. Turn off all sources of ignition. Do not attempt to handle a large spill of flammable liquids. Vacate the laboratory immediately and call for assistance:

Call University Police (28)5-1111 or 911 - they will notify the necessary agencies.

Office of Environmental Health & Safety (28)5-2807

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving flammable liquids must be conducted in a fume hood, glove box or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood. Vacuum pumps should be rated for use with flammable liquids.

Waste disposal

Most flammable liquids are hazardous wastes when they are spent or to be discarded. Questions regarding waste disposal should be directed to the Office of Environmental Health and Safety.

Corrosive Chemicals - Acids, Bases and Dehydrating Agents

Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

Corrosive chemicals are substances that cause visible destruction or permanent changes in human skin tissue at the site of contact, or are highly corrosive to steel. The major classes of corrosives include strong acids, bases, and dehydrating agents.

Securing of gas cylinders

Not applicable

Decontamination procedures

- Personnel: Immediately flush contaminated area with copious amounts of water after contact with corrosive materials. Remove any jewelry to facilitate removal of chemicals. If a delayed response is noted report immediately for medical attention. Be prepared to detail what chemicals were involved.
- **If the incident involves Hydrofluoric acid (HF), seek immediate medical attention.**
- If there is any doubt about the severity of the injury, seek immediate medical attention.
- Area: Decontamination procedures vary depending on the material being handled. The corrosivity of some materials can be neutralized with other reagents. Special neutralizing agents should be on hand to decontaminate areas.

Designated area

Not applicable

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed for corrosives due to their variety and often opposing neutralization requirements. The procedures should address as a minimum the following:

- Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)
- The location of all safety equipment (showers, spill clean up supplies, eye wash, fire extinguishers, etc.)
- The method used to alert personnel in nearby areas of potential hazards
- Special first aid treatment required by the type of corrosive material(s) handled in the laboratory
- The methods and substances to neutralize the corrosive material. Normally, both acidic and basic neutralizing / absorption materials should be available.

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling corrosive materials. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of thePracticefor Occupational and Educational Eyeand Face Protection (ANSI Z.87. 1 1989)and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn. It is recommended that face shields be worn when a splash potential exists with corrosive materials.

Eyewash

Where the eyes or body of any person may be exposed to corrosive chemicals, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Manipulation of corrosive substances should be carried out in a fume hood if corrosive vapor production is anticipated.

Glove (dry) box

Not applicable

Gloves

Gloves should be worn when handling corrosive chemicals. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.

Hazard assessment

Hazard assessment should include instruction on proper use and handling; spill control; and splash protection.

OEHS Notification

Not applicable

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling corrosive materials. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of corrosive materials which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the corrosive materials is used.

Signs and labels

Containers: All corrosive chemical must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable. The containers should also be labeled as “Corrosive”.

Special storage

Segregate the various types of corrosives. Separate acids and bases. Liquids and solids should also be separated. Specially designed corrosion resistant cabinets should be used for the storage of large quantities of corrosive materials. Store corrosives on plastic trays. Do not store corrosive materials on high cabinets or shelves.

Special ventilation

Manipulation of some corrosive materials outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to corrosive materials in the laboratory and are the preferred ventilation control device.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any corrosive chemical. Corrosive spill controls neutralize the hazardous nature of the spilled material. Acids and bases require different types of spill control materials. Hydrofluoric acid may require specific neutralization and absorption materials.

In the event of a significant spill all personnel in the area should be alerted. Do not attempt to handle a large spill of corrosive materials. Vacate the laboratory immediately and call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Not applicable

Waste disposal

Most corrosive materials are hazardous wastes when disposed. Questions regarding waste disposal should be directed to the Office of Environmental Health and Safety at (28)5-2807.

Water Sensitive Chemicals

Generic Laboratory Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the principal investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Safety is available to provide guidance during the development of alternate procedures.

Water sensitive chemicals are chemicals that react vigorously with moisture. The most common water sensitive chemicals include sodium, potassium, lithium metals and aluminum alkyls. These, and others, are listed below:

Alkali metals, such as Na, Li, K
Alkali metal hydrides, such as LiH, CaH2, LiAlH4, NaBH4, alkali metal amides, such as NaNH2
Metal alkyls, such as lithium and aluminum alkyls
Grignard reagents, RMgX
Halides of nonmetals, such as BCl3, BF3, PCl3, PCl5, SiCl4, S2Cl2
Inorganic acid halides, such as POCl3, SOCl2, SO2Cl2
Anhydrous metal halides, such as AlCl3, TiCl4, ZrCl4, SnCl4
Phosphorus pentoxide
Calcium carbide
Organic acid halides and anhydrides of low molecular weight, such as, acetylchloride acetic acid anhydride.

Securing of gas cylinders

Not applicable

Decontamination procedures

- Personnel: Wash hands and arms with soap and water immediately after handling water sensitive chemicals.
- Area: Carefully clean work area after use.

Designated area

Not applicable

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed The procedures should address as a minimum the following:

- Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)
- The location of all safety equipment (showers, spill equipment, eye wash, fire extinguishers, etc.)
- The location and quantity of all water sensitive chemicals in the laboratory
- The method used to alert personnel in nearby areas of potential hazards
- Special first aid treatment required by the type of water sensitive chemicals handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling water sensitive chemicals. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the American Standard Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to water sensitive chemicals, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Many water sensitive chemicals will liberate hydrogen when they react with water. The use of a fume hood is recommended to prevent the buildup of combustible gases.

Glove (dry) box

A glove box may be used to handle water sensitive chemicals when a dry atmosphere is required.

Gloves

Gloves should be worn when handling water sensitive chemicals. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.

Hazard assessment

Hazard assessment of work involving water sensitive chemicals should address proper use and handling techniques, fire safety (including the need for Class D fire extinguishers), storage, water reactivity, and waste disposal issues.

OEHS Notification

Not Applicable

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling water sensitive chemicals. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of water sensitive chemicals which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the water sensitive chemicals is used.

Signs and labels

Containers: All water reactive chemicals chemical must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Special storage

Water sensitive chemicals should be stored in a cool and dry location. Keep water sensitive chemicals segregated from all other chemicals in the laboratory. Minimize the quantities of water sensitive chemicals stored in the laboratory.

Date all containers upon receipt. Potassium will form peroxides and superoxides when stored under oil at room temperature. Examine storage containers frequently. Dispose of any container that exhibits salt build up on its exterior. Dispose of all water sensitive chemicals whenever they are no longer required for current research.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container which may cause a fire or explosion.

Special ventilation

Special ventilation is required if these materials are used outside of a fume hood. If your research does not permit the handing of water sensitive chemicals in a fume hood you must contact the Office of Environmental Health and Safety to review the adequacy of all special ventilation.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any water sensitive chemicals. Spill control materials for water sensitive chemicals are designed to be inert and will not react with the reagent. Do not put water on the spill.

In the event of a spill alert personnel in the area that a spill has occurred. Do not attempt to handle a large spill of water sensitive chemicals. Turn off all ignition sources and vacate the laboratory immediately. Call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Not applicable

Waste disposal

All materials contaminated with water sensitive chemicals should be disposed of as hazardous waste. Alert the Office of Environmental Health and Safety if you generate wastes contaminated by water sensitive chemicals. These wastes may pose a flammability risk and should not remain in the laboratory overnight.

Pyrophoric Chemicals

Generic Laboratory Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the principal investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Safety is available to provide guidance during the development of alternate procedures.

Pyrophoric chemicals are liquids and solids that will ignite spontaneously in air at about 130 ^{o}F. Titanium dichloride and phosphorus are examples of pyrophoric solids; tributylaluminum and related compounds are examples of pyrophoric liquids. Generally, pyrophoric chemicals include the following:

Grignard reagents, RMgX

Metal alkyls and aryls, such as RLi, RNa, R3Al, R2Zn

Metal carbonyls, such as Ni(CO)4, Fe(CO)5, Co2(CO)8

Alkali metals such as Na, K

Metal powders, such as Al, Co, Fe, Mg, Mn, Pd, Pt, Ti, Sn, Zn, Zr

Metal hydrides, such as NaH, LiAlH4

Nonmetal hydrides, such as B2H6 and other boranes, PH3, AsH3

Nonmetal alkyls, such as R3B, R3P, R3As

Phosphorus (white)

Securing of gas cylinders

Not applicable

Decontamination procedures

Personnel: Wash hands and arms with soap and water immediately following any skin contact with pyrophoric chemicals.

Designated area

Not applicable

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed The procedures should address as a minimum the following:

- Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)
- The location of all safety equipment (showers, eye wash, fire extinguishers, etc.)
- The method used to alert personnel in nearby areas of potential hazards
- Special spill control materials required by the type of pyrophoric chemicals handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling pyrophoric chemicals. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of
the Practice for Occupational and EducationalEye and FaceProtection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to pyrophoric chemicals, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Many pyrophoric chemicals release noxious or flammable gases and should be handled in a hood. In addition some pyrophoric materials are stored under kerosene (or other flammable solvents), therefore the use of a fume hood is required to prevent the release of flammable vapors in the laboratory. Glove boxes may be also be used (see special ventilation).

Glove (dry) box

Glove boxes may be used to handle pyrophoric chemicals if inert or dry atmospheres are required.

Gloves

Gloves should be worn when handling pyrophoric chemicals. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated. Refer also to the “Glove Compatibility” section of the BSU CHP.

Hazard assessment

Hazard assessment for work involving pyrophoric chemicals should thoroughly address the issue of fire safety (including the need for Class D fire extinguishers), proper use and handling techniques, chemical toxicity, storage, and spill response.

OEHS Notification

Not applicable

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling pyrophoric chemicals. Additional protective clothing should be wrn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of pyrophoric chemicals which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the pyrophoric chemicals are used.

Signs and labels

Containers: All pyrophoric chemicals must be clearly labelled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Special storage

Pyrophoric chemicals should be stored under an atmosphere of inert gas or under kerosene as appropriate. Do not store pyrophoric chemicals with flammable materials or in a flammable-liquids storage cabinet. Store these materials away from sources of ignition. Minimize the quantities of pyrophoric chemicals stored in the laboratory.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container which may cause a fire or explosion.

Special ventilation

Always attempt to handle pyrophoric chemicals in a fume hood or glove box. If your research does not permit the handing of pyrophoric chemicals in a fume hood or glove box you must contact the Office of Environmental Health and Safety to review the adequacy of all special ventilation.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any pyrophoric chemicals. Spill control materials for pyrophoric chemicals are designed to be inert and will not react with the reagent.

In the event of a spill alert personnel in the area that a spill has occurred. Do not attempt to handle a large spill of pyrophoric chemicals. Turn off all ignition sources and vacate the laboratory immediately. Call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving pyrophoric chemicals must be conducted in a fume hood or isolated in an acceptable manner. Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood. Vacuum pumps should be rated for use with pyrophoric chemicals.

Waste disposal

All materials containing or significantly contaminated with pyrophoric chemicals should be disposed of as hazardous waste. Alert the Office of Environmental Health and Safety if you generate wastes contaminated with pyrophoric chemicals. These wastes may pose a flammability risk and should not remain in the laboratory overnight.

Reactive Liquids

Generic Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the principal investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Safety is available to provide guidance during the development of alternate procedures.

Reactive liquids are chemicals that react vigorously with moisture or oxygen or other substances.

Securing of gas cylinders

Not applicable

Decontamination procedures

- Personnel: Wash hands and arms with soap and water immediately after handling reactive liquids.
- Area: Carefully clean work area after use.
- Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

Designated area

Not applicable

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of signs and symptoms of overexposure must be developed. The procedures should address as a minimum the following:

- Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)
- The location of all safety equipment (showers, spill equipment, eye wash, fire extinguishers, etc.
- The location and quantity of all reactive liquids in the laboratory
- The method used to alert personnel in nearby areas of potential hazard
- Special first aid treatment required by the type of reactive liquids handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling reactive liquids. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the Practice for Occupational and EducationalEyeand Face Protection (ANSI Z.87.1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to reactive liquids, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Many reactive liquids will ignite or liberate combustible gas when exposed to water vapor or air. The use of a fume hood is recommended to prevent the buildup of flammable gases.

Glove (dry) box

A glove box may be used to handle reactive liquids if an inert or dry atmosphere is required.

Gloves

Gloves should be worn when handling reactive liquids. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated. Consult the “glove compatibility” section of the BSU Laboratory CHP.

Hazard assessment

Hazard assessment of work involving reactive liquids should address proper use and handling techniques, fire safety (including the need for Class D fire extinguishers), storage, the specific reactive nature of the material (such as water and air reactivity), and waste disposal issues.

OEHS Notification

Not applicable

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling reactive liquids. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of reactive liquids that pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the reactive liquids are used.

Signs and labels

Containers: All reactive liquids must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Special storage

Reactive liquids should be stored in a cool and dry location. Keep reactive liquids segregated from all other chemicals in the laboratory. Minimize the quantities of reactive liquids stored in the laboratory.

Date all containers upon receipt. Examine storage containers frequently. Dispose of any container that exhibits salt build up on its exterior. Dispose of all reactive liquids whenever they are no longer required for current research.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container that may cause a fire or explosion.

Special ventilation

Special ventilation may be required if these materials are used outside a fume hood. If your research does not permit the handing of reactive liquids in a fume hood you must contact the Office of Environmental Health and Safety to review the adequacy of all special ventilation.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any reactive liquids. Spill control materials for reactive liquids are designed to be inert and will not react with the reagent.

In the event of a spill alert personnel in the area that a spill has occurred. Do not attempt to handle a spill of reactive liquids. Turn off all ignition sources and vacate the laboratory immediately. Call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Not applicable

Waste disposal

All materials containing or significantly contaminated with reactive liquids should be disposed of as hazardous waste. Alert the Office of Environmental Health and Safety if you generate wastes contaminated by reactive liquids. These wastes may pose a flammability risk and should not remain in the laboratory overnight.

Reactive Solids

Generic Laboratory Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the principal investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Safety is available to provide guidance during the development of alternate procedures.

Reactive solids are chemicals that react vigorously with moisture and other substances. The most common reactive solids include sodium, potassium and lithium metals; acid anhydrides and acid chlorides.

Securing of gas cylinders

Not applicable

Decontamination procedures

- Personnel: Wash hands and arms with soap and water immediately after handling reactive solids.
- Area: Carefully clean work area after use.

Designated area

Not applicable

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed The procedures should address as a minimum the following:

- Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)
- The location of all safety equipment (showers, spill equipment, eye wash, fire extinguishers, etc.)
- The location and quantity of all reactive solids in the laboratory
- The method used to alert personnel in nearby areas of potential hazards
- Special first aid treatment required by the type of reactive solids material(s) handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling reactive solids. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the PracticeforOccupational and Educational Eyeand FaceProtection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to reactive solids, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Many reactive solids will liberate hydrogen when they react with water. The use of a fume hood is recommended to prevent the buildup of combustible gases.

Glove (dry) box

Glove boxes may be used to handle reactive solids if inert or dry atmospheres are required.

Gloves

Gloves should be worn when handling reactive solids. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated. Refer to the “Glove Compatibility” guide in the BSU CHP.

Hazard assessment

Hazard assessment of work involving reactive solids should address proper use and handling techniques, fire safety (including the need for Class D fire extinguishers), storage, potential peroxide formation, water and air reactivity, and waste disposal issues.

OEHS Notification

Not applicable.

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling reactive solids. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of reactive solids which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the reactive solids are used.

Signs and labels

Containers: All reactive solids must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Special storage

Reactive solids should be stored in a cool and dry location. Keep reactive solids segregated from all other chemicals in the laboratory. Minimize the quantities of reactive solids stored in the laboratory.

Date all containers upon receipt. Potassium will form peroxides and superoxides when stored under oil at room temperature. Examine storage containers frequently. Dispose of any container that exhibits salt build up on its exterior. Dispose of all reactive solids whenever they are no longer required for current research.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container which may cause a fire or explosion.

Special ventilation

Special ventilation is required if these materials are used outside of a fume hood or glove box. If your research does not permit the handing of reactive solids in a fume hood or glove box you must contact the

Office of Environmental Health and Safety to review the adequacy of all special ventilation.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any reactive solids chemical. Spill control materials for reactive solids are designed to be inert and will not react with the reagent.

In the event of a spill, alert personnel in the area that a spill has occurred. Do not attempt to handle a spill of reactive solids. Turn off all ignition sources and vacate the laboratory immediately. Call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive. In the event of a spill alert personnel in the area that a spill has occurred. Do not attempt to handle a large spill of reactive solids. Turn off all ignition sources and vacate immediately. Call for assistance.

Compressed Gases

Generic Laboratory Standard Operating Procedures

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2507) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator. Additional requirements may apply if the material is an acutely toxic compressed gas. Please refer to the SOP for acutely toxic gases if applicable.

Securing of gas cylinders

Cylinders of compressed gases must be handled as high energy sources. They pose a serious hazard if the cylinder valve is dislodged. When storing or moving a cylinder, have the cap securely in place to protect the stem. Use suitable racks, straps, chains or stands to support cylinders. Empty cylinders must have the cap replaced. Incompatible materials must be segregated.

Do not store cylinders or lecture bottles with the regulator in place. If the regulator fails, the entire contents of the gas cylinder may be discharged.

Decontamination procedures

Not Applicable

Designated area

Compressed gas cylinders which contain acutely toxic gases must be stored in a designated area. See the SOP for acutely toxic compressed gases.

Emergency Procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptoms of overexposure must be developed The procedures should address as a minimum the following:

Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)

The location of all safety equipment (showers, eye wash, fire extinguishers, etc.)

The method used to alert personnel in nearby areas of potential hazards

Special first aid treatment required by the type of compressed gas handled in the laboratory

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Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling compressed gases. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of thePracticefor Occupational and Educational Eyeand Face Protection (ANSI Z.87. 1 1989)and must be equipped with side shields.

Eyewash

Not applicable.

Fume hood

Manipulation of compressed gases should typically be carried out in a fume hood if the compressed gas is an irritant, oxidizer, asphyxiant, or has other hazardous properties.

Glove (dry) box

Not applicable

Gloves

Not applicable

Hazard assessment

Hazard assessment for work with compressed gases should assure that all staff understand proper use and handling precautions; that all pressurized equipment is properly shielded; regulators are not interchanged between different gas types; all hose connections are properly secured and are appropriate for the pressure(s) used.

OEHS Notification

Not applicable

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling compressed gases.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of compressed gases which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants are acceptable.

Safety shower

Not applicable

Signs and labels

Containers: All compressed gases must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable. The compressed gas cylinder should also be labeled to indicate if the container is full or empty. Hazard labels should be clearly affixed to the cylinders to indicate the hazard class(es) of the contained gas.

Special storage

Cylinders should be stored in an upright position and secured to a wall or laboratory bench through the use of chains or straps. Cylinder caps should remain on the cylinder at all times unless a regulator is in place. Cylinders should be stored in areas where they will not become overheated. Avoid storage near radiators, areas in direct sunlight, steam pipes and heat releasing equipment such as sterilizers.

Transport compressed gas cylinders on equipment designed for this function. Never carry or "walk" cylinders by hand.

Special ventilation

Manipulation of compressed gas that is an irritant, oxidizer, asphyxiant, or has other hazardous properties outside of a fume hood may require special ventilation controls in order to minimize exposure to the

material. Fume hoods provide the best protection against exposure to compressed gases in the laboratory and are the preferred ventilation control device. If you have questions contact the Office of Environmental Health and Safety to review the adequacy of all special ventilation.

Spill response

In the event of a spill of a compressed gas that is an irritant, oxidizer, asphyxiant, or has other hazardous properties all personnel in the area should be alerted. Vacate the laboratory immediately and call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel. *Office of Environmental Health & Safety* (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Not applicable

Waste disposal

All empty or partially filled compressed gas cylinders should be returned to the supplier. If the supplier does not accept empty or partially filled cylinders, contact the Office of Environmental Health and Safety concerning disposal.

Oxidizing Chemicals

Generic Laboratory Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

Oxidizing chemicals are materials that spontaneously evolve oxygen at room temperature or with slight heating or promote combustion. This class of chemicals includes peroxides, chlorates, perchlorates, nitrates, and permanganates. Strong oxidizers are capable of forming explosive mixtures when mixed with combustible, organic or easily oxidized materials. Examples of strong oxidizers are listed at the end of this SOP.

Securing of gas cylinders

Not applicable

Decontamination procedures

- Personnel: Wash hands and arms with soap and water immediately after handling oxidizing chemicals.
- Area: Carefully clean work area after use. Paper towels or similar materials contaminated with strong oxidizing chemicals may pose a fire risk.

Designated area

Not applicable

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed The procedures should address as a minimum the following:

Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)

- The location of all safety equipment (showers, spill equipment, eye wash, fire extinguishers, etc.)
- The method used to alert personnel in nearby areas of potential hazards
- Special first aid treatment required by the type of oxidizing chemicals material(s) handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling oxidizing chemicals. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the Practice for Occupational and EducationalEyeand Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to oxidizing chemicals, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

The use of certain concentrations of perchloric acid must be performed in a fume hood equipped with wash down facilities. Contact the Office of Environmental Health and Safety for fume hood requirements.

Glove (dry) box

Not applicable.

Gloves

Gloves should be worn when handling oxidizing chemicals. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.

Hazard assessment

Hazard assessment should address proper use and handling techniques, fire safety, storage, and waste disposal issues.

OEHS Notification

You should notify the Office of Environmental Health and Safety prior to the initial use of the following oxidizers: perchloric acid.

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling oxidizing chemicals. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of oxidizing chemicals which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the oxidizing chemicals are used.

Signs and labels

Containers: All oxidizing chemicals must be clearly labelled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable. The “Oxidizer” label should be applied to the container.

Special storage

Oxidizers should be stored in a cool and dry location. Keep oxidizers segregated from all other chemicals in the laboratory. Minimize the quantities of strong oxidizers stored in the laboratory.

Never return excess chemicals to the original container. Small amounts of impurities may be introduced into the container which may cause a fire or explosion.

Special ventilation

The use of certain concentrations of perchloric acid must be performed in a fume hood equipped with wash down facilities. Contact the Office of Environmental Health and Safety for fume hood requirements.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any oxidizing chemicals. Spill control materials for oxidizers are designed to be inert and will not react with the reagent. Never use paper towels or other inappropriate materials which are combustible. The waste materials generated during spill cleanup may pose a flammability risk and should not remain in the laboratory overnight unless it is stored in an appropriate container.

In the event of a spill. Alert personnel in the area that a spill has occurred. Do not attempt to handle a large spill of oxidizing chemicals. Extinguish all flames and ignition sources and relocate any ignitable, flammable, and combustible materials from the spill area. Vacate the laboratory immediately and call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving oxidizing chemicals must be conducted in a fume hood, glove box or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

Waste disposal

All materials contaminated with oxidizing chemicals pose a fire hazard and should be disposed of as hazardous waste. Alert the Office of Environmental Health and Safety if you generate wastes contaminated by oxidizers. Do not let contaminated wastes remain in the laboratory overnight unless proper containers are provided.

Examples of strong oxidizers

- Ammonium perchlorate
- Ammonium permanganate
- Barium peroxide
- Bromine
- Calcium chlorate
- Calcium hypochlorite
- Chlorine trifluoride
- Chromium anhydride
- Chromic acid
- Dibenzoyl peroxide
- Fluorine
- Hydrogen peroxide
- Magnesium peroxide
- Nitrogen trioxide
- Perchloric acid
- Potassium bromate
- Potassium chlorate
- Potassium peroxide
- Propyl nitrate
- Sodium chlorate
- Sodium chlorite
- Sodium perchlorate
- Sodium peroxide

Source: CRC Handbook of Laboratory Safety, 3rd edition.

Carcinogens

Generic Laboratory Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the principal investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Safety is available to provide guidance during the development of alternate procedures.

A carcinogen commonly describes any agent that can initiate or speed the development of malignant or potentially malignant tumors, malignant neoplastic proliferation of cells, or cells that possess such material. A list of carcinogenic materials is found in the BSU CHP.

Securing of gas cylinders

Not applicable

Decontamination procedures

- Personnel: Wash hands and arms with soap and water immediately after handling carcinogens.
- Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.
- Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

Designated area

The room sign for the laboratory must contain a '*Designated Areas Within'* identifier.
All locations within the laboratory where carcinogens are handled should be demarcated with designated area caution tape (available from OEHS) and/or posted with designated area caution signs. This includes all fume hoods and bench tops where the carcinogens are handled.

Where feasible, carcinogens should be manipulated over plastic-backed disposable paper work surfaces. These disposable work surfaces minimize work area contamination and simplify clean up.

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed. The procedures should address as a minimum the following:

Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)

- The location of all safety equipment (showers, eye wash, fire extinguishers, etc.)
- The method used to alert personnel in nearby areas of potential hazards
- Special first aid treatment required by the type of carcinogens handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling carcinogens. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the Practice for Occupational and EducationalEyeand Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to carcinogens, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Manipulation of carcinogens should be carried out in a fume hood. If the use of a fume hood proves impractical refer to the section on special ventilation.

All areas where carcinogens are stored or manipulated must be labeled as a designated area.

Glove (dry) box

Certain carcinogens must be handled in a glove box rather than a fume hood. The Office of Environmental Health and Safety (5-2807) or the Principal Investigator will determine if this is required.

Gloves

Gloves should be worn when handling carcinogens. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.

Hazard assessment

Hazard assessment should focus on proper use and handling techniques, education of laboratory workers concerning the health risks posed by carcinogens, and the demarcation of designated areas.

OEHS Notification

You should notify the Office of Environmental Health and Safety prior to the initial use of carcinogens. Use the form available from OHES 285-2807 for this purpose. Notification is also required following

significant changes in procedures or the quantity of materials used.

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling carcinogens. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of carcinogens which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the carcinogens are used.

Signs and labels

Signage is required in carcinogen use areas:

- Doorways: The room sign must contain a *Designated Area Within Caution* where carcinogens, reproductive hazards, and/or acutely toxic chemicals are stored or used.
- Containers: All containers of carcinogens must be clearly labelled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Special storage

Carcinogens must be stored in a designated area.

Special ventilation

Manipulation of carcinogens outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to carcinogens in the laboratory and are the preferred ventilation control device. When possible, handle carcinogens in a fume hood. If the use of a fume hood proves impractical, attempt to work in a glove box or on an isolated area on the bench top.

If available, consider using a Biological Safety Cabinet. The biological safety cabinet is designed to remove particulates (the carcinogen) before the air is discharged into the environment. Carcinogens that are volatile must not be used in a biological safety cabinet unless the cabinet is vented to the outdoors.

If your research does not permit the handling of carcinogens in a fume hood, biological safety cabinet, or glove box, you must contact the Office of Environmental Health and Safety. All areas where carcinogens are stored or manipulated must be labeled as a designated area.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any carcinogen.

In the event of a spill alert personnel in the area that a spill has occurred. Do not attempt to handle a large spill of carcinogenic material. Vacate the laboratory immediately and call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-2807 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving carcinogens must be conducted in a fume hood, glove box or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

Waste disposal

All materials contaminated with carcinogens may need to be disposed of as hazardous waste. Characterization of the waste should be carefully completed. Wherever possible, design research in a manner that reduces the quantity of waste generated. Questions regarding waste pick up should be directed to the Office of Environmental Health and Safety.

Reproductive Toxin Hazards

Generic Laboratory Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the principal investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Safety is available to provide guidance during the development of alternate procedures.

Reproductive hazards are substances which affect the reproductive capabilities including chromosomal damage (mutagens) and effects on the fetus (teratogens). A list of reproductive hazards is included in the BSU Chemical Hygiene Plan.

Securing of gas cylinders

Not applicable

Decontamination procedures

- Personnel: Wash hands and arms with soap and water immediately after handling reproductive hazards.
- Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as hazardous waste.
- Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

Designated area

The room sign for the laboratory must contain a "***Designated Areas Within"*** identifier.

All locations within the laboratory where reproductive hazards are handled should be demarcated with designated area caution tape (available from OHES 295-2807) and/or posted with designated area caution signs. This includes all fume hoods and bench tops where the reproductive hazards are handled.

Where feasible, reproductive hazards should be manipulated over plastic-backed disposable paper work surfaces. These disposable work surfaces minimize work area contamination and simplify clean up.

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed. The procedures should address as a minimum the following:

- Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)
- The location of all safety equipment (showers, eye wash, fire extinguishers, etc.)
- The method used to alert personnel in nearby areas of potential hazards
- The location and quantity of all reproductive hazards stored in the laboratory
- Special first aid treatment required by the type of reproductive hazards handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling reproductive hazards. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the American Standard Practice forOccupationaland EducationalEye andFace Protection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for a splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to reproductive hazards, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Manipulation of reproductive hazards should be carried out in a fume hood. If the use of a fume hood proves impractical refer to the section on special ventilation.

All areas where reproductive hazards are stored or manipulated must be labeled as a designated area.

Glove (dry) box

Certain reproductive hazards must be handled in a glove box rather than a fume hood. The Office of Environmental Health and Safety or the Principal Investigator will determine if this is required.

Gloves

Gloves should be worn when handling reproductive hazards. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.

Hazard assessment

Hazard assessment should focus on proper handling techniques, education of laboratory workers concerning the health risks posed by reproductive hazards, and the demarcation of designated areas.

OEHS Notification

You should notify the Office of Environmental Health and Safety prior to the initial use of reproductive hazards. Notification is also required following significant changes in procedures or the quantity of

materials used.

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling reproductive hazards. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of reproductive hazards which pose this risk should be performed in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the reproductive hazards are used.

Signs and labels

Doorways: The room sign must contain a *Designated Area Within Caution* where carcinogens, reproductive hazards, and/or acutely toxic chemicals are stored or used.

Containers: All containers of reproductive hazards must be clearly labeled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable.

Special storage

Reproductive hazards must be stored in a designated area.

Special ventilation

Manipulation of reproductive hazards outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to reproductive hazards in the laboratory and are the preferred ventilation control device. When possible, handle reproductive hazards in a fume hood. If the use of a fume hood proves impractical attempt to work in a glove box or on an isolated area of the bench top.

If available, consider using a Biological Safety Cabinet. The biological safety cabinet is designed to remove particulates (the reproductive hazard) before the air is discharged into the environment. Reproductive hazards that are volatile must not be used in a biological safety cabinet unless the cabinet is vented to the outdoors.

If your research does not permit the handing of reproductive hazards in a fume hood, biological safety cabinet, or glove box, you must contact the Office of Environmental Health and Safety.

All areas where reproductive hazards are stored or manipulated must be labeled as a designated area.

Spill response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any reproductive hazard.

In the event of a spill alert personnel in the area that a spill has occurred. Do not attempt to handle a spill of reproductive hazards. Vacate the laboratory immediately and call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving reproductive hazards must be conducted in a fume hood, glove box or isolated in an acceptable manner. Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered

to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

Waste disposal

All materials contaminated with reproductive hazards may need to be disposed of as a hazardous waste. Wherever possible, design research in a manner that reduces the quantity of waste generated. Questions regarding waste pick up should be directed to the Office of Environmental Health and Safety.

Acutely Toxic Chemicals

Generic Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure contact the Office of Environmental Health and Safety (295-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the principal investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the principal investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Safety is available to provide guidance during the development of alternate procedures.

A partial list of acutely toxic chemicals is included in of the BSU Chemical Hygiene Plan.

Securing of gas cylinders

Not applicable

Decontamination procedures

Personnel: Wash hands and arms with soap and water immediately after handling acutely toxic chemicals.

Area: Decontamination procedures vary depending on the material being handled. The toxicity of some materials can be neutralized with other reagents. All surfaces should be wiped with the appropriate cleaning agent following dispensing or handling. Waste materials generated should be treated as a hazardous waste.

Equipment: Decontaminate vacuum pumps or other contaminated equipment (glassware) before removing them from the designated area.

Designated area

The room sign for the laboratory must contain a "***Designated Areas Within"*** identifier.

All locations within the laboratory where acutely toxic chemicals are handled should be demarcated with designated area caution tape and/or posted with designated area caution signs.
This includes all fume hoods and bench tops where the acutely toxic chemicals are handled.

Where feasible acutely toxic chemicals should be manipulated over plastic-backed disposable paper work surfaces. These disposable work surfaces minimize work area contamination and simplify clean up.

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptom of overexposure must be developed. The procedures should address as a minimum the following:

Who to contact: (University police, and Office of Environmental Health and Safety, Principal investigator of the laboratory including evening phone number)

- The location of all safety equipment (showers, eye wash, fire extinguishers, etc.)
- The method used to alert personnel in nearby areas of potential hazards
- Special first aid treatment required by the type of acutely toxic material(s) handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling acutely toxic chemicals. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of
the Practice for OccupationalandEducationalEyeand Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes, therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to acutely toxic chemicals, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Manipulation of acutely toxic chemicals should be carried out in a fume hood. If the use of a fume hood proves impractical refer to the section on special ventilation.

All areas where acutely toxic chemicals are stored or manipulated must be labeled as a designated area.

Glove (dry) box

Certain acutely toxic chemicals must be handled in a glove box rather than a fume hood. The Office of Environmental Health and Safety (5-2807) or the Principal Investigator will determine if this is required.

Gloves

Gloves should be worn when handling acutely toxic chemicals. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. Lab workers should contact OEHS for advice on chemical resistant glove selection when direct or prolonged contact with hazardous chemicals is anticipated.

Hazard assessment

Hazard assessment should focus on proper use and handling procedures, the education of employees concerning the health risk posed by acutely toxic materials, and on the demarcation of designated areas.

OEHS Notification

You should notiy the Office of Environmental Health and Safety prior to the initial use of acutely toxic substances. Notification is also required following significant changes in procedures or the quantity of materials used.

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling acutely toxic chemicals. Additional protective clothing should be worn if the possibility of skin contact is likely.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of acutely toxic chemicals which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants, are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the acutely toxic chemicals are used.

Signs and labels

Doorways: The room sign must contain a ***Designated Area Within Caution*** where carcinogens, reproductive hazards, and/or acutely toxic chemicals are stored or used.

Containers: All acutely toxic chemicals must be clearly labelled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable. A label for acutely toxic chemicals is available (part number (available from oehs, the cell center, or chemistry stockroom).

Special storage

Acutely toxic chemicals must be stored in a designated area.

Special ventilation

Manipulation of acutely toxic chemicals outside of a fume hood may require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to acutely toxic chemicals in the laboratory and are the preferred ventilation control device. Where possible handle acutely toxic chemicals in a fume hood. If the use of a fume hood proves impractical attempt to work in a glove box or in an isolated area on the laboratory bench top.

If available, consider using a Biological Safety Cabinet. The biological safety cabinet is designed to remove the acutely toxic chemicals before the air is discharged into the environment. Acutely toxic chemicals that are volatile must not be used in a biological safety cabinet unless the cabinet is vented to the outdoors.

If your research does not permit the handing of acutely toxic chemicals in a fume hood, biological safety cabinet, or glove box, you must contact the Office of Environmental Health and Safety.

All areas where acutely toxic chemicals are stored or manipulated must be labeled as a designated area.

Spill Response

Anticipate spills by having the appropriate clean up equipment on hand. The appropriate clean up supplies can be determined by consulting the material safety data sheet. This should occur prior to the use of any acutely toxic chemical.

In the event of a spill alert personnel in the area that a spill has occurred. Do not attempt to handle a large spill of acutely toxic chemicals. Vacate the laboratory immediately and call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.
Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum Protection

Evacuated glassware can implode and eject flying glass, and splattered chemicals. Vacuum work involving acutely toxic chemicals must be conducted in a fume hood, glove box or isolated in an acceptable manner.

Mechanical vacuum pumps must be protected using cold traps and, where appropriate, filtered to prevent particulate release. The exhaust for the pumps must be vented into an exhaust hood.

Waste Disposal

All materials contaminated with acutely toxic chemicals may need to be disposed of as a hazardous waste. Wherever possible, attempt to design research in a manner that reduces the quantity of waste generated. Questions regarding waste characterization should be directed to the Office of Environmental Health and Safety.

Acutely Toxic Gases

Generic Laboratory Standard Operating Procedure

Standard operating procedures (SOP) are intended to provide you with general guidance on how to safely work with a specific class of chemical or hazard. This SOP is generic in nature. It addresses the use and handling of substances by hazard class only. In some instances multiple SOPs may be applicable for a specific chemical (i.e., both the SOPs for flammable liquids and carcinogens would apply to benzene). If you have questions concerning the applicability of any items listed in this procedure, contact the Office of Environmental Health and Safety (285-2807) or the Principal Investigator of your laboratory. Specific written procedures are the responsibility of the Principal Investigator.

If compliance with all the requirements of this standard operating procedure is not possible, the Principal Investigator must develop a written procedure that will be used in its place. This alternate procedure must provide the same level of protection as the SOP it replaces. The Office of Environmental Health and Safety is available to provide guidance during the development of alternate procedures.

A partial list of acutely toxic gases is included in the BSU Chemical Hygiene Plan.

Securing of gas cylinders

Cylinders of compressed gases must be handled as high energy sources. When storing or moving a cylinder, have the cap
securely in place to protect the stem. Use suitable racks, straps, chains or stands to support cylinders.

Decontamination procedures

Personnel: Wash hands and arms with soap and water immediately after handling acutely toxic gases.

Designated area

The room sign for the laboratory must contain a **"Designated Areas Within"** identifier.

All locations within the laboratory where acutely toxic gases are handled should be demarcated with designated area caution tape and/or posted with designated area caution signs.

This includes all fume hoods and bench tops where the acutely toxic gases are handled.

Emergency procedure

Emergency procedures which address response actions to fires, explosions, spills, injury to staff, or the development of sign and symptoms of overexposure must be developed. The procedures should address as a minimum the following:

- Who to contact: (University police, and Office of Environmental Health and Safety, Principal Investigator of the laboratory including evening phone number)
- The location of all safety equipment (showers, eye wash, fire extinguishers, etc.)
- The method used to alert personnel in nearby areas of potential hazards
- Special first aid treatment required by the type of acutely toxic material(s) handled in the laboratory

Eye protection

Eye protection in the form of safety glasses must be worn at all times when handling acutely toxic gases. Ordinary (street) prescription glasses do not provide adequate protection. (Contrary to popular opinion these glasses cannot pass the rigorous test for industrial safety glasses.) Adequate safety glasses must meet the requirements of the Practice for Occupational and Educational Eye and Face Protection (ANSI Z.87. 1 1989) and must be equipped with side shields. Safety glasses with side shields do not provide adequate protection from splashes; therefore, when the potential for splash hazard exists other eye protection and/or face protection must be worn.

Eyewash

Where the eyes or body of any person may be exposed to acutely toxic gases, suitable facilities for quick drenching or flushing of the eyes and body shall be provided within the work area for immediate emergency use. Bottle type eyewash stations are not acceptable.

Fume hood

Manipulation of acutely toxic gases should typically be carried out in a fume hood. All areas where acutely toxic gases are stored or manipulated must be labeled as a designated area.

Glove (dry) box

Some processes involving acutely toxic gases may be performed in a properly vented glove box rather than a fume hood.

Gloves

Gloves should be worn when handling acutely toxic gases. Disposable latex or nitrile gloves provide adequate protection against accidental hand contact with small quantities of most laboratory chemicals. For these chemicals, refer to the “Glove Permeability” section of the BSU Chemical Hygiene Plan.

Hazard assessment

Hazard assessment should focus on the education of employees concerning the health risk posed by acutely toxic gases, on proper use and handling procedures, the demarcation of designated areas, and emergency evacuation and notification procedures in the event of a spill.

OEHS Notification

You should notify the Office of Environmental Health and Safety (285-2807) prior to the initial use of acutely toxic gases. Notification is also required following significant changes in procedures or the quantity of materials used.

Protective apparel

Lab coats, closed toed shoes and long sleeved clothing should be worn when handling acutely toxic gases. The need for additional protective equipment will be determined by the Office of Environmental Health and Safety on a case-by-case basis.

Safety shielding

Safety shielding is required any time there is a risk of explosion, splash hazard or a highly exothermic reaction. All manipulations of acutely toxic gases which pose this risk should occur in a fume hood with the sash in the lowest feasible position. Portable shields, which provide protection to all laboratory occupants are acceptable.

Safety shower

A safety or drench shower should be available in a nearby location where the acutely toxic gases are used.

Signs and labels

- Doorways: The room sign must contain a ***Designated Area Within*** Caution where carcinogens, reproductive hazards, and/or acutely toxic chemicals are stored or used. Designated Area signage may be necessary for any or all of the following:
    - Carcinogen
    - Teratogen
    - ToxicChemical
- Containers: All acutely toxic gas cylinders must be clearly labelled with the correct chemical name. Handwritten labels are acceptable; chemical formulas and structural formulas are not acceptable. A label for acutely toxic gases is available.

Special storage

Acutely toxic gases must be stored in a designated area. Special ventilation of the stored cylinders is required and must be approved by the Office of Environmental Health and Safety.

Continuous monitoring devices which will alert staff of a release of the acutely toxic gas is required for certain gases. The Office of Environmental Health and Safety will contact you concerning this requirement after receipt of notification.

The quantity of an acutely toxic gas that may be stored in a laboratory will be determined on a case-by-case basis by the Office of Environmental Health and Safety.

Special ventilation

Manipulation of acutely toxic gases outside of a fume hood will require special ventilation controls in order to minimize exposure to the material. Fume hoods provide the best protection against exposure to acutely toxic gases in the laboratory and are the preferred ventilation control device. Always attempt to handle acutely toxic gases in a fume hood. If your research does not permit the handing of acutely toxic gases in your fume hood you must contact the Office of Environmental Health and Safety to review the adequacy of all special ventilation.

Spill response

In the event of a escape of gas alert personnel in the area that a spill has occurred. Do not attempt to handle a spill of acutely toxic gases. Vacate the laboratory immediately and call for assistance.

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive.

Vacuum protection

Not applicable

Waste disposal

All empty or partially filled acutely toxic gas cylinders should be returned to the supplier. If the supplier does not accept empty or partially filled cylinders, contact the Office of Environmental Health and Safety concerning disposal. Lecture bottles (non-returnable) of these gases should not be purchased.

HANDLING ACID SOLUTIONS	

GENERIC LABORATORY STANDARD OPERATING PROCEDURE

PROCESS

Mixing various concentrations of aqueous acid solutions.

HAZARDOUS CHEMICALS/CLASS OF HAZARDOUS CHEMICALS

Acids - nitric, sulfuric, hydrochloric, acetic, phosphoric

PERSONAL PROTECTIVE EQUIPMENT

Safety goggles, nitrile, PVC, or neoprene gloves. Avoid skin contact, serious burns may result. Gloves made of nitrile, neoprene, or PVC can provide effective skin protection. Wear safety glasses or chemical safety goggles with face shield when using large quantities, or chemical safety goggles when using small quantities. Wear rubber, neoprene, or PVC apron when using large quantities and splash potential exists.

ENGINEERING/VENTILATION CONTROLS

Use concentrated acids in fume hood. A safety shower and eyewash must be available and accessible when working with corrosive liquids.

SPECIAL HANDLING PROCEDURES AND STORAGE REQUIREMENTS

Store mineral acids together, separate from oxidizing agents and organic materials. Store containers of acids and bases separately in chemical resistant secondary containers. This could be a polyethylene, PYREX or Nalgene tray or pan.

ACID & CORROSIVE CABINETS

Bottles of acid should be stored in an acid (corrosive) cabinet. While acids and bases are both considered to be corrosive, care must be taken to not store acids and bases in the same cabinet. It is particularly important to avoid storing ammonium hydroxide and strong mineral acids in the same cabinet.

Oxidizing acids, such as fuming nitric, fuming sulfuric and nitric should be stored separately, in a secondary container within an acid cabinet. Polypropylene boxes for use in acid cabinets are available commercially.

Glacial acetic acid, although it is both a corrosive and flammable, should be stored with other, non-oxidizing acids away from those mentioned above, not in a flammables cabinet.

SPILL AND ACCIDENT PROCEDURES

Skin exposure: Rinse affected skin with plenty of water while removing contaminated clothing and shoes. Rinse for at least 15 minutes. Seek medical attention.

Eye exposure: Splashes may cause tissue destruction. Wash eyes for at least 15 minutes, lifting the upper and lower eyelids occasionally. Seek medical attention immediately.

Small spills: Do not attempt cleanup if you feel unsure of your ability to do so or if you perceive the risk to be greater than normal laboratory operations. Cover spill with sodium carbonate or bicarbonate. When reaction stops pickup with damp sponge or paper towels.

Large Spills: Notify others in area of spill. Turn off ignition sources in area. Evacuate area and post doors to spill area. Call EH&S:

University Police: (28)5-1111 or 911 (24-hour): They will notify the necessary response personnel.

Office of Environmental Health & Safety (28)5-1507 or (28)5-5081 (FPM Work Control)

Remain on the scene, but at a safe distance, to receive and direct safety personnel when they arrive. Restrict persons from area of spill or leak until cleanup is complete. Remain in area in safe location to assist EH&S with response.

WASTE DISPOSAL

Dispose of waste through EH&S. Small quantities of acid solutions may be neutralized and disposed as non-hazardous waste if done properly.

SPECIAL APPROVAL REQUIRED

NO

DECONTAMINATION

Use sodium bicarbonate and water.

DESIGNATED AREA

NO

26.0 STANDARD OPERATING PROCEDURES (CONTINUED)

26.2 "FILLABLE' LABORATORY SPECIFIC STANDARD OPERATING PROCEDURE FORM

BSU SOP Form.pdf

27.0 OSHA LABORATORY STANDARD

The OSHA Laboratory Standard (copy)

U.S. Department of Labor

Occupational Safety & Health Administration

Regulations (Standards - 29 CFR) - Table of Contents

- Part Title: Occupational Safety and Health Standards
- Part Number: 1910
- Subpart: Z
- Subpart Title: Toxic and Hazardous Substances
- Standard Number: 1910.1450
- Title: Occupational exposure to hazardous chemicals in laboratories
- Appendices: A and B

1910. 1450(a)

Scope and application.

1910. 1450(a)(1)
This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

1910. 1450(a)(2)
Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

1910. 1450(a)(2)(i)
For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

1910. 1450(a)(2)(ii)
Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

1910. 1450(a)(2)(iii)
Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

1910. 1450(a)(3)

This section shall not apply to:

1910. 1450(a)(3)(i)
Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

1910. 1450(a)(3)(ii)
Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:
910. 1450(a)(3)(ii)(A)
Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

1910. 1450(a)(3)(ii)(B)
Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

1910. 1450(b)
Definitions --

Action level means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)-hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (see select carcinogen).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to

place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

Combustible liquid means any liquid having a flashpoint at or above 100 deg. F (37.8 deg. C), but below 200 deg. F (93.3 deg. C), except any mixture having components with flashpoints of 200 deg. F (93.3

deg. C), or higher, the total volume of which make up 99 percent or more of the total volume of the mixture.

Compressed gas means:

(iv) A gas or mixture of gases having, in a container, an absolute pressure exceeding 40 psi at 70 deg. F (21.1 deg. C); or

(v) A gas or mixture of gases having, in a container, an absolute pressure exceeding 104 psi at 130 deg. F (54.4 deg C) regardless of the pressure at 70 deg. F (21.1 deg. C); or

(vi) A liquid having a vapor pressure exceeding 40 psi at 100 deg. F (37.8 C) as determined by ASTM D-323-72.

Designated area means an area which may be used for work with "select carcinogens," reproductive toxins or substances which have a high degree of acute toxicity. A designated area may be the entire laboratory, an area of a laboratory or a device such as a laboratory hood.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Explosive means a chemical that causes a sudden, almost instantaneous release of pressure, gas, and heat when subjected to sudden shock, pressure, or high temperature.

Flammable means a chemical that falls into one of the following categories:

(i) Aerosol, flammable means an aerosol that, when tested by the method described in 16 CFR 1500.45, yields a flame protection exceeding 18 inches at full valve opening, or a flashback (a flame extending back to the valve) at any degree of valve opening;

(ii) Gas, flammable means:

(A) A gas that, at ambient temperature and pressure, forms a flammable mixture with air at a concentration of 13 percent by volume or less; or

(B) A gas that, at ambient temperature and pressure, forms a range of flammable mixtures with air wider than 12 percent by volume, regardless of the lower limit.

(iii) Liquid, flammable means any liquid having a flashpoint below 100 deg F (37.8 deg. C), except any mixture having components with flashpoints of 100 deg. C) or higher, the total of which make up 99 percent or more of the total volume of the mixture.

(iv) Solid, flammable means a solid, other than a blasting agent or explosive as defined in § 1910.109(a), that is liable to cause fire through friction, absorption of moisture, spontaneous

chemical change, or retained heat from manufacturing or processing, or which can be ignited readily and when ignited burns so vigorously and persistently as to create a serious hazard. A

chemical shall be considered to be a flammable solid if, when tested by the method described in 16 CFR 1500.44, it ignites and burns with a self-sustained flame at a rate greater than one-tenth of an inch per second along its major axis.

Flashpoint means the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite when tested as follows:

(iv) Tagliabue Closed Tester (See American National Standard Method of Test for Flash Point by Tag Closed Tester, Z1 1.24 - 1979 (ASTM D 56-79)) - for liquids with a viscosity of less than 45 Saybolt Universal Seconds (SUS) at 100 deg. F (37.8 deg. C), that do not contain suspended solids and do not have a tendency to form a surface film under test; or

(v) Pensky-Martens Closed Tester (See American National Standard Method of Test for Flashpoint by Pensky-Martens Closed Tester, Z1 1.7 - 1979 (ASTM D 93-79)) - for liquids with a viscosity equal to or greater than 45 SUS at 100 deg. F (37.8 deg. C), or that contain suspended solids, or that have a tendency to form a surface film under test; or

(vi)Setaflash Closed Tester (see American National Standard Method of test for Flash Point by Setaflash Closed Tester (ASTM D 3278-78)).

Organic peroxides, which undergo autoaccelerating thermal decomposition, are excluded from any of the flashpoint determination methods specified above.

Hazardous chemical means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes, or mucous membranes.

Appendices A and B of the Hazard Communication Standard (29 CFR 1910.1200) provide further guidance in defining the scope of health hazards and determining whether or not a chemical is to be considered hazardous for purposes of this standard.

Laboratory means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safety manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a movable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"
(ii) Multiple chemical procedures or chemicals are used;
(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and
(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Organic peroxide means an organic compound that contains the bivalent -O-O- structure and which may be considered to be a structural derivative of hydrogen peroxide where one or both of the hydrogen atoms has been replaced by an organic radical.

Oxidizer means a chemical other than a blasting agent or explosive as defined in § 1910.109(a), that initiates or promotes combustion in other materials, thereby causing fire either of itself or through the release of oxygen or other gases.

Physical hazard means a chemical for which there is scientifically valid evidence tat it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer pyrophoric, unstable (reactive) or water-reactive.

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins means chemicals which affect the reproductive chemicals which affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis).

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or
(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP)(latest edition); or
(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for research on Cancer Monographs (IARC)(latest editions); or
(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to

be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m(3);

(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or

(C) After oral dosages of less than 50 mg/kg of body weight per day.

Unstable (reactive) means a chemical which is the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shocks, pressure or temperature.

Water-reactive means a chemical that reacts with water to release a gas that is either flammable or presents a health hazard.

1910. 1450(c)

Permissible exposure limits. For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

1910. 1450(d)

Employee exposure determination

1910. 1450(d)(1)

Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

1910. 1450(d)(2)

Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

1910. 1450(d)(3)

Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

1910. 1450(d)(4)

Employee notification of monitoring results. The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

1910. 1450(e)

Chemical hygiene plan -- General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910. 1450(e)(1)

Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910. 1450(e)(1)(i)

Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

1910. 1450(e)(1)(ii)

Capable of keeping exposures below the limits specified in paragraph (c) of this section.

1910. 1450(e)(2)

The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

1910. 1450(e)(3)

The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

1910. 1450(e)(3)(i)

Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

1910. 1450(e)(3)(ii)

Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

1910. 1450(e)(3)(iii)

A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

1910.1 450 (e)(3)(iv)

Provisions for employee information and training as prescribed in paragraph (f) of this section;

1910. 1450(e)(3)(v)

The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

1910. 1450(e)(3)(vi)

Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

1910. 1450(e)(3)(vii)

Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and

1910. 1450(e)(3)(viii)

Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1910. 1450(e)(3)(viii)(A)
Establishment of a designated area;

1910. 1450(e)(3)(viii)(B)

Use of containment devices such as fume hoods or glove boxes;

1910. 1450(e)(3)(viii)(C)

Procedures for safe removal of contaminated waste; and

1910. 1450(e)(3)(viii)(D)
Decontamination procedures.

1910. 1450(e)(4)

The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

1910. 1450(f)

Employee information and training.

The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.

1910. 1450(f)(2)

Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.

1910. 1450(f)(3)

Information. Employees shall be informed of:

1910. 1450(f)(3)(i)

The contents of this standard and its appendices which shall be made available to employees;

1910. 1450(f)(3)(ii)

the location and availability of the employer's Chemical Hygiene Plan;

1910. 1450(f)(3)(iii)

The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

1910. 1450(f)(3)(iv)

Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

1910. 1450(f)(3)(v)

The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, Material Safety Data Sheets received from the chemical supplier.

1910. 1450(f)(4)
Training.

1910. 1450(f)(4)(i)

Employee training shall include:

1910. 1450(f)(4)(i)(A)

Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

1910. 1450(f)(4)(i)(B)

The physical and health hazards of chemicals in the work area; and

1910. 1450(f)(4)(i)(C)

The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

1910. 1450(f)(4)(ii)

The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

1910. 1450(g)

Medical consultation and medical examinations.

The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

1910. 1450(g)(1)(i)

Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

1910. 1450(g)(1)(ii)

Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

1910. 1450(g)(1)(iii)

Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

1910. 1450(g)(2)

All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

1910. 1450(g)(3)

Information provided to the physician. The employer shall provide the following information to the physician:

1910. 1450(g)(3)(i)

The identity of the hazardous chemical(s) to which the employee may have been exposed;

1910. 1450(g)(3)(ii)

A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

1910. 1450(g)(3)(iii)

A description of the signs and symptoms of exposure that the employee is experiencing, if any.

1910. 1450(g)(4) Physician's
written opinion.

1910. 1450(g)(4)(i)

For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

1910. 1450(g)(4)(i)(A)

Any recommendation for further medical follow-up;

1910. 1450(g)(4)(i)(B)

The results of the medical examination and any associated tests;

1910. 1450(g)(4)(i)(C)

Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

1910. 1450(g)(4)(i)(D)

A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

1910. 1450(g)(4)(ii)

The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

1910. 1450(h)

Hazard identification.

1910. 1450(h)(1)

With respect to labels and material safety data sheets:

1910. 1450(h)(1)(i)

Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

1910. 1450(h)(1)(ii)

Employers shall maintain any material safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

1910. 1450(h)(2)

The following provisions shall apply to chemical substances developed in the laboratory:

1910. 1450(h)(2)(i)

If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

1910. 1450(h)(2)(ii)

If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

1910. 1450(h)(2)(iii)

If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of material safety data sheets and labeling.

1910. 1450(i)

Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

1910.1450(j)
Record keeping.

1910. 1450(j)(1)

The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

1910. 1450(j)(2)

The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

1910. 1450(k)
Dates --

1910. 1450(k)(1)

Effective date. This section shall become effective May 1, 1990.

1910. 1450(k)(2)
Start-up dates.

1910. 1450(k)(2)(i)

Employers shall have developed and implemented a written Chemical Hygiene Plan no later than January 31, 1991.

1910. 1450(k)(2)(ii)

Paragraph (a)(2) of this section shall not take effect until the employer has developed and implemented a written Chemical Hygiene Plan.

1910. 1450(l)

Appendices. The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

[55 FR 3327, Jan. 31, 1990; 55 FR 7967, March, 6, 1990; 55 FR 12777, March 30, 1990; 61 FR 5507, Feb. 13, 1996]

Occupational Safety & Health Administration 200 Constitution Avenue, NW Washington, DC 20210

Appendix A to the OSHA Laboratory Standard

U.S. Department of Labor

Occupational Safety & Health Administration

Regulations (Standards - 29 CFR) - Table of Contents

- Part Number: 1910
- Part Title: Occupational Safety and Health Standards
- Subpart: Z
- Subpart Title: Toxic and Hazardous Substances
- Standard Number: 1910.1450 App A
- Title: National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

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Foreword

As guidance for each employer's development of an appropriate laboratory Chemical Hygiene Plan, the following non-mandatory recommendations are provided. They were extracted form "Prudent Practices" for Handling Hazardous Chemicals in Laboratories" (referred to below as "Prudent Practices"), which was published in 1981 by the National Research Council and is available from the National Academy Press, 2101 Constitution Ave., NW,. Washington DC 20418.

"Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by members of the laboratory community through the sponsorship of the National Research Council. However, none of the recommendations given here will modify any requirements of the laboratory standard. This Appendix merely presents pertinent recommendations from "Prudent Practices", organized into a form convenient for quick reference during operation of a laboratory facility and during development and application of a Chemical Hygiene Plan. Users of this appendix should consult "Prudent Practices" for a more extended presentation and justification for each recommendation.

"Prudent Practices" deal with both safety and chemical hazards while the laboratory standard is concerned primarily with chemical hazards. Therefore, only those recommendations directed primarily toward control of toxic exposures are cited in this appendix, with the term "chemical Hygiene" being substituted for the word "safety". However, since conditions producing or threatening physical injury often pose toxic risks as well, page references concerning major categories of safety hazards in the laboratory are given in section F.

The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized, and headings have been added. However, their sense has not been changed.

Corresponding Sections of the Standard and this Appendix

The following table is given for the convenience of those who are developing a Chemical Hygiene Plan which will satisfy the requirements of paragraph (e) of the standard. It indicates those sections of this appendix which are most pertinent to each of the sections of paragraph (e) and related paragraphs.

Paragraph and topic in laboratory standard	Relevant appendix section
(e)(3)(i) Standard operating procedures for handling toxic chemicals.	C, D, E
(e)(3)(ii) Criteria to be used for implementation of measures to reduce exposures.	D
(e)(3)(iii) Fume hood performance	C4b
(e)(3)(iv) Employee information and training (including emergency procedures).	D10, D9
(e)(3)(v) Requirements for prior approval of laboratory activities.	E2b, E4b
(e)(3)(vi) Medical consultation and medical examinations.	D5, E4f
(e)(3)(vii) Chemical hygiene responsibilities.	B
(e)(3)(viii) Special precautions for work with particularly hazardous substances.	E2, E3, E4

In this appendix, those recommendations directed primarily at administrators and supervisors are given in sections A-D. Those recommendations of primary concern to employees who are actually handling laboratory chemicals are given in section E. (Reference to page numbers in "Prudent Practices" are given in parentheses.)

A. General Principles for Work with Laboratory Chemicals

In addition to the more detailed recommendations listed below in sections B-E, "Prudent Practices" expresses certain general principles, including the following:

1. It is prudent to minimize all chemical exposures. Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted, rather than specific guidelines for particular chemicals (2,10). Skin contact with chemicals should be avoided as a cardinal rule (198).
2. Avoid underestimation of risk. Even for substances of no known significant hazard, exposure should be minimized; for work with substances which present special hazards, special precautions should be taken (10, 37, 38). One should assume that any mixture will be more toxic than its most toxic component (30, 103) and that all substances of unknown toxicity are toxic (3, 34).
3. Provide adequate ventilation. The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by use of hoods and other ventilation devices (32, 198).
4. Institute a chemical hygiene program. A mandatory chemical hygiene program designed to minimize exposures is needed; it should be a regular, continuing effort, not merely a standby or short-term activity (6,11). Its recommendations should be followed in academic teaching laboratories as well as by full-time laboratory workers (13).
5. Observe the PELs, TLVs. The Permissible Exposure Limits of OSHA and the Threshold Limit

Values of the American Conference of Governmental Industrial Hygienists should not be exceeded (13).

B. Chemical Hygiene Responsibilities

Responsibility for chemical hygiene rests at all levels (6, 11, 21) including the:

1. Chief executive officer, who has ultimate responsibility for chemical hygiene within the institution and must, with other administrators, provide continuing support for institutional chemical hygiene (7, 11).

2. Supervisor of the department or other administrative unit, who is responsible for chemical hygiene in that unit (7).

3. chemical hygiene officer(s), whose appointment is essential (7) and who must:

(a) Work with administrators and other employees to develop and implement appropriate chemical hygiene policies and practices (7);
(b) Monitor procurement, use, and disposal of chemicals used in the lab (8);
(c) See that appropriate audits are maintained (8);
(d) Help project directors develop precautions and adequate facilities (10);
(e) Know the current legal requirements concerning regulated substances (50); and
(f) Seek ways to improve the chemical hygiene program (8, 11).

4. Laboratory supervisor, who has overall responsibility for chemical hygiene in the laboratory (21) including responsibility to:

(a) Ensure that workers know and follow the chemical hygiene rules, that protective equipment is available and in working order, and that appropriate training has been provided (21, 22);
(b) Provide regular, formal chemical hygiene and housekeeping inspections including routine inspections of emergency equipment (21, 171);
(c) Know the current legal requirements concerning regulated substances (50, 231);
(d) Determine the required levels of protective apparel and equipment (156, 160, 162); and
(e) Ensure that facilities and training for use of any material being ordered are adequate (215).

5. Project director or director of other specific operation, who has primary responsibility for chemical hygiene procedures for that operation (7).

6. Laboratory worker, who is responsible for:

(a) Planning and conducting each operation in accordance with the institutional chemical hygiene procedures (7, 21, 22, 230); and
(b) Developing good personal chemical hygiene habits (22).

C. The Laboratory Facility

1. Design. The laboratory facility should have:

(a) An appropriate general ventilation system (see C4 below) with air intakes and exhausts located so as to avoid intake of contaminated air (194);

(b) Adequate, well-ventilated stockrooms/storerooms (218, 219).
(c) Laboratory hoods and sinks (12, 162);
(d) Other safety equipment including eyewash fountains and drench showers (162, 169); and
(e) Arrangements for waste disposal (12, 240).

2. Maintenance. Chemical-hygiene-related equipment (hoods, incinerator, etc.) should undergo continual appraisal and be modified if inadequate (11, 12).

3. Usage. The work conducted (10) and its scale (12) must be appropriate to the physical facilities available and, especially, to the quality of ventilation (13).

4. Ventilation -

(a) General laboratory ventilation. This system should: Provide a source of air for breathing and for input to local ventilation devices (199); it should not be relied on for protection from toxic substances released into the laboratory (198); ensure that laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day (194); direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building (194).
(b) Hoods. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals (199); each hood should have a continuous monitoring device to allow convenient confirmation of adequate hood performance before use (200, 209). If this is not possible, work with substances of unknown toxicity should be avoided (13) or other types of local ventilation devices should be provided (199). See pp. 201-206 for a discussion of hood design, construction, and evaluation.
(c) Other local ventilation devices. Ventilated storage cabinets, canopy hoods, snorkels, etc. should be provided as needed (199). Each canopy hood and snorkel should have a separate exhaust duct (207).
(d) Special ventilation areas. Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system (208). Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure (209).
(e) Modifications. Any alteration of the ventilation system should be made only if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate (12, 193, 204).
(f) Performance. Rate: 4-12 room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control (194).
(g) Quality. General air flow should not be turbulent and should be relatively uniform throughout the laboratory, with no high velocity or static areas (194, 195); airflow into and within the hood should not be excessively turbulent (200); hood face velocity should be adequate (typically 60- 100 lfm) (200, 204).
(h) Evaluation. Quality and quantity of ventilation should be evaluated on installation (202), regularly monitored (at least every 3 months) (6, 12, 14, 195), and reevaluated whenever a change in local ventilation devices is made (12, 195, 207). See pp 195-198 for methods of evaluation and for calculation of estimated airborne contaminant concentrations.

D. Components of the Chemical Hygiene Plan

1. Basic Rules and Procedures (Recommendations for these are given in section E, below)
2. Chemical Procurement, Distribution, and Storage
(a) Procurement. Before a substance is received, information on proper handling, storage, and

disposal should be known to those who will be involved (215, 216). No container should be accepted without an adequate identifying label (216). Preferably, all substances should be received in a central location (216).

(b) Stockrooms/storerooms. Toxic substances should be segregated in a well-identified area with local exhaust ventilation (221). Chemicals which are highly toxic (227) or other chemicals whose containers have been opened should be in unbreakable secondary containers (219). Stored chemicals should be examined periodically (at least annually) for replacement, deterioration, and container integrity (218-19).

Stockrooms/storerooms should not be used as preparation or repackaging areas, should be open during normal working hours, and should be controlled by one person (219).

(c) Distribution. When chemicals are hand carried, the container should be placed in an outside container or bucket. Freight-only elevators should be used if possible (223).

(d) Laboratory storage. Amounts permitted should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom (225-6, 229).

3. Environmental Monitoring

Regular instrumental monitoring of airborne concentrations is not usually justified or practical in laboratories but may be appropriate when testing or redesigning hoods or other ventilation devices (12) or when a highly toxic substance is stored or used regularly (e.g., 3 times/week) (13).

4. Housekeeping, Maintenance, and Inspections

(a) Cleaning. Floors should be cleaned regularly (24).

(b) Inspections. Formal housekeeping and chemical hygiene inspections should be held at least quarterly (6, 21) for units which have frequent personnel changes and semiannually for others; informal inspections should be continual (21).

(c) Maintenance. Eye wash fountains should be inspected at intervals of not less than 3 months (6). Respirators for routine use should be inspected periodically by the laboratory supervisor (169). Other safety equipment should be inspected regularly. (e.g., every 3-6 months) (6, 24, 171). Procedures to prevent restarting of out-of-service equipment should be established (25).

(d) Passageways. Stairways and hallways should not be used as storage areas (24). Access to exits, emergency equipment, and utility controls should never be blocked (24).

5. Medical Program

(a) Compliance with regulations. Regular medical surveillance should be established to the extent required by regulations (12).

(b) Routine surveillance. Anyone whose work involves regular and frequent handling of toxicologically significant quantities of a chemical should consult a qualified physician to determine on an individual basis whether a regular schedule of medical surveillance is desirable (11, 50).

(c) First aid. Personnel trained in first aid should be available during working hours and an emergency room with medical personnel should be nearby (173). See pp. 176-178 for description of some emergency first aid procedures.

6. Protective Apparel and Equipment

These should include for each laboratory:

(a) Protective apparel compatible with the required degree of protection for substances being handled (158-161);
(b) An easily accessible drench-type safety shower (162, 169);
(c) An eyewash fountain (162)
(d) A fire extinguisher (162-164);
(e) Respiratory protection (164-9), fire alarm and telephone for emergency use (162) should be available nearby; and
(f) Other items designated by the laboratory supervisor (156, 160).

7. Records

(a) Accident records should be written and retained (174).
(b) Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations (7).
(c) Inventory and usage records for high-risk substances should be kept as specified in sections E3e below.
(d) Medical records should be retained by the institution in accordance with the requirements of state and federal regulations (12).

8. Signs and Labels

Prominent signs and labels of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers (28);
(b) Identity labels, showing contents of containers (including waste receptacles) and associated hazards (27, 48);
(c) Location signs for safety showers, eyewash stations, other safety and first aid equipment, exits (27) and areas where food and beverage consumption and storage are permitted (24); and
(d) Warnings at areas or equipment where special or unusual hazards exist (27).

9. Spills and Accidents

(a) A written emergency plan should be established and communicated to all personnel; it should include procedures for ventilation failure (200), evacuation, medical care, reporting, and drills (172).
(b) There should be an alarm system to alert people in all parts of the facility including isolation areas such as cold rooms (172).
(c) A spill control policy should be developed and should include consideration of prevention, containment, cleanup, and reporting (175).
(d) All accidents or near accidents should be carefully analyzed with the results distributed to all who might benefit (8, 28).

10. Information and Training Program

(a) Aim: To assure that all individuals at risk are adequately informed about the work in the laboratory, its risks, and what to do if an accident occurs (5, 15).
(b) Emergency and Personal Protection Training: Every laboratory worker should know the location and proper use of available protective apparel and equipment (154, 169).

- Some of the full-time personnel of the laboratory should be trained in the proper use of emergency equipment and procedures (6).
- Such training as well as first aid instruction should be available to (154) and encouraged for

(176) everyone who might need it.

(c) Receiving and stockroom/storeroom personnel should know about hazards, handling equipment, protective apparel, and relevant regulations (217).

(d) Frequency of Training: The training and education program should be a regular, continuing activity - not simply an annual presentation (15).

(e) Literature/Consultation: Literature and consulting advice concerning chemical hygiene should be readily available to laboratory personnel, who should be encouraged to use these information resources (14).

11. Waste Disposal Program.

(a) Aim: To assure that minimal harm to people, other organisms, and the environment will result from the disposal of waste laboratory chemicals (5).

(b) Content (14, 232, 233, 240): The waste disposal program should specify how waste is to be collected, segregated, stored, and transported and include consideration of what materials can be incinerated. Transport from the institution must be in accordance with DOT regulations (244).

(c) Discarding Chemical Stocks:

- Unlabeled containers of chemicals and solutions should undergo prompt disposal; if partially used, they should not be opened (24, 27).
- Before a worker's employment in the laboratory ends, chemicals for which that person was responsible should be discarded or returned to storage (226).

(d) Frequency of Disposal: Waste should be removed from laboratories to a central waste storage area at least once per week and from the central waste storage area at regular intervals (14).

(e) Method of Disposal:

- Incineration in an environmentally acceptable manner is the most practical disposal method for combustible laboratory waste (14, 238, 241).
- Indiscriminate disposal by pouring waste chemicals down the drain (14, 231, 242) or adding them to mixed refuse for landfill burial is unacceptable (14).
- Hoods should not be used as a means of disposal for volatile chemicals (40, 200).
- Disposal by recycling (233, 243) or chemical decontamination (40, 230) should be used when possible.

E. Basic Rules and Procedures for Working with Chemicals

The Chemical Hygiene Plan should require that laboratory workers know and follow its rules and procedures. In addition to the procedures of the sub programs mentioned above, these should include the rules listed below.

1. General Rules

The following should be used for essentially all laboratory work with chemicals:

(a) Accidents and spills

- Eye Contact: Promptly flush eyes with water for a prolonged period (15 minutes) and seek medical attention (33, 172).
- Ingestion: Encourage the victim to drink large amounts of water (178).
- Skin Contact: Promptly flush the affected area with water (33, 172, 178) and remove any contaminated clothing (172, 178). If symptoms persist after washing, seek medical attention

(33).

- Clean-up. Promptly clean up spills, using appropriate protective apparel and equipment and proper disposal (24, 33). See pp. 233-237 for specific clean-up recommendations.

(b) Avoidance of "routine" exposure:

- Develop and encourage safe habits (23); avoid unnecessary exposure to chemicals by any route (23);
- Do not smell or taste chemicals (32). Vent apparatus which may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices (199).
- Inspect gloves (157) and test glove boxes (208) before use.
- Do not allow release of toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres (209).

(c) Choice of chemicals: Use only those chemicals for which the quality of the available ventilation system is appropriate (13).

(d) Eating, smoking, etc.:

- Avoid eating, drinking, smoking, gum chewing, or application of cosmetics in areas where laboratory chemicals are present (22, 24, 32, 40); wash hands before conducting these activities (23, 24).
- Avoid storage, handling, or consumption of food or beverages in storage areas, refrigerators, glassware or utensils which are also used for laboratory operations (23, 24, 226).

(e) Equipment and glassware: Handle and store laboratory glassware with care to avoid damage; do not use damaged glassware (25). Use extra care with Dewar flasks and other evacuated glass apparatus; shield or wrap them to contain chemicals and fragments should implosion occur (25). Use equipment only for its designed purpose (23, 26).

(f) Exiting: Wash areas of exposed skin well before leaving the laboratory (23).

(g) Horseplay: Avoid practical jokes or other behavior which might confuse, startle or distract another worker (23).

(h) Mouth suction: Do not use mouth suction for pipeting or starting a siphon (23, 32).

(i) Personal apparel: Confine long hair and loose clothing (23, 158). Wear shoes at all times in the laboratory but do not wear sandals, perforated shoes, or sneakers (158).

(j) Personal housekeeping: Keep the work area clean and uncluttered, with chemicals and equipment being properly labeled and stored; clean up the work area on completion of an operation or at the end of each day (24).

(k) Personal protection:

- Assure that appropriate eye protection (1 54-1 56) is worn by all persons, including visitors, where chemicals are stored or handled (22, 23, 33, 154).
- Wear appropriate gloves when the potential for contact with toxic materials exists (157); inspect the gloves before each use, wash them before removal, and replace them periodically (157). (A table of resistance to chemicals of common glove materials is given p. 159).
- Use appropriate (164-168) respiratory equipment when air contaminant concentrations are not sufficiently restricted by engineering controls (164-5), inspecting the respirator before use (169).
- • Use any other protective and emergency apparel and equipment as appropriate (22, 157- 162).
- Avoid use of contact lenses in the laboratory unless necessary; if they are used, inform supervisor so special precautions can be taken (155).
- Remove laboratory coats immediately on significant contamination (161).

(l) Planning: Seek information and advice about hazards (7), plan appropriate protective

procedures, and plan positioning of equipment before beginning any new operation (22, 23).

(m) Unattended operations: Leave lights on, place an appropriate sign on the door, and provide for containment of toxic substances in the event of failure of a utility service (such as cooling water) to an unattended operation (27, 128).

(n) Use of hood:

- Use the hood for operations which might result in release of toxic chemical vapors or dust (198-9).
- As a rule of thumb, use a hood or other local ventilation device when working with any appreciably volatile substance with a TLV of less than 50 ppm (13).
- Confirm adequate hood performance before use; keep hood closed at all times except when adjustments within the hood are being made (200); keep materials stored in hoods to a minimum and do not allow them to block vents or air flow (200).
- Leave the hood "on" when it is not in active use if toxic substances are stored in it or if it is uncertain whether adequate general laboratory ventilation will be maintained when it is "off" (200).

(o) Vigilance: Be alert to unsafe conditions and see that they are corrected when detected (22).

(p) Waste disposal:

- Assure that the plan for each laboratory operation includes plans and training for waste disposal (230).
- Deposit chemical waste in appropriately labeled receptacles and follow all other waste disposal procedures of the Chemical Hygiene Plan (22, 24).
- Do not discharge to the sewer concentrated acids or bases (231); highly toxic, malodorous, or lachrymatory substances (231); or any substances which might interfere with the biological activity of waste water treatment plants, create fire or explosion hazards, cause structural damage or obstruct flow (242).

(q) Working alone: Avoid working alone in a building; do not work alone in a laboratory if the procedures being conducted are hazardous (28).

2. Working with Allergens and Embryotoxins

(a) Allergens (examples: diazomethane, isocyanates, bichromates): Wear suitable gloves to prevent hand contact with allergens or substances of unknown allergenic activity (35).

(b) Embryotoxins (34-5) (examples: organomercurials, lead compounds, formamide):

- If you are a woman of childbearing age, handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact.
- Review each use of these materials with the research supervisor and review continuing uses annually or whenever a procedural change is made.
- Store these substances, properly labeled, in an adequately ventilated area in an unbreakable secondary container.
- Notify supervisors of all incidents of exposure or spills; consult a qualified physician when appropriate.

3. Work with Chemicals of Moderate Chronic or High Acute Toxicity

Examples: diisopropylfluorophosphate (41), hydrofluoric acid (43), hydrogen cyanide (45).
Supplemental rules to be followed in addition to those mentioned above (Procedure B of "Prudent Practices", pp. 39-41):

(a) Aim: To minimize exposure to these toxic substances by any route using all reasonable

precautions (39).

(b) Applicability: These precautions are appropriate for substances with moderate chronic or high acute toxicity used in significant quantities (39).

(c) Location:

- Use and store these substances only in areas of restricted access with special warning signs (40, 229).
- Always use a hood (previously evaluated to confirm adequate performance with a face velocity of at least 60 linear feet per minute) (40) or other containment device for procedures which may result in the generation of aerosols or vapors containing the substance (39); trap released vapors to revent their discharge with the hood exhaust (40).

(d) Personal protection: Always avoid skin contact by use of gloves and long sleeves (and other protective apparel as appropriate) (39). Always wash hands and arms immediately after working with these materials (40).

(e) Records: Maintain records of the amounts of these materials on hand, amounts used, and the names of the workers involved (40, 229).

(f) Prevention of spills and accidents:

- Be prepared for accidents and spills (41).
- Assure that at least 2 people are present at all times if a compound in use is highly toxic or of unknown toxicity (39).
- Store breakable containers of these substances in chemically resistant trays; also work and mount apparatus above such trays or cover work and storage surfaces with removable, absorbent, plastic backed paper (40).
- If a major spill occurs outside the hood, evacuate the area; assure that cleanup personnel wear suitable protective apparel and equipment (41).

(g) Waste:

- Thoroughly decontaminate or incinerate contaminated clothing or shoes (41). If possible, chemically decontaminate by chemical conversion (40).
- Store contaminated waste in closed, suitably labeled, impervious containers (for liquids, in glass or plastic bottles half-filled with vermiculite) (40).

4. Work with Chemicals of High Chronic Toxicity

(Examples: dimethylmercury and nickel carbonyl (48), benzo-a-pyrene (51), N-nitrosodiethylamine (54), other human carcinogens or substances with high carcinogenic potency in animals (38).) Further supplemental rules to be followed, in addition to all these mentioned above, for work with substances of known high chronic toxicity (in quantities above a few milligrams to a few grams, depending on the substance) (47). (Procedure A of "Prudent Practices" pp. 47-50).

(a) Access: Conduct all transfers and work with these substances in a "controlled area": a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substances being used and necessary precautions (48).

(b) Approvals: Prepare a plan for use and disposal of these materials and obtain the approval of the laboratory supervisor (48).

(c) Non-contamination/Decontamination: Protect vacuum pumps against contamination by scrubbers or HEPA filters and vent them into the hood (49). Decontaminate vacuum pumps or other contaminated equipment, including glassware, in the hood before removing them from the controlled area (49, 50).

Decontaminate the controlled area before normal work is resumed there (50).

(d) Exiting: On leaving a controlled area, remove any protective apparel (placing it in an appropriate, labeled container) and thoroughly wash hands, forearms, face, and neck (49).
(e) Housekeeping: Use a wet mop or a vacuum cleaner equipped with a HEPA filter instead of dry sweeping if the toxic substance was a dry powder (50).
(f) Medical surveillance: If using toxicologically significant quantities of such a substance on a regular basis (e.g., 3 times per week), consult a qualified physician concerning desirability of regular medical surveillance (50).
(g) Records: Keep accurate records of the amounts of these substances stored (229) and used, the dates of use, and names of users (48).
(h) Signs and labels: Assure that the controlled area is conspicuously marked with warning and restricted access signs (49) and that all containers of these substances are appropriately labeled with identity and warning labels (48).
(i) Spills: Assure that contingency plans, equipment, and materials to minimize exposures of people and property in case of accident are available (233-4).
(j) Storage: Store containers of these chemicals only in a ventilated, limited access (48, 227, 229) area in appropriately labeled, unbreakable, chemically resistant, secondary containers (48, 229).
(k) Glove boxes: For a negative pressure glove box, ventilation rate must be at least 2 volume changes/hour and pressure at least 0.5 inches of water (48). For a positive pressure glove box, thoroughly check for leaks before each use (49). In either case, trap the exit gases or filter them through a HEPA filter and then release them into the hood (49).
(l) Waste: Use chemical decontamination whenever possible; ensure that containers of contaminated waste (including washings from contaminated flasks) are transferred from the controlled area in a secondary container under the supervision of authorized personnel (49, 50, 233).

5. Animal Work with Chemicals of High Chronic Toxicity

(a) Access: For large scale studies, special facilities with restricted access are preferable (56).
(b) Administration of the toxic substance: When possible, administer the substance by injection or gavage instead of in the diet. If administration is in the diet, use a caging system under negative pressure or under laminar air flow directed toward HEPA filters (56).
(c) Aerosol suppression: Devise procedures which minimize formation and dispersal of contaminated aerosols, including those from food, urine, and feces (e.g., use HEPA filtered vacuum equipment for cleaning, moisten contaminated bedding before removal from the cage, mix diets in closed containers in a hood) (55, 56).
(d) Personal protection: When working in the animal room, wear plastic or rubber gloves, fully buttoned laboratory coat or jumpsuit and, if needed because of incomplete suppression of aerosols, other apparel and equipment (shoe and head coverings, respirator) (56).
(e) Waste disposal: Dispose of contaminated animal tissues and excreta by incineration if the available incinerator can convert the contaminant to non-toxic products (238); otherwise, package the waste appropriately for burial in an EPA-approved site (239).

F. Safety Recommendations

The above recommendations from "Prudent Practices" do not include those which are directed primarily toward prevention of physical injury rather than toxic exposure. However, failure of precautions against injury will often have the secondary effect of causing toxic exposures. Therefore, we list below page

references for recommendations concerning some of the major categories of safety hazards which also have implications for chemical hygiene:

1. Corrosive agents: (35-6)
2. Electrically powered laboratory apparatus: (179-92)
3. Fires, explosions: (26, 57-74, 162-64, 174-5, 219-20, 226-7)
4. Low temperature procedures: (26, 88)
5. Pressurized and vacuum operations (including use of compressed gas cylinders): (27, 75-101)

G. Material Safety Data Sheets

Material safety data sheets are presented in "Prudent Practices" for the chemicals listed below. (Asterisks denote that comprehensive material safety data sheets are provided).

Appendix B to the OSHA Laboratory Standard

- Part Number: 1910
- Part Title: Occupational Safety and Health Standards
- Subpart: Z
- Subpart Title: Toxic and Hazardous Substances
- Standard Number: 1910.1450 App B
- Title: References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory.

(a) Materials for the development of the Chemical Hygiene Plan:

1. American Chemical Society, Safety in Academic Chemistry Laboratories, 4th edition, 1985.
2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.
3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL, 1978.
4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing Co., NY, 1978.
5. Kaufman, James A., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.
6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.
7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.
8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories,

National Academy Press, Washington, DC, 1981.
9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, J. Chem. Ed., American Chemical Society, Easlon, PA, 1981.
10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA, 18042, Vol. I, 1967, Vol. II, 1971, Vol. III, 1974.
11. Steere, Norman V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.
12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.

(b) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211-4438.
2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.
4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.
5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.
6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).
7. IARC Monographs on the Evaluation of the Carcinogenic Risk of chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).
8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).
9. Occupational Health Guidelines, NIOSH/OSHA. NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.
10. Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes).
11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of documents US. Govt. Printing Office, Washington, DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.
14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications. Park Ridge, NJ, 1981.

(c) Information on Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.
2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National

Standards Institute, N.Y. 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.
4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982.
Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.
Fire Protection Guide on Hazardous Materials, 7th edition, 1978.

National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF7-1980, 1101 16th Street, NW., Washington, DC 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.
2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103. [55 FR 3327, Jan. 31, 1990; 57 FR 29204, July 1, 1992; 61 FR 5507, Feb. 13, 1996]

28.0 LABORATORY / BUILDING EVACUATION LAYOUT(S)

Layout of laboratory, studio, or chemical store room to be inserted here by Safety Officer or Department – should show the lab/studio/area configuration and features, local ventilation systems, the location of the fire extinguishers, spill response supplies, eye wash and shower, and the exits in the event of an emergency

29.0 HAZARDOUS MATERIALS INVENTORY (OR LOCATION REFERENCED)

The use of the web-based BSU ChemTracker System is the preferred chemical and material inventory tracking system. See **Chapter 6, Section 3 (6.3).** However, if that system has not been in use by your Department – see below:

A PDF FILLABLE CHEMICAL INVENTORY FORM IS AVAILABLE AT THE FOLLOWING LOCATION:

http://cms.bsu.edu/-/media/WWW/DepartmentalContent/Facilities/PDF/chemicalinventory.pdf

Ball State University Chemical Inventory List

Building: _____ Performed By: _____ Page: ___ of: _____

Department: _____ Phone: _____ Date: _____

Room: _____ Supervisor: _____

Chemical/Product Name	Quantity	Identifying Numbers (CAS or catalog)	Manufacturer	Location	MSDS on file?	Date on Container

Note: Completed inventories are to be sent to Harriette Harra, Facilities Planning & Management

30.0 SAFETY DATA SHEETS (SDSs), MATERIAL SAFETY DATA SHEETS (MSDSs), PATHOGEN SAFETY DATA SHEETS, (OR REFERENCED LOCATION)

31.0 COMPLETED LABORATORY INSPECTION SHEETS (OR REFERENCED LOCATION)

32.0 COMPLETED TRAINING AND AWARENESS CERTIFICATIONS (OR REFERENCED LOCATION OF THE TRAINING FORMS)

33.0 BSU LABORATORY WASTE MANAGEMENT PLAN

BSU Laboratory Waste Management Plan

Prepared by the:

Environmental Health and Safety Office

North Service Building

3401 North Tillotson Avenue

Muncie, Indiana 47306

765-285-2807 or tlrussell@bsu.edu

Initial: August 2013

Revised: January 2014 (label changes)

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1. Introduction and Applicability of the Regulation

The purpose of this Laboratory Management Plan (LMP) is to standardize the management of materials discarded at Ball State University (BSU) educational and research laboratories, laboratory-support wastes, and wastes from School of Art studios and workshops that are covered by the Resource Conservation and Recovery Act (RCRA) regulations under 40 CFR 262 Subpart K. Subpart K establishes an alternate process for academic institution to manage their hazardous wastes. This process differs from the one originally established by RCRA for the industrial generators of hazardous waste.

Subpart K allows more flexibility to eligible academic entities in certain areas that are unique to their operation. The Environmental Protection Agency (EPA) has determined that any institution (college or University) who wants to opt into subpart K MUST meet the following definition:

> *A private or public, post-secondary, degree-granting, academic institution, that is accredited by an accrediting agency listed annually by the U.S. Department of Education.*

BSU is an eligible academic entity under this definition and therefore can manage its hazardous wastes pursuant to Subpart K. After careful evaluation, BSU has decided to modify the management process of its hazardous waste to comply with this alternate set of regulations.

It is vital to note that the waste management process described in this *Laboratory Waste Management Plan* applies only to *Laboratories* as defined in Section 2. It does not apply to other operations, shops, or generators on the BSU Campus who will continue to follow the normal generator standards under the federal regulations at 40 CFR 262, et.seq., and the parallel State of Indiana rules.

The following Figure illustrates what IS and what IS NOT a laboratory under Subpart K and which BSU laboratories will be subject to Subpart K requirements:

What IS a laboratory under Subpart K?	YES	NO
Teaching and research labs	√	
Art studios	√	
Photo labs	√	
Field labs	√	
Diagnostic labs in teaching hospitals	√	
Areas that support labs (e.g. chemical stockrooms, prep rooms)	√	
Chemical stockrooms that do not support labs		√
Vehicle maintenance areas		√
Custodial storage rooms		√
Machine shops		√
Print shops		√
Purchasing storage and excess		√
Service and Stores trade shops		√
Commercial photo processing		√
Power plants – Heat/Chill		√
Dining establishments		√
Sport/Recreational Facilities		√

This LMP has been developed in accordance with the Subpart K requirements. It delineates the management of all regulated waste materials generated in laboratories (educational and research) and art studios or workshops within the premises of the BSU main campus in Muncie, Indiana. A revised U.S. EPA Notification Form was submitted to the Indiana Department of Environmental Management (IDEM) in August of 2013 notifying those agencies that BSU had elected coverage under Subpart K for the main campus laboratory and art operations.

2. Definitions

CENTRAL ACCUMULATION AREA means an on-site hazardous waste accumulation area subject to either 40 CFR § 262.34(a) of this part (large quantity generators); or 40 CFR § 262.34(d)–(f) of this part (small quantity generators). A central accumulation area at an eligible academic entity that chooses to be subject to this subpart must also comply with 40 CFR § 262.211 when accumulating unwanted material and/or hazardous waste.

CHEMTRACKER is a web-based chemical inventory management system, hosted by Stanford University, capable of tracking chemical inventory and providing a robust environment in which to track substances and maintain compliance with all governmental regulations. The ChemTracker system is in the process of being implemented campus-wide, beginning with the laboratory-oriented Departments of the School of Science and Humanities and the School of Art.

COLLEGE/UNIVERSITY means a private or public, post-secondary, degree-granting, academic institution, that is accredited by an accrediting agency listed annually by the U.S. Department of Education. Ball State University meets this definition.

ENVIRONMENTAL HEALTH AND SAFETY OFFICE (EHS) means the Ball State University Environmental Health and Safety Office. This is inclusive of references to the EHS Environmental Specialist and Chemical Hygiene Officer who has primary responsibility for compliance with waste management and laboratory safety at Ball State University.

ELIGIBLE ACADEMIC ENTITY means a college or university, or a non-profit research institute that is owned by or has a formal written affiliation agreement with a college or university, or a teaching hospital that is owned by or has a formal written affiliation agreement with a college or university. Formal written affiliation agreement for a non-profit research institute means a written document that establishes a relationship between institutions for the purposes of research and/or education and is signed by authorized representatives, as defined by 40 CFR § 260.10, from each institution. A relationship on a project-by-project or grant-by-grant basis is not considered a formal written affiliation agreement. A formal written affiliation agreement for a teaching hospital means a master affiliation agreement and program letter of agreement, as defined by the Accreditation Council for Graduate Medical Education, with an accredited medical program or medical school. Ball State University meets this definition and is an *Eligible Academic Entity.*

LABORATORY means an area owned by an eligible academic entity where relatively small quantities of chemicals and other substances are used on a nonproduction basis for teaching or research (or diagnostic purposes at a teaching hospital) and are stored and used in containers that are easily manipulated by one person. Photo laboratories, art studios, and field laboratories are considered laboratories for the purposes of the regulation and this Plan. Areas such as chemical stockrooms and preparatory laboratories that provide a support function to teaching or research laboratories (or diagnostic laboratories at teaching hospitals) are also considered laboratories.

LAB WASTES (UNWANTED MATERIAL) means any chemical, mixtures of chemicals, products of experiments or other material from a Laboratory, as defined, that is no longer needed, wanted or usable in the laboratory and that is destined for hazardous waste determination by a trained professional. *Lab Wastes*, the term used by BSU for *Unwanted Materials* as defined under 49 CFR 262, Subpart K, include reactive acutely hazardous unwanted materials and materials that may eventually be determined not to be solid waste pursuant to 40 CFR § 261.2, or a hazardous waste pursuant to 40 CFR § 261.3. If an eligible academic entity elects to use another equally effective term in lieu of "unwanted material," as allowed by 40 CFR §262.206(a)(1)(i); as in this case, the term, "Lab Waste", the equally effective term has the same meaning and is subject to the same requirements as "unwanted material" under this subpart as it applies to BSU.

LABORATORY CLEAN-OUT means an evaluation of the inventory of chemicals and other materials in a laboratory that are no longer needed or that have expired and the subsequent removal of those chemicals or other unwanted materials from the laboratory. A cleanout may occur for several reasons. It may be on a routine basis (e.g., at the end of a semester or academic year) or as a result of a renovation, relocation, or change in laboratory supervisor/ occupant. A regularly scheduled removal of unwanted material as required by 40 CFR § 262.208 does not qualify as a laboratory clean-out.

LABORATORY WORKER means a person who handles chemicals and/or unwanted material in a laboratory and may include, but is not limited to, faculty, staff, post-doctoral fellows, interns, researchers, technicians, supervisors/managers, and principal investigators. A person does not need to be paid or otherwise compensated for his/her work in the laboratory to be considered a laboratory worker. Undergraduate and graduate students in a supervised classroom setting are not laboratory workers.

NON-PROFIT RESEARCH INSTITUTE means an organization that conducts research as its primary function and files as a nonprofit organization under the tax code of 26 U.S.C. 501(c)(3).

REACTIVE ACUTELY HAZARDOUS UNWANTED MATERIAL means an unwanted material that is one of the acutely hazardous commercial chemical products listed in § 261.33(e) for reactivity.

TRAINED PROFESSIONAL means a person who has completed the applicable RCRA training requirements of 40 CFR § 265.16 for large quantity generators, or is knowledgeable about normal operations and emergencies in accordance with 40 CFR § 262.34(d)(5)(iii) for small quantity generators and conditionally

exempt small quantity generators. A trained professional may be an employee of the eligible academic entity or may be a contractor or vendor who meets the requisite training requirements.

WASTE VENDOR means, for purposes of this Plan and RCRA hazardous waste management on the Ball State Campus, the chemical waste vendor retained by BSU to assist in hazardous waste determinations, bulking, packaging, labeling, and transportation for proper off-site disposal of hazardous and non-hazardous chemical and biological wastes. The *field chemists* employed by this contractor meet the minimum qualifications as *trained professionals* under this Laboratory Waste Management Plan.

WORKING CONTAINER means a small container (i.e., two gallons or less) that is in use at a laboratory bench, hood, or other work station, to collect unwanted material from a laboratory experiment or procedure.

3. Part I: Enforceable Requirements

3.1 Container Labeling

This section will explain the minimum requirements for labeling containers used to store Lab Wastes (unwanted materials) in BSU laboratories and art studios/workshops. The requirements established in this section are compulsory and must be applied in all academic laboratory and art departments.

Please refer to Section 2.10 for the definition of LAB WASTE. BSU has decided to include in this definition of unwanted materials all chemical substances that are expired, used, or generated due to experiments, artwork, or educational demonstrations unless determined otherwise by the laboratory or art studio worker, or until a formal determination is performed by the BSU Environmental Specialist or Chemical Hygiene Officer.

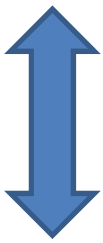
A label (or one or more labels) will be used to identify unwanted materials in the laboratories, except provided otherwise hereunder. All containers used to store unwanted materials **MUST** be labeled. At a minimum they will contain the following information:

All containers of Lab Waste ("unwanted materials") must be labeled with:

Affixed or Attached to the Container:

1. The words **"Lab Waste"**; and,

2. Information to alert emergency responders to the contents of the container (e.g., name or list of chemicals or hazard classes)



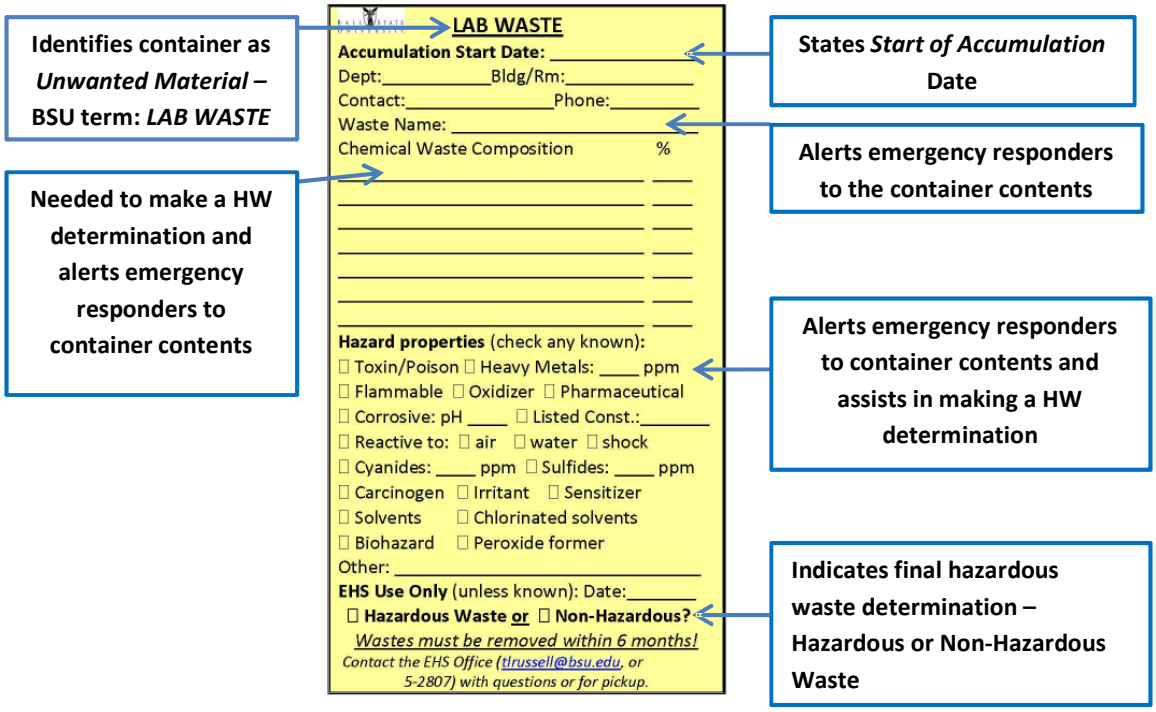
All waste containers must also have the following information either directly on the container, or associated with the container label:

Associated With Container Label – May be Affixed or Attached if Desired:

3. Information sufficient to make a Hazardous Waste determination; and,

4. Accumulation start date (of the waste in the container)

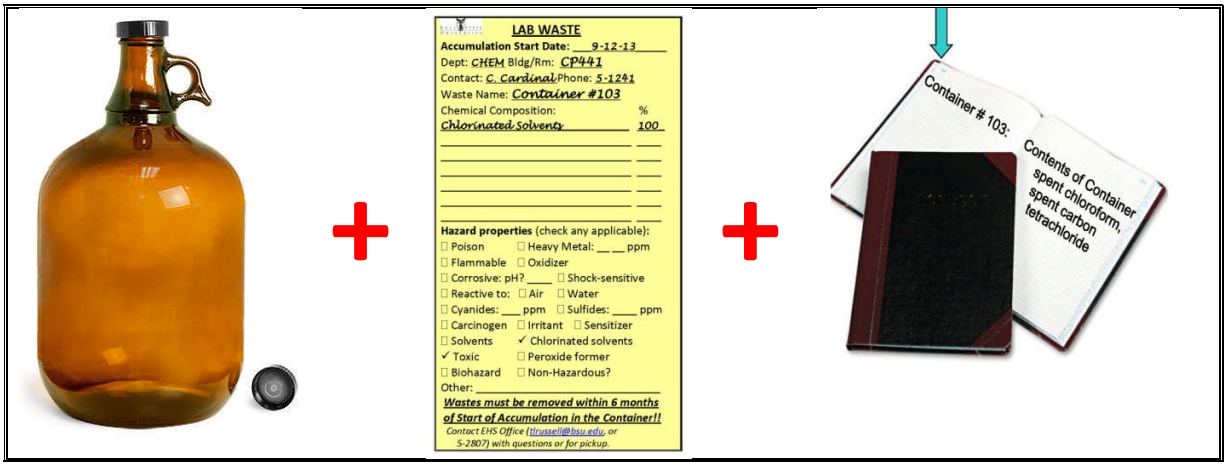
The preferred method for conveying the above-required information is through the use of a standard BSU Lab Waste Label which exhibits all of the necessary information, including the words *LAB WASTE*, and the *Start of Accumulation Date*, as well as information adequate to both inform emergency responders of the hazards presented by the waste, and sufficient to make a hazardous waste determination. The latter information is provided through both a listing of the waste components, and a checklist of hazard properties presented by the waste.



The Lab Waste label should be applied directly to the container if possible, but if not possible due to size or visibility restrictions, it may be applied to a tag that is then attached to the container or placed on an outer container accommodating the subject waste container.

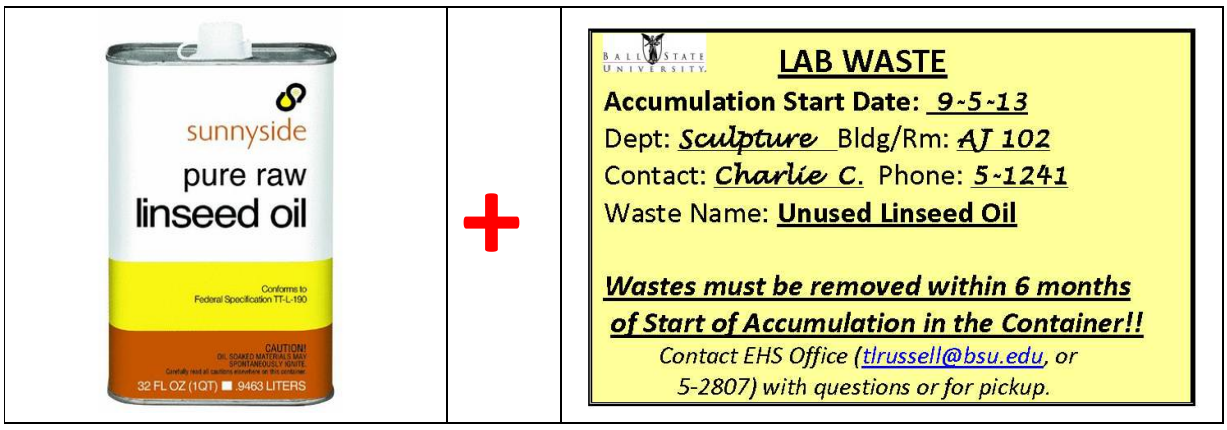
ASSOCIATED WITH INFORMATION:

If adequate information to make a hazardous waste determination is not, or cannot be displayed on the *BSU Lab Waste Label*--the trained laboratory, studio, or stock room personnel may utilize a reference system that allows tracking the information back to a specific container such as a spreadsheet, log book, electronic storage, or barcoding system as in the example below.



The label still shows the required LAB WASTE statement and information for emergency responders (as well as accumulation start date). Additional information for waste characterization, though, is here *associated with* the container rather than *affixed to* the container. Accumulation start date could also be in the log book or other reference source.

ORIGINAL LABEL OPTION: The original manufacturer label may be used. This label must be located in the original container and continue to exhibit the container contents. However, it is important to clarify that it can only be used as an alternate label if it is in good condition. Good condition means that is clearly readable, all warnings and contents are visible, and remain accurate and applicable to the contained material that is now a waste. The laboratory worker must add the word LAB WASTE to the container and the *accumulation start date*. This is NOT an approved option if any chemical materials other than the ones stated on the original label are stored in the container. The information to be *Associated With the Label*, must still be provided—either on the container itself, or associated with the container.



Here you can cut off part of the LAB WASTE label if you like –still need to show that and the Accumulation Start Date, etc. The material hazards (flammability, etc.) and contents should already be on the original container label.

32 Method of Removal of Lab Wastes

Waste containers, regardless of the remaining capacity of the container, must be removed for disposal within required timeframes, or based on total quantities accumulated in a particular laboratory, stock room, or studio:

Time Limit (6 Month): Unwanted materials will be removed from the laboratory using a *rolling 6 months* approach; that is, each container must be removed within 6 months from the container's accumulation start date.

Quantity Limits: Regardless of the above time limit for the accumulation of Lab Wastes in a particular laboratory or studio, if either of the following total waste quantity limits are exceeded, the wastes must be removed expeditiously:

- **55-Gallon Maximum:** If a particular laboratory, studio, or support area accumulates a total volume of unwanted material in excess of 55 gallons: All containers of unwanted material in the laboratory, studio, or support area will be removed within 10 calendar days of the date that 55 gallons was exceeded.
- **P-Listed Waste Maximum – 1 Quart:** If a laboratory accumulates more than 1 quart of any of the following six (6) P-listed reactive acutely hazardous lab wastes: All containers of reactive acutely hazardous unwanted material must be removed from the laboratory within 10 calendar days of the date that 1 quart was exceeded.

  To ensure compliance with this requirement, the 6 P-listed reactive acutely hazardous Lab Waste materials are:

  - *P006 – Aluminum phosphide*
  - *P009 – Ammonium picrate*
  - *P065 – Mercury fulminate*
  - *P081 - Nitroglycerine*
  - *P112 - Tetranitromethane*
  - *P122 – Zinc phosphide (> 10%)*

Laboratories that generate more than 55 gallons of unwanted materials, or 1 quart of reactive acutely unwanted materials, will need to mark on the subject containers the date the threshold volume of unwanted material is reached. The Department, or the EHS Office, must be immediately contacted in order to remove the accumulated waste within the required 10 day timeframe. The laboratory workers, instructors, researchers, or graduate assistants assigned to each generation point are responsible to comply with all EPA/IDEM requirements and those established by the EHS Office. It is the science or art department's responsibility to ensure compliance with all federal, state, and EHS requirements, including appropriate labeling, use of correct containers, notification times, and requests for Lab Waste removal.

3.3 Hazardous Waste Determinations for Unwanted Materials

Once the unwanted materials are removed from the laboratory by a *trained professional*, the hazardous wastes determination will be made in the Central Accumulation Area (CAA) within four (4) days of the unwanted materials arriving at this location. All RCRA applicable requirements for small quantity generators including those on 40 CFR 262.34(d), 262.34(f) and 40 CFR 265 Subpart I will be observed in the CAA. The hazardous waste determination may also be made by a *trained professional* while the unwanted material is at the source (laboratory, art studio, etc.) where the waste was generated, or at the time the material is removed. The contracted BSU waste vendor also provides *trained professionals* in the person(s) of field chemists to aid in the hazardous waste determinations and disposition and disposal of Lab Wastes.

Note: Pursuant to 40 CFR 262.215, *Unwanted Material That is Not Solid or Hazardous Waste,* if Lab Waste (or unwanted material) does not meet the definition of solid waste in §261.2, or hazardous waste in §261.3, it is no longer subject to the RCRA hazardous waste regulations or this Lab Waste Management Plan--but must be managed in compliance with other applicable regulations.

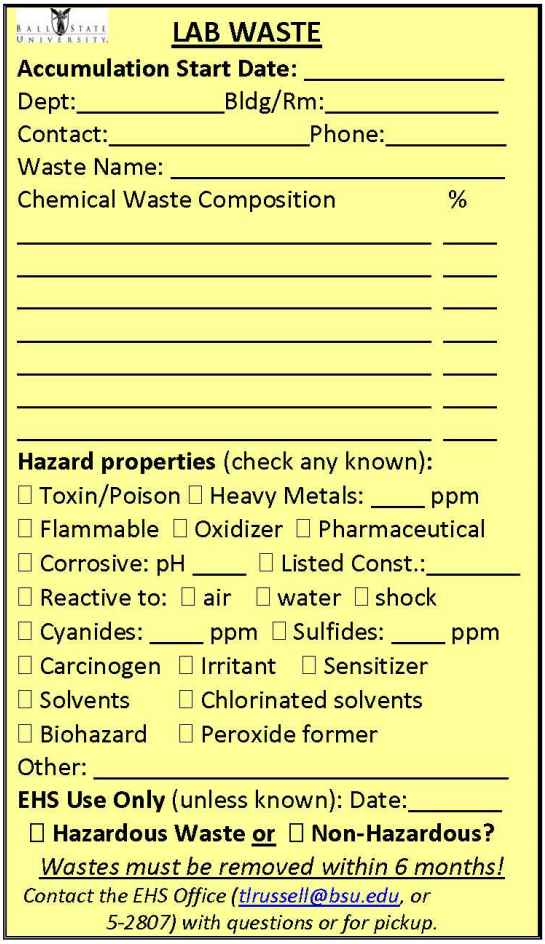
4. Part II – Non-Enforceable Requirements (Best Management Practices)

Best Management Practices (BMP)

This section of the document will discuss the *Best Management Practices* that will be applicable to all areas that generate unwanted material. The selection, implementation, and verification of these BMPs will be the primary responsibility of the Department or location generating the Lab Wastes. EHS will provide technical support and assistance to the various Schools and Departments, laboratories, studios, workshops, and associated support functions. The following procedures are not directly enforceable by the U.S. EPA, IDEM, or other regulatory authorities, but need to be followed to ensure compliance with the *Enforceable* procedures established in Section 3 of this *Laboratory Waste Management Plan*. Oversight of these BMPs and procedures will be performed by the BSU EHS Office. A checklist is provided in Appendix C to assist laboratory and studio personnel in following these practices.

4.1 Container Labeling and Management

Ball State University will use, whenever possible, the following label for all LAB WASTES generated by laboratory operations and art activities. This label meets, as discussed in Section 3, meets or surpasses all of the required EPA/IDEM criteria for labeling of *Unwanted Materials (Lab Wastes)*.



LAB WASTE

Accumulation Start Date: _____

Dept:_____Bldg/Rm:_____

Contact:_____Phone:_____

Waste Name: _____

Chemical Waste Composition %

_____ ____

_____ ____

_____ ____

_____ ____

_____ ____

_____ ____

_____ ____

Hazard properties (check any known):

☐ Toxin/Poison ☐ Heavy Metals: ____ ppm

☐ Flammable ☐ Oxidizer ☐ Pharmaceutical

☐ Corrosive: pH ____ ☐ Listed Const.:_____

☐ Reactive to: ☐ air ☐ water ☐ shock

☐ Cyanides: ____ ppm ☐ Sulfides: ____ ppm

☐ Carcinogen ☐ Irritant ☐ Sensitizer

☐ Solvents ☐ Chlorinated solvents

☐ Biohazard ☐ Peroxide former

Other: _____

EHS Use Only (unless known): Date:_____

☐ **Hazardous Waste or** ☐ **Non-Hazardous?**

Wastes must be removed within 6 months!

Contact the EHS Office (tlrussell@bsu.edu, or 5-2807) with questions or for pickup.

Instructions for completing the LAB WASTE Label are provided below. You should contact a *trained professional* in your Department or the EHS Office if you have any questions on

Contact the EHS Office (285-2807, or tlrussell@bsu.edu) if your Department, lab, or studio needs an initial or additional supply of these labels.

LAB WASTE LABEL INSTRUCTIONS

Accumulation Start Date: This is the date that wastes are first placed into the container – or, if transferring waste to a new container (larger, different type, etc.), the *start of accumulation date* from the original waste container.

Dept.: Name of the Department in which the waste was generated; e.g., Biology, NREM, Physiology, Geology, Art-Metalworking, etc.

Bldg./Rm.: The Building and Room in which the waste is being, or was, generated; e.g., WQ 007, CP441, etc.

Contact: The name of the lab or studio worker, student, instructor, or researcher responsible for the generated waste and container. Who best knows the nature of the waste?

Phone: The phone number (or, email if preferred) of the Contact person responsible for the waste.

Waste Name: Common name for the waste material. A few examples:

Formalin	Magnesium hydroxide	Lead chromate
Acetone	Sulfuric acid	Expired test kit
Extraction solvents	Water test ampoules	Vacuum pump oil
Diethyl Ether	Mixed caustics	Expired amines
Algal culture media	Unused benzene	Ethidium bromide
Contaminated ethanol	Sodium azide	Calcium flakes in mineral oil
Waste ceramic glaze	Linseed oil	Paints (oil-based)

If the waste is expired, excess, or an unused chemical or compound for another reason, that information should be added to the Waste Name, e.g., *expired* formic acid, or *unused* methyl hydrazine).

Chemical Composition: List the known or approximate chemical composition of the wastes in the container. The percentage present should equal 100. Example:

Chemical Composition:	**%**
Acetone	*30*
Hexane	*40*
Xylene	*20*
Organic solids	*10*

Hazard Properties (check all that are applicable to the waste): The following relates the basic physical or health properties of the hazard categories listed. This information is necessary both to declare the hazards of a waste, but also to aid in determining whether or not the waste material is a *Hazardous Was*te for handling and disposal purposes. Often the hazard class can be found by checking the Safety Data Sheet(s) or original containers for the chemical constituents in the waste.

Toxin/Poison: A waste that either exhibits ***Toxic*** hazards as defined below, or is otherwise designated a ***Poison*** based on shipping labels on the constituent containers, on Safety Data Sheets, or container labels related to the contents of the waste container.

Toxin: A waste having the capacity to cause death, illness, or diminished function. A material that meets one or more of the following criteria should be considered toxic:

- Has a published LD_{50} equal to or less than 0.5 g/kg of body weight.
- Has a published LC_{50} equal to or less than 1000 ppm.
- Has an OSHA permissible exposure limit (PEL) or ACGIH Threshold Limit Value (TLV) equal to or less than 5000 ppm.
- Has an OSHA PEL or ACGIH TLV equal to or less than 10 mg/m^3.

Heavy Metal: This refers to the 8 RCRA metals – Arsenic (As), Barium (Ba), Cadmium (Cd), Chromium (Cr), Mercury (Hg), Lead (Pb), and Selenium (Se), and Silver (Ag). If present in the waste in appreciable amounts, name the metal and its approximate concentration.

Flammable: Liquids having a flashpoint of less than 140°F. For solids--may cause a fire through friction; show a burning rate faster than 2.2 mm (0.087 inches) per second; or any metal powders that can be ignited and react over the whole length of a sample in 10 minutes or less. Naphthalene, matches, aluminum powder, and magnesium are examples of flammable solids.

Oxidizer: Any compound that spontaneously evolves oxygen at room temperature or under slight heating. The term includes such chemicals as chlorates, perchlorates, nitrates, and permanganates. Peroxide-formers should be checked separately where indicated

Pharmaceutical: Note if the waste is a pharmaceutical that may require special disposal considerations – controlled substance, recalcitrant to treatment.

Corrosives: Acids and bases or mixtures having a pH less than or equal to 2 or greater than or equal to 12.5, and materials that burn the skin or dissolve metals. Examples are strong mineral acids (chromic, sulfuric, hydrochloric, or nitric) strong alkalis (potassium hydroxide, sodium hydroxide), rust removers, and acid or alkaline cleaning fluids. Specify the pH of the waste where indicated if known or a potential hazard. The presence of perchloric or hydrofluoric acid should also be noted in the *Waste Name* or *Other* category. List the pH of any aqueous wastes.

Reactivity: A waste material, other than an explosive, which will vigorously polymerize, decompose, condense, or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants or in contact with incompatible material. Check if the material is air or water reactive or shock sensitive. Also, check and provide the concentration of any **cyanides** or

sulfides in the waste. A waste is hazardous if it is a cyanide- or sulfide-bearing waste which generates toxic gases or vapors at a quantity sufficient to present a health or physical danger.

Carcinogen: Any substance or agent capable of causing or producing cancer in mammals, including humans. A chemical is considered to be a carcinogen if it has been listed as such by the International Agency for Research on Cancer (IARC), by the National Toxicology Program (NTP) (latest edition), or if it is regulated by OSHA as a carcinogen.

Irritant: A chemical/material that causes a reversible inflammatory effect on living tissue, and may cause soreness, redness or discomfort.

Sensitizer: A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.

Solvents: Identify if the waste contains materials that were used as a solvent or extraction fluid – either **halogenated** (methylene chloride, chloroform, trichloroethylene, dichloroethylene, Tetrachloroethylene, 1,1,1-trichloroethane, carbon tetrachloride, chlorinated fluorocarbons, etc.); or non-halogenated (Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol, etc.)

Peroxide Formers: Organic peroxides are very unstable carbon-based chemicals that contain the characteristic peroxide (-O-O-) bond. Peroxides can be formed when commonly used laboratory chemicals with the potential to form peroxides react with air, moisture, or impurities. Organic peroxides are extremely sensitive to shock, sparks, heat, friction, impact, and light. These include acetal, acrylonitrile, butadiene, cyclohexene, cyclopentene, decalin, diacetylene, dicyclopentadiene, dioxane, ethylene glycol diethyl ether, furan, isopropyl ether, methyl isobutyl ketone, methyl acetylene, methyl cyclopentane, methyl methacrylate, styrene, sodium amide, tetrahydrofuran, tetrahydronapthalene, vinyl acetate, vinyl acetylene, vinyl chloride, and vinyl ethers.

Biohazard: An agent of biological origin (e.g., all infectious organisms, their toxins, allergens of biological origin, and genetic fragments) that has the capacity to cause ill-effects in humans.

Peroxide Formers: Organic peroxides are very unstable carbon-based chemicals that contain the characteristic peroxide (-O-O-) bond. Peroxides can be formed when commonly used laboratory chemicals with the potential to form peroxides react with air, moisture, or impurities. Organic peroxides are extremely sensitive to shock, sparks, heat, friction, impact, and light. These include acrylonitrile, butadiene, cyclohexene,, ethylene glycol diethyl ether, furan, isopropyl ether, methyl isobutyl ketone, vinyl acetate, vinyl chloride, and vinyl ethers.

Explosive: The term "explosive" or "explosives" includes any chemical compound or mechanical mixture which, when subjected to heat, impact, friction, shock, detonation or other suitable

initiation, undergoes a very rapid chemical change with the evolution of large volumes of highly heated gases which exert pressures in the surrounding medium. The term applies to materials that either detonate or deflagrate. Explosive wastes do not appear as a label hazard as such materials should be immediately brought to the attention of the BSU EHS Office for proper handling.

Other: Can include any other hazard not listed.

Non-Hazardous: Many chemicals and compounds would not constitute hazardous wastes, only a very few examples include neutralized caustics (pH between 5 and 10), collagen, cytosine, nutrients, starches, cellulase, many biologicals and media, salines, potassium thiosulfate, plasmin, calcium citrate, pectrin, and many others. If a trained individual, based on knowledge of the waste contents and characteristics can determine that the waste is not a RCRA Hazardous Waste, this class may be checked. Normally, this determination will be made following removal of the waste by the Chemical Hygiene Officer or field chemists employed by BSU's waste vendor personnel. However, if you are sure the waste is innocuous it may be checked as Non-Hazardous here--or separately disposed as solid waste or to the sewer if allowable and authorized in the *BSU Waste Management Guide*.

It is the responsibility of the laboratory or studio worker, Instructor, Principal Investigator, or manager within the laboratory or studio to prepare the label(s) completely and verify that labels are placed on all containers of lab wastes stored in the laboratory, studio, or associated storage or preparation room. In order for the container to be removed from a laboratory or studio it must be identified with the required information.

WASTE REMOVAL:

The EHS Office schedules quarterly waste pickups across the campus on the following academic calendar schedule:

1. **Mid-August (after the 2nd Summer Session-before Fall Term)**
2. **December-early January (during Winter Break)**
3. **March (during Spring Break)**
4. **May (after Spring term-before 1st Summer Session)**

However, BSU will maintain at least one Central Accumulation Area for the temporary storage and staging of Lab Wastes and other waste materials on the BSU campus between the quarterly scheduled pickups for off-site treatment and disposal. Trained personnel from your Department may be available to remove wastes at any time when containers are full, if total waste quantities are approaching the limits, or the 6-month removal deadlines are approaching. EHS personnel may also be contacted to remove Lab Wastes if

the laboratory or studio places a request for removal by emailing the BSU Environmental Specialist at tlrussell@bsu.edu or by calling 285-2807.

The removal of Lab Wastes from a laboratory is parallel to, but different from, a *Laboratory Clean-Out* procedure. The clean-out process can only be implemented once a year per laboratory or generation area. Refer to **Section 4.2.2** to come for the *Laboratory Clean-out Process*.

LAB WASTE CONTAINERS

The selection of the containers used to hold unwanted materials will be based on the hazardous characteristic of the Lab Waste material. The requirements of the containers for subsequent transportation are established by the Department of Transportation (DOT).

Two distinct classes of containers will be used in the laboratory to hold Lab Wastes— *Working*, and *Non-working containers*. Working containers are defined as: "small containers (i.e., two gallons or less) that are in use at a laboratory bench, hood, or other work station, to collect unwanted material from a laboratory experiment or studio procedure. Working containers may remain open until the end of the procedure or shift, or until it is full, at which time the working container must either be closed or the contents emptied into a separate container that is then closed. Non-working containers are those into which unwanted materials will be deposited and will remain closed except when adding or removing unwanted materials. Working containers will not exceed one (1) gallon while non-working containers shall not exceed the five (5) gallon mark. The use of larger containers (15-55 gallon) may be approved on a case-by-case basis by the EHS Office.

As stated above, Lab Waste containers must be kept closed at all times unless adding, removing, or bulking waste, or:

1. When venting of a container is necessary;
2. For the proper operation of laboratory equipment, such as with in-line collection of unwanted materials from high performance liquid chromatographs; or,
3. To prevent dangerous situations--such as build-up of extreme pressure.

For the safe and suitable handling of all unwanted materials, but especially of the potentially hazardous waste materials that are generated in the laboratories and some art studios or workshops, it is essential to select the appropriate containers. The following provides guidelines for the appropriate selection of containers to be used for the handling of unwanted materials at the laboratories:

- The most appropriate container for the different types of lab wastes should be used.
- Separate containers for non-hazardous lab wastes, biomedical, and radioactive waste mixtures, among others should be used.

- Under no circumstances is the use of food, beverage, or household containers suitable for the storage of lab or studio wastes!
- Separate containers for liquids, solids, and gases should be used.
- Containers that are compatible with the properties of the materials to be contained, considering possible secondary reactions should be used.
- Plastic and glass containers should be used for lab waste handling. These can either be new or reused containers of chemical substances used in the laboratories.
- Containers must be clean and free of polluting agents, and must have their original caps or closures.
- Plastic containers should be made of polyethylene (HDPE or LDPE), polypropylene, polystyrene (PET), polymers of vinyl, or TEFLON, such as polytetrafluoroethylene (PTFE) and fluorinated ethylene propylene (FEP).
- Glass containers of chemical substances can be reused (i.e. soda lime) or glasswork made especially for laboratory use by known brands, such as Pyrex, Kimax, Corning, and Kimble. Glass non-working containers for liquid unwanted materials can range in size from 500 ml up to 3.78 L (1 gallon). Preferably, 2.5 liters and 1 gallon containers must have an ear-like handle. The use of glass containers with a capacity superior to 1 gallon will not be allowed.
- Plastic non-working containers for liquid lab wastes can range in size from 500 ml up to 5 gallons. Containers with a capacity that surpasses 5 gallons will only be allowed in those laboratories where the volume of 5 gallons is attained in 5 days
- Plastic or glass containers for solid lab wastes can range in size from 250 g up to 2.2 Kg (5 pounds). The use of containers with a capacity that exceeds 2.2 Kg (5 pounds) will not be allowed.
- Metal containers should never be used for corrosive or aqueous lab wastes. These metal containers will not be used as secondary containments for liquid wastes. Polyethylene containers must not be used for chlorinated solvents.
- Use separate containers for unwanted materials that can be recycled or that can easily be treated in the laboratory (for example: basic neutralization of acids and strong bases) to prevent excessive waste generation.
- Avoid, when possible, mixing chlorinated and non-chlorinated solvents or extraction agents in the same waste container.
- Avoid mixing oil-based and water-based solvents, paints, and coatings in the same container.

Please refer to **Appendix A** of this Lab Waste Management Plan for suggested glass and plastic containers.

EHS will provide technical guidance and assistance to all areas. Prior to their removal from the laboratory these containers must be clean and properly labeled in accordance with section 3.1 and 4.1 of this Plan. Labels that are not in good condition should be replaced.

All non-working containers holding Lab Wastes in liquid form will be kept in a designated area in the laboratory or studio. In addition, the cabinets used to store chemicals must be classified in accordance with their chemical properties. Incompatible chemicals will be stored separately to prevent any chemical reaction. In the selection and acquisition of chemical storage cabinets, their characteristics must be considered.

Lab Wastes, like all chemicals, must be stored in accordance with local and International Fire Code standards and not exceed the maximum quantities allowed in a particular room or control area. No chemicals, including wastes, should be stored on the floor or in a manner that obstructs aisles or exits. Please refer to **Appendix B** for tips regarding the proper handling of Lab Waste containers, ranging from waste characterization to inspection.

4.2 Training for Laboratory Workers

All laboratory workers, including students, must be trained. The training must be commensurate with their duties so the employees, technicians, faculty, researchers, assistants, and students understand the requirements in this Plan and can implement them. The following classifies laboratory workers relative to the level and nature of training to be provided:

Laboratory/Studio Workers	Level of Training*	Training Methods
Students	Lab Safety Training	Powerpoint Presentation/Videos
Graduate/Teaching Assistants	Lab Safety Training	Powerpoint Presentation/Videos
Equipment Technician	Lab Safety Training	Powerpoint Presentation/Videos
Laboratory Technician	Lab Safety Training	Powerpoint Presentation/Videos
Laboratory Manager	Lab Safety Training	Powerpoint Presentation/Videos
Instructor	Lab Safety Training	Powerpoint Presentation/Videos
Faculty	Lab Safety Training	Powerpoint Presentation/Videos
Researcher	Lab Safety Training	Powerpoint Presentation/Videos
Lab Waste Coordinators / Trained Professionals	Lab Safety Training and Waste Management	Presentation by BSU EHS Environmental Specialist/Chemical Hygiene Officer

**The training to be provided to School of Art workers and students engaged in studio and workshop endeavors includes the same module on Lab Waste Management. This training is entitled, "Art Studio and Workshop Safety Training".*

The BSU Lab (and Art Studio) Safety Training includes a module on Lab Waste generation and handling and the procedures contained in this *Lab Safety Management Plan*. This training is applicable to all BSU science laboratory and art studio workers.

Different methods are planned for the development and deployment of the laboratory workers' training programs – these may include recorded presentations by Powerpoint or video, or

classroom training, as well as laboratory-specific training. The training schedule and content will be prepared or approved by the BSU Environmental Health and Safety (EHS) Office and/or the BSU Laboratory Safety and Security Committee. The main training method for laboratory workers at present is classroom training. All laboratory workers, including staff and students, must be trained in laboratory and studio safety, and the laboratory and art studio safety training sessions include a section and discussion on waste management, including the content of this *Laboratory Waste Management Plan*. The training also covers the safe transportation and movement of chemicals, which would encompass laboratory and studio wastes. The departments are responsible for coordinating the necessary training for their laboratory and art studio workers and students every term. Normally, the first training of the term will be classroom based. For those laboratory workers unable to attend classroom training, web based or recorded training opportunities will be made available.

While training records are not required for Small Quantity Generators such as BSU under RCRA Subpart K, it is intended that the various science and art departments utilizing laboratories and studios will maintain such records as part of their overall employee/student safety training records.

4.3 Training for *Trained Professionals*

The *Lab Waste Coordinators* identified in the preceding Table are considered to be *Trained Professionals* under the Subpart K RCRA regulations as they may make hazardous waste determinations in the laboratory or studio settings or may accompany or oversee the transfer of Lab Wastes to the CAA upon removal. Additional training is provided to these individuals by the BSU EHS Environmental Specialist who is a Certified Hazardous Materials Manager and also serves as the Chemical Hygiene Officer. The Environmental Specialist also serves as a *Trained Professional* and is considered qualified and trained for that function. Both to comply with the requirements of Subpart K and to ensure the safe on-site transfers on laboratory wastes, only trained professionals will:

1. Accompany the transfer of Lab Wastes (unwanted material) when they are removed from the laboratory, studio, or support area; either for consolidation in another laboratory or chemical stockroom, or taken to the CAA; and,
2. Make the hazardous waste determination, pursuant to §262.11, for Lab Wastes (unwanted materials).

The Environmental Specialist/Chemical Hygiene Officer from the EHS office already receives training in RCRA, OSHA HAZWOPER, Hazard Communication, DOT Hazardous Materials, OSHA Laboratory Safety Standard, the BSU Chemical Hygiene Plan, and other regulatory programs, documents, plans, and requirements. Training will continually be refreshed and expanded as necessary using classroom, video presentations, web-based, and other training methods.

4.4 Removing Unwanted Materials from the Laboratory

As previously mentioned, the principal method to remove unwanted material from the laboratory will be time based, using a 6 month rolling approach. (Refer to Section 3.3)

To ensure that a container does not exceed the six month limit in the laboratory, a BSU Lab Waste label, or one of the expressed options allowed in Section 3.1, any of which include display of the accumulation start date on the container, will be required. Having this information on each container will allow for the time a container of unwanted material remains in a laboratory to be monitored. Once the container is nearing its six time limit in the laboratory, or is otherwise ready to be picked up, a trained professional in the Department or the EHS Office will be notified. The trained professional will then proceed to transfer, or oversee the transfer, of the container from the laboratory, studio, workshop, or associated area where it was generated to the CAA and make the hazardous waste determination.

If the 55 gallon of unwanted material or one quart of acutely reactive unwanted material volume limit is reached in the laboratory, the laboratory worker will immediately notify the Department's trained professional or the EHS Office to alert them of the volume being exceeded. EHS personnel will assign priority status to the laboratory to ensure that the unwanted materials are removed within ten calendar days.

The removal of most Lab Wastes, however, will be associated with the quarterly chemical waste pickups which are announced throughout the university 2-3 weeks prior to the date of the scheduled waste pickup by BSU's chemical waste contractor. The subject departments, shops, or areas then notify the EHS Office of the location, quantity, and nature of the wastes they plan to have ready for pickup on the scheduled dates. The majority of these wastes are than gathered by *trained professionals* in the EHS Office or the various departments for transport to the CAA in Cooper Science Hall (or at temporary CAAs at other locations on the BSU premises). In this way, the largest volume of Lab Waste hazardous waste determinations can be made in coordination with the BSU chemical waste vendor's trained professionals upon, or within 4 days of, their arrival at the CAA. Wastes that are removed, or arrive at the CAA, before that time will be characterized by the EHS or a department trained professional.

BSU promotes consolidation of compatible unwanted materials, allowing containers to be reused whenever possible. The label of the consolidation container must reflect its contents and the earliest accumulation date of the generated substance.

Only trained professionals may transfer unwanted materials between laboratories or from a laboratory to a chemical stock room for consolidation. Areas consolidating unwanted materials will be subjected to the Subpart K requirements, including the time and volume limits.

4.5 Making Hazardous Waste Determination

Unwanted materials will be moved only by EHS authorized personnel to the Central Accumulation Area (CAA). Only the EHS Office and those departments having one or more trained professionals have access to the CAA. Once the unwanted material is moved to the CAA, the hazardous waste determination will be made within four days of the material arriving at the CAA. Within this four-day time frame, EHS personnel can determine that the material is eligible for re-use, recycling, or may be handled as a non-hazardous waste. Those wastes which are determined to constitute hazardous wastes will be labeled as such on the container, along with the relevant EPA hazardous waste code(s). After the hazardous waste determination is made, all applicable requirements in the CAA will continue to apply and be observed as usual.

4.6 Laboratory Clean-out Procedures

Performing a Laboratory Clean-out procedure is NOT mandatory and will be directly influenced by the availability of funding to carry out a clean-out. The EHS office, its waste contractor, or the responsible science or art department, will evaluate the laboratory inventory of chemicals and other materials which are no longer needed or that have expired, in order to determine the subsequent removal of those chemicals or other unwanted materials. Conducting a clean-out will be considered for one of the following reasons: It may be on a routine basis (e.g., at the end of a term or academic year); as a result of a renovation, relocation, or change in laboratory or studio supervisor/occupant; or a change in the research or studio art endeavor.

The clean-out process allows for the redistribution of the chemicals. If a laboratory worker makes a determination that a chemical can be used in another laboratory, it would be considered a product and thus not regulated under RCRA. However, if such determination is made after it is removed from the laboratory, the clean-out chemical would be regulated as an unwanted material until it is redistributed from the CAA to another laboratory for further use

The laboratory clean-out process allows the disposal or redistribution of chemical products in a 30 calendar day period. Once a clean-out has been declared, waste resulting from unused commercial chemical products will not be counted toward generator status. Generator status will not be affected by the volume of waste generated during this process. The 30 day period will start when EHS personnel in coordination with laboratory or studio personnel begin sorting through and evaluating the inventory of laboratory chemicals, making the corresponding unwanted materials determination. This process will be led by EHS personnel which will develop the clean-out schedule.

Clean-outs may only be performed once every twelve (12) months per laboratory. At the conclusion of the laboratory clean-out, all unwanted materials must be removed from the laboratory.

All records pertaining to a laboratory clean-out including the laboratory being cleaned out, the date the laboratory clean-out begins and ends, and the volume of hazardous waste generated during the laboratory clean-out will be kept in the EHS office. These records will be maintained for a period of three years from the date the clean-out ends.

4.7 Emergency Preparedness

To ensure a quick response in case of an emergency occurring in a BSU laboratory or studio, emergency contact information will be posted in every laboratory, studio, and associated support area on or near the entry doorway. This list will include contact information for both emergency responders on campus and off campus. Evacuation routes will also be posted for every laboratory.

An inventory of all chemical materials in BSU laboratories and art studios will be kept in ChemTracker. This information is continually being updated and is available to campus administrators and emergency responders through the EHS office. Chemicals that might become dangerous over time, such as peroxide formers, are assigned a one year expiration date from the date they are first added to the inventory. Once the year time limit is reached, the system will require the user to visually inspect the material, and allows for a one-year extension of the expiration date only if the container and content are in good condition. If either the container or content show signs of deterioration, or the possible development of peroxides, the laboratory worker will notify the EHS and follow the procedure to have the container removed from the laboratory as a Lab Waste

All Laboratories should have an adequate spill response kit. All laboratory personnel must be familiar with this equipment and know how to deploy it. In addition all personnel must be familiar with the Campus spill response procedures and emergency management (Refer to EHS Spill Response Plans and the BSU Emergency Response Plan).

4.8 Laboratory Waste Management Plan Availability

This plan will be made available to laboratory workers, students, or any others at the University who request it. The Plan will also be maintained on the EHS Office website.

Appendix A

Suggested Containers for Handling of Lab Wastes

HDPE Narrow-Mouth Bottles

HDPE Wide-Mouth Oblong Bottles

Wide-Mouth LDPE Bottles

Wide-Mouth Polypropylene Bottles

Higher temperature resistance than LDPE or H DP E

HDPE Round Bottles Rigid, translucent bottles are suitable for storing a variety of items including liquids, solids, and chemicals

Wide-Mouth PTFE Bottles

Amber Wide-Mouth HDPE Bottles

Reduces UV light transmission to protect light-sensitive liquids

Amber Narrow-Mouth HDPE Bottles

Protect light-sensitive materials during sampling, shipping or storage

Clear Standard Wide Mouth Bottles with PTFE-faced PE-lined Caps

Good for storing dry materials and specimens

Narrow-Mouth Field Sample Bottles

Certified Clean Amber Boston Rounds

Clear Boston Rounds with PTFE Faced PE-lined Caps

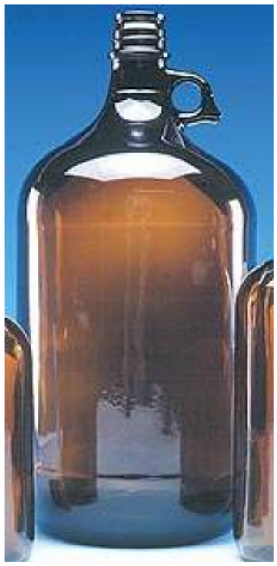
Amber Wide-Mouth Packers with PTFE Faced PE-lined Caps

Amber Wide-Mouth Packers

LDPE Boston Rounds

Safety-Coated Amber Boston Rounds

HDPE Cylinder Rounds



Amber Glass Jugs

Clear Glass Jugs

HDPE Jugs

Safety Waste Jug

Polyethylene

Red Metal or Plastic Safety Can

Used for solvent waste [5 gallon, 2.5 gallons, 1

Polyethylene Drum

[55 gallon, Closed head]

Used for large volumes of liquid corrosive wastes

Metal 55 gallon, closed head drum

Used for large volumes of non-corrosive liquids

Metal Drums

[55 gallons, 30 gallons, 10 gallons]

High Density Polyethene Containers
[5 gallons, 12.2 gallons]

5 Gal Pail

5 Gal Poly drum

Appendix B

Management of Lab Waste (Unwanted Material) Containers

The guidance in this Appendix was obtained from the ***Best Management Practices Handbook for Hazardous Waste Containers*** developed for the Environmental Protection Agency (EPA) Region 6, for the Compliance Assurance and Enforcement Division of EPA Region 6 and adapted by the BSU Environmental Health and Safety Office to fit the university's academic environment.

Tips for Waste Characterization

1. Look at a Safety data sheet (SDS) if it is available either for the product as a whole or its individual components or constituents. Some information areas on the MSDS to look for are physical property, reactivity, fire and explosion hazard, and special protection information.
2. If a product being used in a process meet some or more hazardous characteristics, the waste generated may exhibit some of the same characteristics.
3. Be aware of any changes in a process which could alter the composition of the waste generated.

Tips for Waste Characterization of Containerized Waste

1. Pay attention to marking/labeling which may indicate that a material is flammable, corrosive, etc.
2. Always check with your supervisor before handling unknown containers, or containers which you feel are labeled or marked incorrectly.
3. Look at a material safety data sheet (MSDS) if it is available.
4. If waste is in a plastic container it is a good indication the waste may be corrosive.
5. Special methods and equipment may be required to manage wastes which are:
    a. Corrosive
    b. Combustible
    c. Flammable
    d. Oxidizer
    e. Poison
    f. Toxic
    g. Reactive

Tips for Container Selection

1. Consult a corrosion resistance guide to determine if the container and waste are compatible.

2. Refer to the U.S. Department of Transportation Hazardous Material website and references for listings of acceptable container types and packaging for the hazardous material.

Tips for Safely Putting Wastes in Containers

1. Make sure you know which wastes are reactive and/or incompatible. Keep these wastes away from each other. Put them in separate containers.
2. Make sure the container cannot be harmed by the waste.
3. If you rinse out containers onsite, be aware that rinse water generated from container washing must be contained and characterized prior to disposal. Those that contained "P" or "U"-listed constituents must be triple rinsed with suitable solvents prior to disposal or re-use.
4. If you frequently reuse containers, consider "assigning" wastes to certain containers. This will allow you to reuse the container without washing.
5. Use a funnel to prevent spills, and do not use the same funnel for all wastes.
6. Certain chemicals may need room for expansion, or they may require zero headspace depending on the characteristics of the waste and storage conditions (e.g., temperature fluctuations)

Tips for Marking/Labeling Containers

1. Have all personnel use the same method (e.g., prepared labels) to label containers. Make sure all handlers know how to label the containers to convey the identity and nature of the wastes contained therein.
2. Besides the start date and the words "Lab Waste," include information about contents e.g., toxic, reactive, incompatible).
3. Apply DOT labels to the container when waste is first placed in the container. The label will be in place for shipment and provides information about the waste to drum handlers.
4. Before reusing containers, make sure all old markings/labels are washed off or blacked out.

Tips for Safely Managing Containers

1. Do not store wastes next to a sink or drain in the event of a leak from the container or spillage to the drain.
2. Provide secondary containment (a tub or bucket) for liquid wastes where possible.
3. Use a funnel or hose to add or transfer wastes to containers. This will prevent spills. Remember to rinse the funnel and characterize the rinse water (a dedicated funnel would not have to be rinsed).
4. If you notice a leak, or a container is in poor condition, transfer the waste to a new container immediately.
5. Keep containers cool and dry.
6. Make sure all container storage areas are clearly marked -- keep ignitable/reactive wastes in their own area.
7. Don't stack ignitable/reactive wastes.

8. Don’t push, roll, or drag containers. Use the right equipment to move the containers and drums.
9. Make sure the containers are easy to reach -- keep an open aisle space so that people and equipment can move freely.

Tips for Conducting Inspections

1. Be thorough. Check the tops of containers to look for waste residue or corrosion.
2. Look or walk all the way around containers – check the entire container or waste storage or use area.
3. Check containment areas, fume hoods, floors, cabinets, benches, etc. for stains.
4. Note anything unusual in lab or studio area -- even if it might not be a problem.
5. If problems are found, get the problem taken care of immediately – contact BSU Work Control or the EHS Office.

Appendix C

Lab Waste Management Checklist

BALL STATE UNIVERSITY	Environmental Health and Safety Office North Service Building	Contact: Tom Russell, CHMM 765-285-2807 tlrussell@bsu.edu

Chemical Waste / Lab Waste Management in Laboratories and Art Studios/Workshops

This checklist is for managing *Lab Wastes* (Chemical Wastes) in science education and research laboratories, and art studios and workshops, on the main campus of Ball State University. Other generators of chemical wastes (maintenance shops, housing, dining, etc.) must follow the general chemical and hazardous waste handling procedures for waste generators under U.S.EPA/IDEM hazardous waste regulations.

- ☐ Determine that the material is unwanted and is not going to be reused at any time.
- ☐ Determine the container the Lab Waste will be stored in – contact the EHS with questions or if acceptable containers are needed:
  - This container must be in good condition and compatible with the waste.
  - Large volumes of waste should be stored in U.S. DOT approved Hazardous Material shipping containers.
- ☐ Apply a BSU *Lab Waste* label (yellow) to the container at the time of first filling and complete the label fully and accurately:
  - Ensure a descriptive chemical name is printed on the label (no acronyms).
  - Ensure location and contact name is printed on the label.
  - Ensure the *accumulation start date* is printed on the label.
  - Ensure the waste components and hazards are recorded on the label.
- ☐ Use secondary containment (trays or cabinets) to segregate containers according to hazard class and compatibility.
- ☐ Ensure each container is closed at all times (except when adding Lab Wastes). See *working container* and *inline system policies* for more information.
- ☐ Ensure you do not exceed 1 kg. (2.2 lbs) of any of the following acutely hazardous materials: *Aluminum phosphide, Ammonium picrate, Mercury fulminate, Nitroglycerein, Tetranitromethane, or Zinc phosphide >10%.*
- ☐ Ensure that you do not exceed the smaller of 55-gallons or 220 lbs of Lab Waste.
- ☐ Ensure that any Lab Wastes are removed by EHS within 6 months of the *start of accumulation date* on any container – contact the EHS for pickup.
- ☐ Ensure that all personnel and students who manage Lab Wastes have training.
- ☐ Ensure all personnel and students working in the Lab Waste generation and storage areas know emergency and spill procedures:
  - Post emergency/spill/injury procedures near the lab/studio door.
  - Ensure everyone working in the area is familiar with the location and operation of emergency eye washes, showers, fire extinguishers, spill control equipment.
- ☐ Contact the EHS Office to request removal of any Lab Waste containers that are nearly full or upon approaching 6 months of storage, whichever comes first.
- ☐ **Do not dilute or dispose of Lab Wastes via drain/sewer, in trash, dumping on The ground, or by evaporation.**

Environmental Health and Safety Office, Ball State University, North Service Building, 3401 North Tillotson Avenue, Muncie, Indiana 47306, http://cms.bsu.edu/about/administrativeoffices/facilities/ehs

34.0 WASTE MANAGEMENT GUIDE

[NOTE: REGARDING CHEMICAL WASTES FROM LABORATORIES, PLEASE REFER TO THE PRECEDING CHAPTER 33.0, LABORATORY WASTE MANAGEMENT PLAN FOR PROCEDURES IN HANDLING CHEMICAL WASTES FROM LABORATORIES AND ART STUDIOS. THE FOLLOWING GUIDE WILL, HOWEVER, ADDRESS OTHER WASTE STREAMS AND WASTE TYPES GENERATED IN LABORATORIES – SHARPS, INFECTIOUS WASTES, BROKEN GLASS, ETC.]

WASTE MANAGEMENT GUIDE

September 2011 version

Prepared by the:

Environmental Health
and Safety Office
Ball State University

BALL STATE UNIVERSITY WASTE MANAGEMENT GUIDE

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1.0 OVERVIEW

It is the policy and directive of Ball State University (BSU) that all wastes generated be handled in accordance with local, state, and federal requirements; that the volume and toxicity of all waste materials be minimized and eliminated to the extent practicable; and that, when residual waste disposal is necessary, that the wastes be disposed in a safe and environmentally responsible manner.

The regulatory framework for solid (and chemical) waste regulation was established in 1976 by the Federal Resource Conservation and Recovery Act (RCRA). RCRA was enacted by Congress to protect human health and the environment from improper management of hazardous waste. RCRA introduced the concept that the generator of a waste is responsible for proper waste management from "cradle-to-grave" (i.e. from the shop or laboratory to the waste's ultimate destruction). The federal RCRA regulations may be found in 40 CFR Parts 260-279.

1.1 Solid Wastes (Refuse):

Non-recyclable solid wastes generated on campus are collected by the university or private vendors from the numerous dumpsters and roll-off containers located at university buildings and elsewhere on the campus grounds. BSU building maintenance and custodial staff collect the bagged solid waste from dormitories, laboratories, class rooms, offices, and service areas. These are then deposited in the refuse containers for pickup and off-site disposal. Smaller refuse containers are also located on the university grounds, the waste from which is routinely collected by university landscaping staff for proper disposal.

1.2 Recycling and Reuse:

Ball State University is also active in the community collection of recyclables by providing separate "recyclable" collection containers throughout the campus. "Blue bags" for the separate collection of recyclable items including beverage containers, glass, metal, plastics, cardboard, paper and magazines are also provided to all academic, professional, and staff employees, as well as students in dormitories and off campus students requesting these bags for recycling of candidate solid wastes. Depleted toner and ink cartridges will also be collected by Facilities Management staff for recycling. The collection and shipment of electronic wastes for off-site recycling or reuse is another ongoing program at Ball State.

Numerous cardboard box compactors or collection rolloffs/dumpsters are maintained and used by BSU Dining Facilities and Central Receiving and Stores for the recycling of those materials. Other examples of our efforts include the collection and recycling of waste oils and coolants from vehicle and building maintenance, and recycling of cooking oils from the BSU Dining facilities. BSU's recycling program for spent batteries and lamp bulbs are described later in this guidance.

Further, Ball State maintains a large recycling effort at BSU's nearby Heath Farm for landscaping and wood wastes, as well as for concrete, brick, block, and other reclaimable building materials. Landscaping and wood wastes, such as pallets, are ground and composted for reuse as mulch on the campus. Concrete, block and other non-putrescible building wastes are stored at Heath Farm pending crushing for reuse or as fill material. Bricks, when possible are cleaned for reuse in buildings, landscaping, and repairs.

The BSU Landscape and Bus Garage both have equipment that allow the emptying and recycling of aerosol containers and their contents. The device punctures the containers in a closed chamber, uses activated carbon to capture any aerosol or propellant emissions, and contains the residual liquid contents in a 55-gallon steel drum. This allows the steel or aluminum aerosol container to be recycled as scrap metal, and the captured contents to be utilized in a supplemental fuel recovery program.

Scrap steel, particularly larger equipment not collected in the recycling containers on campus is collected by BSU Facilities Management staff and placed in designated roll-off containers, or a scrap pad at the Heath Farm for removal and recycling by our steel recycling vendor.

All University faculty and staff are encouraged to minimize the wastes they or their Department generate, recycle, reclaim, or reuse them as possible, and seek other potential users for surplus chemicals or materials they may come to possess.

1.3 Hazardous, Universal, and Special Wastes:

Other than the solid waste and recyclable waste streams discussed above, many other regulated wastes are generated by the various educational, research, laboratory, and facility maintenance activities performed on the BSU campus. These include hazardous wastes, toxic wastes, other chemical wastes, infectious wastes, universal wastes, and other wastes requiring particular care or

handling for disposal or reclamation. For convenience, we will refer to those wastes that are not hazardous wastes, but which still require particular care, handling, recycling, or disposal procedures, as "Special Wastes".

At Ball State University, chemical waste disposal is coordinated by the Environmental Health and Safety (EHS) Office of Facilities Planning and Management. Hazardous wastes, or other potentially hazardous chemicals are not allowed to be disposed of in the building drains (without EHS and Muncie Sanitary District approval), in the trash, or by evaporation.

There are specific regulatory requirements for the individuals, laboratories, or shops, which generate and accumulate chemical waste. First, and most importantly, these individuals must properly identify and properly label all hazardous wastes in their workplace. Second, they must properly categorize and see to the proper handling, storage, and disposal of other waste materials. As part of that, they must properly store and submit requests to the EHS for disposal of chemical wastes. Finally, they must minimize the amount of waste generated and recycle whenever possible. The purpose of this document is to assist labs, shops, and the various academic, administrative, support, and recreational Departments within the University to ensure both safety and regulatory compliance. Every lab and shop on campus is subject to unannounced inspections by both the Federal Environmental Protection Agency (EPA) and the Indiana Department of Environmental Management (IDEM). Lack of compliance can result in a Notice of Violation and, potentially, fines or other penalties. More importantly, failure to properly identify, characterize, and handle these wastes properly can lead to serious accidents or exposures for employees, students, visitors, or contractors.

The University does not maintain a permitted hazardous waste storage facility on the BSU Campus and it is therefore necessary for the Departments generating the wastes and the EHS Office to coordinate and accumulate them in accordance with the EPA/IDEM waste regulations - pending pickup for transport and off-site disposal. All chemical waste is required to be held in the generating location (this location is defined as a "Satellite Accumulation Area") for subsequent pick-up, recycling, or disposal by EHS through an approved recycling or waste disposal vendor. Some wastes may be relocated by EHS staff to one of two chemical waste accumulation areas maintained by the University for secure storage--while awaiting removal and proper disposal or recycling by our approved waste disposal vendor.

The EHS Office will assist in any way possible with the identification and proper handling of wastes, including hazardous wastes, by the various Departments, laboratories, or other waste generators on the Ball State campus. The regulatory requirements or waste handling procedures covered in this document include the following general waste types:

Waste: A material/chemical that has no intended use or reuse, or for which a decision has been made to discard it, including chemicals and materials from a spill clean-up, or unused commercial

chemical products. Wastes include everything from paper and food scraps to scrap metal, spent batteries, and electronic wastes, to toxic or flammable chemical wastes.

Hazardous Waste: A waste that is EPA listed, possesses one of the EPA's hazardous characteristics, or is determined to be hazardous by review of the material's MSDS or other sources.

Special Waste: A waste that is *not a hazardous waste*, but either requires special handling or disposal, is recyclable or recoverable, or should otherwise not be disposed in refuse containers or dumpsters as a solid waste. Examples would be e-wastes, many liquid chemical wastes, aerosol cans, biological wastes, sharps, etc.

Universal Waste: Universal wastes are *hazardous wastes* that are generated by a wide variety of people that contain mercury, lead, cadmium, copper and other substances hazardous to human and environmental health. While a category of hazardous waste, specific regulations apply to these wastes to encourage their segregation and recycling and to discourage disposal as a solid waste or in landfills. Specifically, in Indiana, these wastes are spent batteries, waste lamps, and mercury containing devices.

The first step is to discuss and provide guidance for the characterization, or identification, of *hazardous wastes*. This is because the risks associated with misidentification, mishandling, or failure to comply with the applicable regulations are potentially the most severe for hazards wastes. Other, or special wastes, will then be discussed separately in Section 5 of this guide. *Special wastes* are those wastes that do not meet the definition or criteria for a hazardous waste, yet may require special handling or disposal methods compared to "normal" solid wastes, and are not to be disposed in campus refuse containers, solid waste dumpsters or roll off containers.

The hazardous waste guidance in Sections 2 through 4 provides information and requirements for the following:

- Identification (waste determination) and handling of hazardous wastes;
- Labeling of hazardous waste containers; and,
- Accumulation of hazardous wastes.

Currently, Ball State University is considered a Small Quantity Generator (SQG) of hazardous waste under EPA and IDEM regulations. This means that less than 1,000 kilograms (2,200 pounds) of hazardous waste are generated monthly from all shops, laboratories, and maintenance activities, and no more than a total of 6,000 kg (13,200 lbs) of hazardous wastes are stored at any time. We endeavor to maintain this status through routine quarterly pickups of hazardous waste throughout the calendar year as the regulatory requirements are less onerous than those for a Large Quantity Generator (LQG) of hazardous waste.

The Top 10 Guidelines for

Environmental Responsibility

1. Attend BSU environmental and waste management training.
2. Properly identify the waste hazards and correctly categorize the waste type: high hazard, hazardous, universal, or special waste.
3. Properly label and store all waste containers.
4. Keep waste in proper containers and segregate incompatible wastes.
5. Use secondary containment for liquid wastes.
6. Keep waste containers closed at all times.
7. Do not dispose of hazardous or special waste by evaporation, dumping down drains or sewers, or putting in trash containers.
8. Notify **BSU University Police (5-1111)** For a major chemical spill (beyond training or capability of employees to handle).
9. Use pollution prevention techniques. (Reduce, Reuse, Recycle).
10. If you have questions or need assistance with waste identification, handling, or spill cleanup call **the BSU EHS Office (285-2807)**

2.0 IDENTIFYING A HAZARDOUS WASTE

The requirements described in this guide do not apply until a material becomes a waste. From a regulatory perspective, a waste is something that is spent, has no further use, or no intended use, and a decision is made that it is to be discarded. A determination must be made for every waste generated at Ball State University as to whether or not the waste should must be handled as a hazardous waste. Most of these determinations are simple, while others may be complex and require sampling and analysis of the waste. A waste is determined to be a "hazardous waste" by one of three means:

1. It is on one of the EPA's lists of hazardous chemicals;

2. It meets the definition of at least one of the EPA-defined characteristics of toxicity, ignitability, reactivity, or corrosiveness; or

3. The waste's generator, utilizing some outside source of information (MSDS, manufacturer's website, etc.) determines that the waste should be treated as a hazardous waste due to its inherent danger.

The waste determination is an important requirement under the hazardous waste rules, but may be based on generator knowledge of the wastes generated, by testing of the waste, or by both methods. Failure to make a "waste determination", or to incorrectly classify a waste, is itself a violation under these regulations.

It should be stressed that not all chemical wastes constitute hazardous wastes, and should not therefore be identified as such. Wastes determined to be hazardous wastes are subject to more intensive regulatory oversight governing their identification, accumulation, handling, storage, transportation, and available means of disposal or recycling. While chemical wastes that are not hazardous wastes are not subject to such intensive oversight, it is still necessary to handle them carefully and ensure they are disposed or recycled properly. Many wastes that do not meet the criteria to be a *hazardous waste* may still have hazardous properties and require similar handling precautions. Non-hazardous, or special, wastes are picked up by the EHS at the same frequency as hazardous wastes and, very often, from the same locations.

2.1 Common sources of hazardous (or special or universal) wastes

The following are some common sources of wastes at Ball State University that must be considered as potential hazardous waste and for which waste determinations must be made:

- **Abandoned Unknowns.** This category is the most difficult. The problems of abandoned unknowns can be avoided with standard shop or laboratory protocol: label each container as to content, concentration, date, prepared or purchased, and your initials. Unknown or unidentified wastes are extraordinarily expensive for disposal--particularly unknown gases.
- **Orphan Wastes.** Waste chemicals from laboratories that are adopted, passed on to subsequent faculty members or researchers, or inherited with the laboratory. These chemicals sometimes date back to the 1960s, "sputnik" era, when government monies were widely available for science education and research at schools and universities.
- **Laboratory Wastes.** Wastes from laboratory demonstrations or research are often hazardous wastes. The principal investigator, faculty, or laboratory manager will need to know the ingredients and characteristics of the wastes generated in the laboratory. Ignitable (D001), corrosive (D002) and reactive (D003) wastes are common.
- **Shop Wastes.** Wastes from the BSU maintenance shops including paints, grindings, ash, used oils and coolants, aerosol cans, paint filters, dust collectors, etc.
- **Art Department Wastes.** Photographic development wastes, paints and solvents, metal working wastes and lubricants, grindings, etc.
- **Dining Wastes.** Used vegetable oils and greases, food wastes, drain cleaners, maintenance and sanitizing chemicals.
- **Building Maintenance and Custodial Wastes.** Cleaning compounds and liquids, broken glass, lamps from lighting fixtures.
- **Medical and Biological Wastes.** Wastes from biological, nursing, health center, human performance research, medical education, and health and physiological research activities.
- **Questionable Purity.** Chemicals of questionable purity should often not be used and should be considered waste.
- **Expiration Date Surpassed.** Please pay special attention to the expiration dates of peroxidizable chemicals. Use or disposal of peroxidizable chemicals before their expiration date is passed is very important.
- **Photographic Process Waste.** The spent chemicals, especially fixer, used in developing photographic and x-ray film contain silver, a RCRA waste. These solutions are collected and recycled.
- **Chemicals from Discontinued Research, Experiments, and Analysis.** When these materials are no longer useful or cannot be recycled, they are considered waste and must be characterized prior to disposal.
- **Excess Stock with No Likelihood of Use.** Stock with no likelihood of use is waste. Careful purchasing can reduce the volume of excess chemicals that have to be managed as hazardous waste.
- **Spent Cleaning and Wash Solvents.** Spent cleaning and organic solvents are almost always hazardous waste because the solvent or the materials which contaminate the solvent may be

hazardous. Spent solvents from automotive parts and washing machines are recycled. Other generators of spent solvents should contact the EHS Office for management options.

- **Spent Acids and Caustics.** Used acids or bases from laboratory work or aqueous solvents used for building maintenance and cleaning purposes, floor stripping, etc.
- **Spent disinfectants.** Chemicals such as chlorine, quaternary ammonium compounds, and glutaraldehyde.
- **Preservatives.** Solutions of formaldehyde (formalin), or alcohols used in the preservation of biological specimens, with or without specimen presence in the waste
- **Waste Paints.** Waste paints containing hazardous metals such as lead or hazardous solvents have to be treated as hazardous waste. Most waste water based (latex) paints are not considered to be hazardous waste, whereas most oil-based paints are ignitable hazardous wastes when disposed.
- **Used Oil.** Oil (petroleum, vegetable, and synthetic) is to be recycled. Used oil filters may be disposed of as ordinary waste provided they are drained of free liquid and crushed.
- **Mercury.** Mercury is commonly found in instrumentation, thermostats, and thermometers. If released, spilled mercury and spill control equipment (absorbents, etc., must be disposed as a hazardous waste. Disposal of a broken mercury thermometer costs many times more than the purchase price of an electronic thermometer. If intact, mercury containing lamps, thermometers, etc., can be handled as universal wastes.
- **Electrical Transformers.** Older (1979 and before) electrical transformers often contain PCB dielectrics. Disposal of PCB dielectric fluids from equipment is very expensive as it is regulated under the federal Toxic Substances Control Act (TSCA). This includes the ballasts from fluorescent light fixtures. Any transformer or capacitor not bearing a “No PCBs” label must be handled as a PCB contaminated device.
- **Fluorescent or mercury-containing lamps.** Used fluorescent bulbs may be recycled for glass and mercury recovery as a universal waste if they are not broken. Broken bulbs must be handled and disposed as hazardous waste.
- **Batteries.** Intact, non leaking batteries that are rechargeable may be recycled as a universal waste. Broken or leaking batteries may need to be disposed as a hazardous waste.
- **Donated or "Free" Chemicals.** The "free" chemicals acquired by various departments on campus have cost thousands of dollars to dispose of as hazardous waste. Accept no donated chemicals from any source without first consulting EHS.

Again, it is important to remember **two points** throughout this guidance document:

- *Not all chemical wastes are hazardous wastes as defined in the RCRA regulations; and,*
- *Although a waste chemical may not be defined as a hazardous waste under the RCRA regulations, such does not mean that it is safe to handle or dispose with other solid waste or refuse.* Procedures and precautions for the handling of other “special” wastes are included in this guidance.

As mentioned previously, there are basically two causes or means by which a particular waste or waste stream must be determined to be a hazardous waste: (1) if it is specifically listed as a hazardous waste due to its process use (F and K Lists) or by its chemical identity (P and U Lists); or, if it exhibits one of the four characteristics of a hazardous waste – ignitability, corrosivity, reactivity, or toxicity. These are discussed in more detail in the following section of this guidance and a simple flow chart is provided. Of course, a generator may also choose to have a waste generated to be handled as a hazardous waste if he believes it's mishandling or disposal may create a physical or health hazard or endanger the environment.

2.2 EPA Characteristic Hazardous Wastes

Rather than being directly identified as comprising a hazardous waste by virtue of being on the F, K, P, or U lists, a waste is a hazardous waste if it exhibits any one of the four physical characteristics of a hazardous waste. The following are the four characteristics and a few examples of common wastes at the University:

2.2.1. Ignitable Wastes

a) Flammable Liquids- Flashpoint <140 F
   Examples: *Alcohols, Benzene, Toluene, Xylene, Acetonitrile*

b) Oxidizers
   Examples: *Nitrates, Perchlorates, Bromates, Permanganates, Peroxides, Periodates*

c) Organic Peroxides
   Examples: *Benzoyl Peroxide, Cumene Hydroperoxide, Methyl Ethyl Ketone*

   Peroxide

2.2.2. Corrosive Wastes – Aqueous liquids with a pH of ≤ 2 or ≥ 12.5

a) Inorganic Acids

Examples: *Hydrochloric Acid, Sulfuric Acid, Nitric Acid, Phosphoric Acid*

b) Organic Acids
Examples: *Formic Acid, Lactic Acid, Acetic Acid*

c) Bases
Examples: *Hydroxide solutions, Amines*

2.2.3. Reactive Wastes –

Materials which can react violently with water, create toxic and /or flammable gases when mixed with water, ignite or react upon exposure to air, or are capable of detonation at standard temperature and pressure. Examples:

a) Sulfides and Cyanides
b) Peroxide formers
c) Alkali metals - Sodium, Potassium, Lithium
d) Dinitro - and Trinitro - compounds - Picric Acid
e) Carbonyl compounds
f) Isocyanates
g) Perchlorate crystal formers - Perchloric Acid

2.2.4. Toxic Wastes

A selected group of eight (8) heavy metals, ten (10) pesticides, and twenty-two (22) organic chemicals are classified as hazardous due to their toxicity characteristic. These materials constitute a hazardous waste if an extract (leachable constituents) of the waste exceeds the quantitative threshold for that constituent. For example, lead-based paint normally fails the TCLP test for lead. The complete list is located in **Appendix 'A'.**

If you are ever unsure of a waste's characteristics, contact the BSU EHS Office so that they can assist with the waste determination. Remember, under the regulations, it is the waste generator's responsibility to determine whether or not a particular waste constitutes a hazardous waste. If the

faculty member or principal investigator makes an incorrect determination considerable liability and risk may result.

2.3 Listed Hazardous Wastes

A hazardous waste can be classified, or listed, as either a process waste or a discarded commercial chemical product. This distinction is particularly important when manifesting and labeling wastes.

2.3.1 Process wastes

A process waste is any waste that, by virtue of some use, process or procedure, no longer meets the manufacturer's original product specifications, has been exhausted, or contaminated to the extent it can no longer be used for its intended purpose. Examples of process wastes are chromatography effluents, spent solvents, electroplating wastes, diluted chemicals, reaction mixtures, contaminated paper, etc. These are referred to as "F" and "K" wastes under the EPA regulations and they are specifically listed by the industrial process or use through which they are generated. Few "K" listed wastes are generated by the University as, for the most part, those are byproducts of industrial scale production practices. Some "F" listed wastes are generated though, particularly F001 – F005 waste streams, from the use of solvents in laboratories and building maintenance activities. The regulatory criteria for the F001-F005 wastes are included in **Appendix B** to this guidance document.

2.3.2 Discarded commercial chemical products

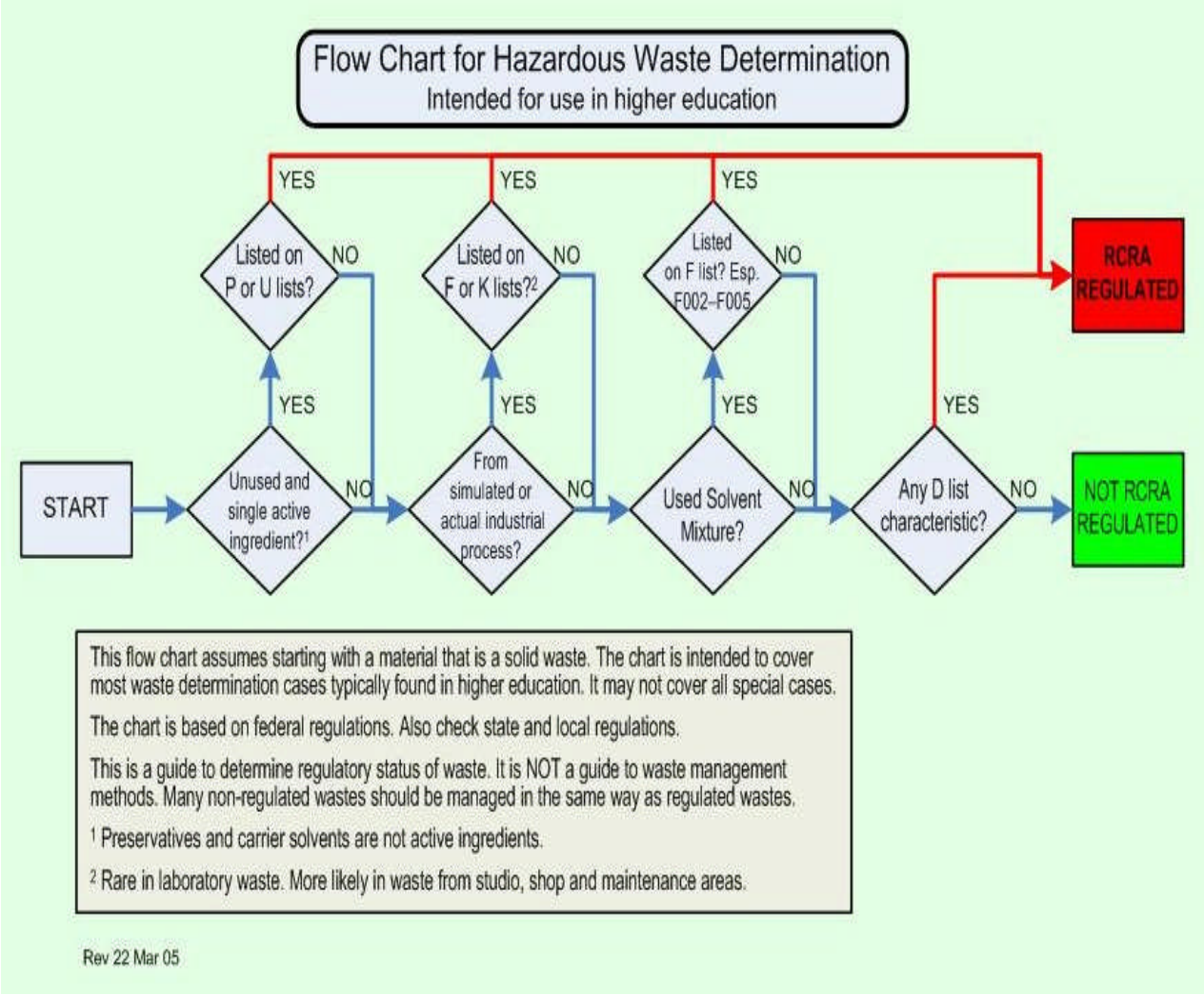
A discarded *commercial chemical product* is the original (virgin) material. Examples are containers of unused or outdated chemicals from laboratories, darkrooms, or service areas. These are referred to as "P" and "U" wastes under the hazardous waste regulations.

Appendix B to this Guidance is a composite of approximately 850 chemicals that are recognized by the EPA and BSU EHS as possible constituents of hazardous wastes. It must be stressed that just because one of the chemicals appearing in **Appendix B** is present in a waste, that does not mean the waste is a hazardous waste. The particular chemical must be the sole active ingredient in the material, and the waste must not have been used for its intended purpose or mixed with any other chemical, compound, or product. Usually these wastes were "off-specification" or chemicals that were not used for whatever reason.

Acutely toxic hazardous wastes, also called "P-listed" wastes, comprise the first list of **Appendix B**. Any container that once held a P-listed waste must be triple rinsed before the container can be discarded. The rinsate cannot be put down the sink. An alternative would be to have EHS handle the unrinsed

empty containers along with other chemical wastes. Additionally, no more than 1 quart of a P-listed waste may be stored in a satellite accumulation area, whereas up to 55-gallons may be stored in such areas of other hazardous wastes, including the U-listed wastes. The EHS Office should be notified if a shop or lab generates or intends to dispose of any quantity of a P-listed waste.

Everyone who generates a U or P-listed waste must be extremely careful not to mix that waste with any other waste--or the entire volume must then be identified, handled and disposed as a listed hazardous waste.



By familiarizing yourself with the hazardous waste characteristics and listings you will be able to determine the waste classification of most materials-- provided you are knowledgeable of their physical and chemical properties. Manufacturer's (MSDS) are excellent sources of information about chemicals.

In the interest of personal safety, one should not routinely handle a material unless you have studied not only its physical and chemical properties but also its health effects.

2.4 High Hazard Wastes

Particular precautions must be taken with some wastes such as picric acid, concentrated perchloric acid and others that are explosive, highly reactive, or extremely toxic. Others require special care as they are regulated under other OSHA, ATFE, EPA, DEA, or fire prevention programs.

Some of these include:

- **Unknowns** - Special effort should be exercised to prevent the generation of unknown wastes, since characterization of unknown wastes significantly increases the cost of disposal. To have unknowns picked up, place a *Hazardous Waste label* on the container with the word *"Unknown"* in the constituents column.

- **Picric Acid -** Picric acid is normally wet with >10% water and is relatively safe in this form. However, picric acid can become explosive if dried or combined with metals.
  - Never store in containers with metal caps.
  - Check frequently to ensure dampness. Add water if needed.
  - Keep cap tight and seal to keep moisture in.
  - If dry picric acid is found, notify HES.

- **Drugs** - There are many chemical and/or pharmaceutical compounds that are used in research that are also considered hazardous wastes by the EPA when disposed.

- **Peroxide Formers** – These compounds must be picked up by EHS within six (6) months after date of opening or one (1) year after date of receipt. Common peroxide formers are ethyl ether, ethylene glycol dimethyl ether (glyme), vinyl ethers, isopropyl ether, potassium

metal, and sodium amide. Chemicals that form peroxides should be dated when received and checked periodically with potassium iodide (KI) paper to detect peroxides. High peroxide concentrations may occur without the presence of visible crystals. Do not even attempt to test containers that are severely outdated as opening the container could cause an explosion. Contact HES for assistance if such outdated materials are encountered. Departments which do not have a documented and functioning program to prevent peroxide formation will be expected to share in the high cost of disposal for these materials. Additional information is available on request from EHS.

- **Dinitro and trinitro compounds** - These compounds must be picked up by EHS before the contents have dried. These crystals can become shock sensitive when the moisture content is less than 10%. Picric acid is a common example of this type of compound.
- **Ethidium bromide** – Concentrated stock solutions must be handled by EHS as a hazardous laboratory waste. The rinsate and destained gels can be placed down the sink and into the trash. EHS will provide a 5 gallon bucket for stained gels to be handled as a hazardous laboratory waste. Researchers concerned about discarding gels or solutions with lower or questionable amounts can have them handled as a hazardous laboratory waste. If a lab chooses to decontaminate their ethidium bromide, the filter and/or resin beads must be handled by EHS.

- **2.4.7 Common-Named Reagents** – The following reagents contain mercury and should be handled as hazardous waste:

Dobbin's Reagent	Nessler's Reagent	Sachsse's Solution
Millon's Reagent	Hubb's Reagent	Knapp's solution
Hayem's Solution	Rohrback's Solution	Speigler's Reagent
Morrell's Solution	Tyrosine Reagents	Tanret's Reagent
Hopkins-Cole Reagent	Jacquemart;s Reagent	Meyer's Solution

Other high hazard reagents include: Flemming's Solution (osmium, chromic acid), Folin-Dennis Solution (mercuric cyanide), Fisher's Reagent (phenyl hydrazine), and Erlicki's Solution (chromium).

- **Controlled Substances** - Disposal of controlled substances is regulated by the Drug Enforcement Administration (DEA). Controlled substances can be disposed of in an EPA approved incinerator, with prior DEA approval. The destruction must have two witnesses and appropriate forms submitted to the DEA. If requesting the disposal of a controlled substance also include the DEA registration number and telephone number of the person who originally authorized the purchase of the material.

- **Stench Chemicals –** While not necessarily a hazardous waste, chemicals that emit a stench such as thiols and sulfur containing compounds should be disposed of in containers with tight fitting lids. They can be double sealed with Parafilm, tape, or overpacked in a slightly larger container.

- **Trace Contaminated Laboratory Waste** - This includes gloves, gowns, bench paper, etc., that have been contaminated with carcinogens, mutagens, teratogens, or heavy metals. Materials from spill cleanups are often included in this category. Sharps, empty or full reagent bottles, and non-contaminated trash should not be packaged with trace contaminated waste in order to minimize the amounts generated. Trace contaminated trash should be double plastic bagged, with each bag sealed, and placed in a sturdy cardboard box, which is sealed with tape and appropriately labeled. Include this material with your wastes for hazardous waste disposal.

- **Pyrophoric Chemicals -** Some chemicals react with air and ignite spontaneously. Pyrophorics should be stored in a tight container in an inert atmosphere. Some common examples are listed below:
    - Activated zinc
    - Butyl lithium
    - Diethyl zinc
    - Phosphorous
    - Raney nickel
    - Trimethyl aluminum

- **Water Reactive Chemicals -** Some chemicals react with water and produce excessive heat, and flammable or toxic gases. These must be identified and stored under conditions that prevent contact with water. Some examples are listed below:

    - Acid anhydrides, e.g., acetic anhydride
    - Acid halides, inorganic, e.g., phosphoryl chloride, sulfuryl chloride
    - Acid halides, organic, e.g., acetyl chloride
    - Alkali metals
    - Alkali metal amides or hydrides
    - Anhydrous metal halides, e.g., aluminum trichloride
    - Calcium carbide
    - Grignard reagents
    - Metal alkyls
    - Non-metal halides, e.g., boron trifluoride, phosphorous trichloride
    - Phosphoric anhydride or phosphorous pentoxide
    - Sodium dithionite

The EHS Office should be notified if any of these, or other materials are generated as wastes in a form or concentration that may present physical risks.

3.0 WASTE TRANSPORT AND STORAGE REQUIREMENTS

3.1 WASTE (AND CHEMICAL) TRANSPORTATION

U.S. Department of Transportation Hazardous Material (HazMat) standards regulate the labeling, packaging, and transportation of hazardous materials. The definition of *hazardous materials* encompasses many chemicals used in laboratories and campus maintenance activities. Training is also required by the DOT for employees handling hazardous materials. BSU employees are exempt from the training requirements when transporting hazardous materials in university vehicles on university business, but any persons shipping hazardous materials off campus by a non-university carrier are subject to the training requirements. The EHS Office should be contacted if you are shipping hazardous materials in regulated quantities or packaging off site.

Many precautions for transporting waste on campus apply to proper chemical handling as well.

- Hazardous materials must be transported and handled on campus in accordance with the BSU *DOT Hazardous Materials Shipping Security Plan.*

- Stock Room or chemical storage personnel should not dispense chemicals in breakable containers of any size unless the customer has an approved transport container in which to place the chemical for transporting before leaving the Stock Room. *Approved transport container* means a commercially available bottle carrier made of rubber, metal or plastic with carrying handle(s) which is large enough to hold the contents of the container transported if broken in transit. Lids or covers are desirable, but not necessary if secondary containment is available. Rubber or plastic should be used for acids/alkalies; and metal, rubber, or plastic for organic solvents.

- Laboratory Carts used to transport chemicals from one area to another must be stable and in good condition. Unless the chemical is in an *approved transport container,* secondary containment should be provided for the primary chemical container. Transport only a quantity which can be handled easily. Plan the route ahead of time so as to avoid all steps, stairs, or persons.

- Use freight elevators, not passenger elevators to transport hazardous chemicals whenever possible. The individual transporting the hazardous chemicals should operate the elevator alone if possible. Avoid getting on an elevator when a person is transporting hazardous chemicals. Request other persons to await the next elevator run rather than ride with the hazardous chemicals.

3.2 HAZARDOUS WASTE ACCUMULATION REQUIREMENTS

Once a waste is determined to constitute a RCRA *hazardous waste*, specific requirements apply to the labeling, accumulation, storage, transportation, and disposal of that waste. While this section specifically addresses hazardous wastes, similar information should be provided and precautions be taken for any chemical wastes – although they would not be labeled as *hazardous waste.*

It is the responsibility of the shop, laboratory, or other generator to ensure that laboratory or other waste generation and storage areas are maintained in accordance with applicable rules and regulations. Waste is to be accumulated only in areas classified as "Satellite Accumulation areas." A *Hazardous Waste Satellite Accumulation Area Requirements* sheet **Appendix C** includes the required criteria to allow hazardous wastes to be stored in *satellite accumulation areas* pending removal for disposal. Information is provided for both shops and laboratory hazardous wastes being generated. The laboratory or shop must ensure that everyone in the lab has read and is familiar with the *Hazardous Waste Satellite Accumulation Area Requirements* sheet and this *Waste Management Guide.*

Hazardous waste at a satellite accumulation area can be accumulated as long as necessary, but the total quantity of all wastes at one Satellite Accumulation Area may never exceed a total of 55 gallons. Additionally, no more than 1 quart or 1 kilogram of an acutely hazardous waste (P-Listed Waste) may be accumulated at one time. Empty containers that once contained a P-listed waste must also be triple rinsed prior to disposal, and the rinsate must be handled as a hazardous waste.

All waste containers must have at least one (1) inch of headspace to allow for expansion. The exterior of the container must be free of chemical contamination. Leaking or overfilled containers must be repackaged before they will be transported by EHS.

A Hazardous Waste label must be affixed to a container before any hazardous waste is put into the container. Refer to **Section 4** for additional labeling requirements. The container must be stored closed except when actively adding or removing wastes.

Incompatible chemicals must not to be placed in the same container and the container must be compatible with the wastes contained in it. **Appendix D** includes information on the compatibility of differing chemicals for storage purposes. When placing a chemical into the waste container, consider venting to prevent over-pressurization resulting from any abnormal reactions. Mixing of

wastes should normally be done in a fume hood or well ventilated area.A spill kit must be accessible to all lab personnel. The spill absorbent or neutralizer must be appropriate for the spilled chemical.

Do not hold unneeded chemicals or waste. Dispose of these promptly to ensure regulatory compliance and to maintain a safe workplace. If 55-gallons of hazardous waste are accumulated in one or more containers, contact the EHS office immediately, as it must then be removed from the satellite accumulation area within three (3) days. The EHS Office will pick up the wastes for continued storage in one of our compliant hazardous waste accumulation areas on campus to await the next quarterly pickup.

Shops, laboratories, or other locations that generate hazardous wastes in satellite accumulation areas should also post emergency contact numbers including the following:

EMERGENCY PHONE NUMBERS

Fire, Explosion, or Major Spill	**5-1111 or 911 (University Police)**
Medical Emergency or exposure	**5-1111 or 911 (University Police)**
IDEM Emergency Response	**888-233-7745**
Gas Leak	**800-227-1376 (Vectren – after 911 call)**
BSU Work Control	**(28)5-5082 (Craft shop assistance)**
University Health Center	**(28)5-8431 (Wood Health Center**
Poison Control	**800-382-9097**
BEST Environmental	**888-561-BEST (Spill cleanup contractor)**
Spill or Exposure Reporting	**(28)5-2807 (EHS Office)**

Hazardous Waste Containers

All hazardous waste material **must** be stored in an appropriate container.

The containers must be:

- Compatible with the waste material being stored; check MSDS
- Sturdy and leak-proof
- An appropriate size
- Under the control of the person generating the waste
- Closed at all times except when adding waste, and have a tight-fitting cap
- Clearly identified with a hazardous waste label

Containers that previously held materials that might be incompatible with the waste to be stored (including food, beverage and detergent containers) are NOT suitable for storing waste.

Incompatible Materials

Certain hazardous wastes **cannot** be safely mixed or stored with other materials because a severe reaction or explosion can occur or an extremely toxic reaction product can result.

The chemical label and/or MSDS should provide information on incompatibilities. In general, hazardous waste containers should be segregated by hazard class as listed below:

- Ignitable/Flammable • Reactive with Water • Corrosive
  Pyrophorics • Reactive with Air • Concentrated Acids
  Explosive • Peroxide Formers • Concentrated Base
  •Oxidizers •Reducers

3.3 OTHER CHEMICAL WASTE STORAGE

While not as onerous as the hazardous waste storage requirements, certain practices must be followed for the safe storage of other hazardous chemicals, regardless of whether they are wastes, on campus and in laboratories. This will prevent breakage or leakage from containers that would create a hazardous waste needing disposal:

- Chemicals should always be segregated according to compatibility. The segregation of chemicals assures the safety of the chemical user, other persons, EHS personnel, and regulatory compliance for the University. Refer to **Appendix D** in this guide, or other chemical compatibility charts.

- Excess or outdated chemicals should not be allowed to accumulate in any location to a point that would create an unsafe working environment for university personnel, students, or visitors.

- Unknown materials cannot be disposed (under state and federal law) until the unknown has been properly identified. Make sure all materials in your work area are properly labeled and identified. If a label has corroded or falling off the container, be sure it is immediately replaced. Analytical services for identifying unknowns are very expensive.

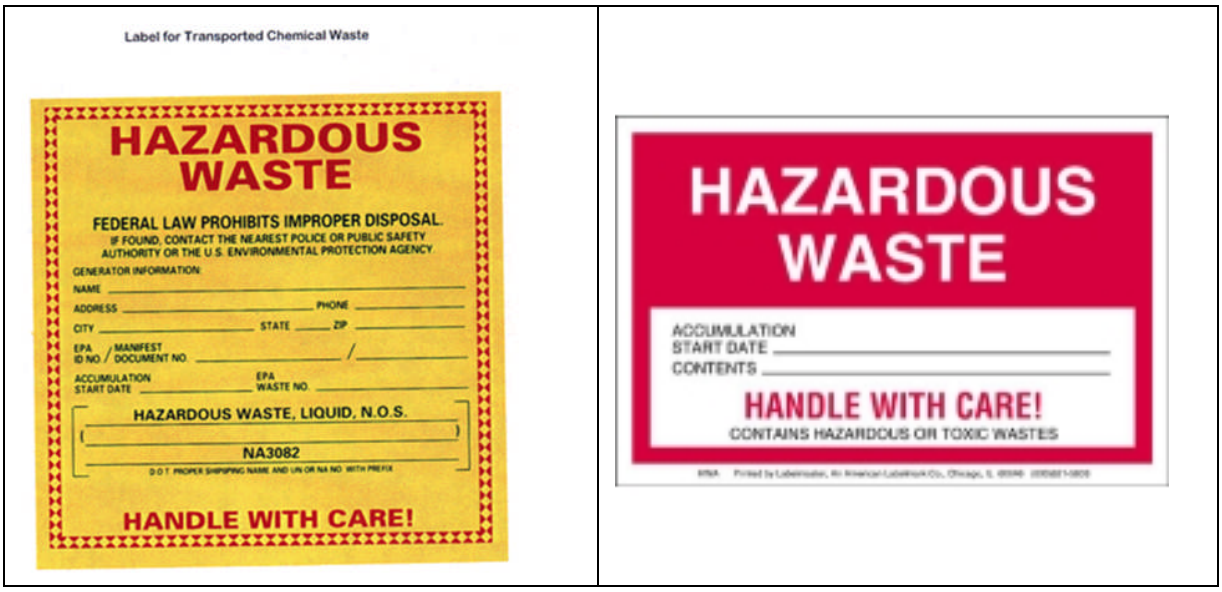
- An annual inventory of all chemicals in every University facility should be conducted. Inventories will reduce the number of unknown chemicals and the tendency to stockpile chemicals. Additional information concerning inventory procedures and record keeping formats are contained in the BSU written *Hazard Communication* (for all BSU employees) and *Chemical Hygiene* (for laboratory workers) *Plans.*

- When possible, chemical containers with liquids should be provided with secondary containment or emergency devices (absorbents, drain seals, etc.) kept available to prevent the escape of any liquids to the environment or that may endanger persons.

- All containers must be tightly capped or closed at all times except when removing the chemical for use.
- All hazardous chemicals, depending on their hazards and quantities, must be stored in compliance with applicable OSHA, EPA, and fire authority standards.
- Ensure that a MSDS is readily available for each hazardous chemical stored.
- Do not store hazardous chemicals near drains

4.0 HAZARDOUS WASTE LABELING REQUIREMENTS

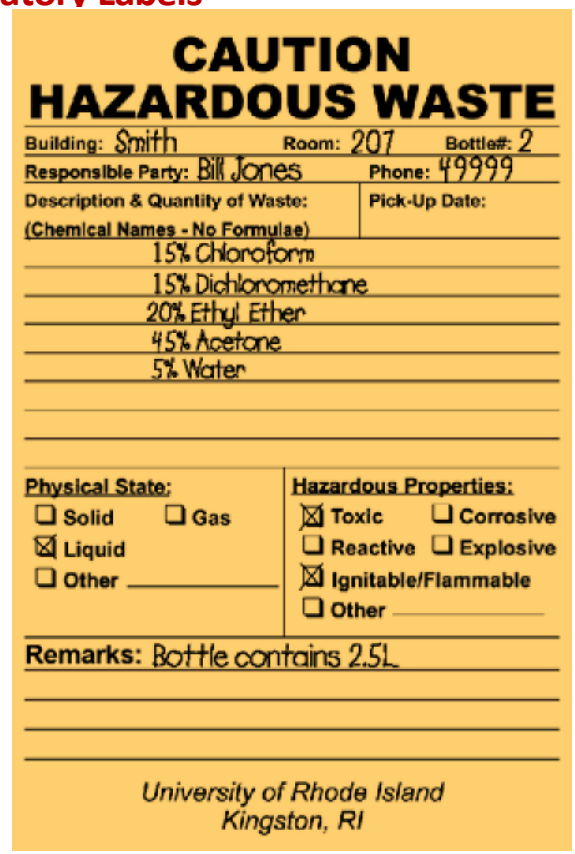
All ***Hazardous Waste containers*** must be labeled correctly. Below are examples of Hazardous Waste Labels that must be affixed to each hazardous waste container (except for laboratory wastes):



Directions for Labeling

1. The *Hazardous Waste* label must be placed on the container BEFORE any waste is put into the container, or at such time that it is determined that the container is holding a waste to be discarded that meets the criteria for a hazardous waste.
2. Abbreviations and formulas are not permitted.
3. Ensure that the laboratory (waste generator), building, and room number are included on the label.
4. If the label is for satellite accumulation in a particular shop or laboratory, write in the words "Satellite Accumulation" in the space for "Accumulation Start Date".
5. Laboratory wastes may utilize other label types as illustrated below due to the smaller size containers often involved. Regardless, the label must identify the waste as a Hazardous Waste, relate the contents, and either list a "start of accumulation" date or the words, "Satellite Accumulation".
6. Laboratory wastes should identify all ingredients or components in the waste container.

Laboratory Labels



CAUTION
HAZARDOUS WASTE

Building: Smith Room: 207 Bottle#: 2
Responsible Party: Bill Jones Phone: 49999
Description & Quantity of Waste: (Chemical Names - No Formulae)
Pick-Up Date:

15% Chloroform
15% Dichloromethane
20% Ethyl Ether
45% Acetone
5% Water

Physical State:
☐ Solid ☐ Gas
☒ Liquid
☐ Other

Hazardous Properties:
☒ Toxic ☐ Corrosive
☐ Reactive ☐ Explosive
☒ Ignitable/Flammable
☐ Other

Remarks: Bottle contains 2.5L

University of Rhode Island
Kingston, RI

The Lab Manager must ensure that the waste container label includes:

- The words "Hazardous Waste"
- The identity of the hazardous waste
- If the waste is a mixture, a list of all the components and the percentage of each (these should sum to 100%)
- The primary hazards presented by the waste (e.g. "toxic", "reactive")
- The name of the person responsible for the waste, their location and phone number

Remove or deface all extraneous container labels.

Particular labels or information is also required for some other wastes that are not hazardous wastes, but those will be presented in **Section 5** of this guidance.

5.0 SPECIAL AND UNIVERSAL WASTE MANAGEMENT PRACTICES

Certain wastes generated at the University may or may not be hazardous wastes, but have special handling ,labeling, management, or disposal requirements. While Universal Wastes, strictly speaking, are hazardous wastes--because of the lesser requirements applied to these materials to accommodate their recycling, they are discussed in this Section of the guidance.

5.1 Special Wastes

As noted previously, a number of types of wastes are not strictly defined as hazardous wastes, but nevertheless fall under other regulatory programs, present hazards that must be recognized, or must be recycled or pretreated (used oils, photo fixer solutions) rather than being directly disposed. Examples are:

5.1.1 Gas Cylinders - Users must establish accounts with suppliers who will allow the return of unused product and empty cylinders. If possible, the entire contents of the cylinder should be used up. Generators must ensure that aging cylinders are picked up by EHS before the integrity of the valve and cylinder is compromised. The department may be billed directly for cylinders that require special handling and disposal procedures such as unknown or old cylinders. Disposal of such cylinders can cost in the thousands of dollars. If empty, the cylinders must be so marked, and remain secured with cylinder caps attached pending removal.

5.1.2 Photo chemicals - EHS intends that labs which use large quantities of photo chemicals have a silver recovery unit installed. This unit treats the spent fixer so that it may be discharged down the drain. If a silver recovery unit is not used, EHS must handle the spent fixer. The developer and stop bath can, if approved by the EHS Office, be combined in a container to neutralize the solutions before being put down the sink. No concentrated photo chemicals of any kind can be placed in the trash or disposed in the sink.

5.1.3 Used Oil – Used oil includes all vacuum pump oil, synthetic oil, transmission and brake fluids, lubricating greases, etc. Used oil must be stored in securely closed containers provided with secondary containment. The secondary containment must have the capacity to hold 110 % of the volume of the largest container within the containment area. Each used oil container must be labeled clearly with the words "Used Oil". Used oil labels are available from the EHS Office.

5.1.4 Broken Glass - Broken glass (uncontaminated) should be placed into a cardboard box, or other puncture resistant container, be tightly taped shut, and clearly marked with the words: *Broken Glass*. The container can then be placed in with the normal trash.

5.1.5 Laboratory Glassware – Used or broken laboratory or other glassware that may be chemically or biologically contaminated must be placed in a proper *Broken Glass Container*. Such containers should be provided for all laboratories. If one is needed, please contact the EHS Office.

5.1.6 Sharps *- This is a regulated waste stream and must not be disposed of in the regular solid waste.* The term "sharps" is a regulatory waste classification associated with those instruments

used to puncture, cut, or scrape body parts and that, in a waste container, can cause punctures or cuts to solid waste handlers or the public. This means that all sharps waste must be placed in appropriate sharps containers for later decontamination prior to disposal. All sharps waste is to be placed in red sharps containers marked with the biohazard symbol. Use appropriate size sharps containers, and do not fill more than two-thirds full.

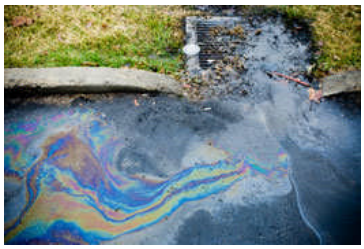
If a sharps container is needed, or a full container needs to be picked up for proper disposal, please contact the EHS Office. Several BSU Departments have arrangements with our disposal vendor for weekly pickup of sharps and biological wastes at their building or location.

***5*.1.7 Biological or Infectious Wastes** – Potentially infectious or biological wastes will be picked up by the BSU biowaste disposal vendor. Biological waste is any material that contains or has been contaminated by a biohazardous agent. Biological waste includes, but is not limited to; Petri dishes, surgical wraps, culture tubes, syringes, needles, blood vials, absorbent material, personal protective equipment and pipette tips. The wastes should be placed in leak-proof containers, which are labeled with a biohazard label. The containers may be a pail with tight fitting lid for liquids or a box with an inner plastic liner, both of which bear a biohazard label.

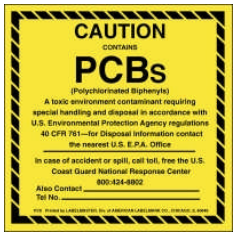
Non infectious materials such as formaldehyde or alcohol preserved biology specimens may, if necessary, also be disposed as biological wastes by overpacking in a plastic container with a tight-fitting lid and biohazard label.

5.1.8 Electronic Wastes - E-waste is any waste that has one or more of these components: a circuit board, electronic component (diode, resistor, capacitor, or coil), display device, computer, or electronic device. It does not include vehicles or white goods (refrigerators, ranges, water heaters, or other similar large appliances). These materials are normally collected by BSU Purchasing through Central Receiving for recycling and disposal through a commercial e-waste recycler.

5.1.9 Spilled Materials - the spilled chemical and the absorbent must be packaged and handled as hazardous waste if it exhibits a hazardous waste characteristic or the spill was of a listed hazardous waste (see Section 2). The *Hazardous Waste* label must name the chemical(s) and the absorbent used. See **Section 7.0** of this document for more details on spill response. Other material spills, such as oils, would not be a hazardous waste but may require solidification prior to disposal.



5.1.10 PCB Containing Materials – Waste or spent materials or devices that contain polychlorinated biphenyls (PCBs) require particular care. Such materials are not hazardous wastes under RCRA, but may be toxic wastes under the federal Toxic Substances Control Act (TSCA). The most common PCB articles to be disposed on the BSU campus are fluorescent light ballasts, though PCBs may be found in other electrical equipment such as switches, capacitors and transformers.



Any electrical ballasts or capacitors manufactured before 1979 should be presumed to contain PCBs unless the device has a label stating “NO PCBs” as shown above. PCB ballasts will be containerized for storage pending disposal at a permitted facility. Non-PCB ballasts can be shipped to a facility that disassembles the devices and recycles them. The EHS Office should be notified of any leaking or overheating PCB ballasts that are in service as cleanup and decontamination may be necessary.

5.1.11 Aerosol Containers –Common aerosol cans are: paint, cleaners, pesticides, coatings (i.e., polyurethane), deodorizers, and lubricants (ie;,WD-40). Aerosol cans contain both the product (i.e., paint, adhesive) and propellant (i.e., propane, butane) which may have hazardous properties (i.e ignitable, toxic). Aerosol cans may be handled as solid (non-hazardous) waste if they meet the following criteria:

- The aerosol container is “empty” – that is, the products have been used for their intended purposes so that when holding the cans upright and pressing down on their nozzles, not enough product comes out for them to be useful anymore; and,
  (a) no more than 3% of the original net content weight remains in the cans; or,

  (b) No more than one inch of liquid remains in the bottoms of the cans; and,

- The cans did not hold chemical formulations with sole active ingredients identified in the P-list hazardous waste listings).

Disposing of an aerosol can that still has product inside the can in the regular trash can be considered improper disposal of hazardous waste. To ensure compliance with hazardous waste regulations, non-empty aerosol cans should be collected and managed as hazardous wastes. As noted previously, the BSU Landscape Department and Bus Garage have devices to puncture and empty aerosol containers so that the residual contents can be used as a fuel substitute, the propellant gases are absorbed, and the steel or aluminum containers can then be recycled as scrap metals.

5.2 Universal Wastes

Universal Wastes are hazardous wastes, but the effect of the Universal Waste Rule is to reduce the regulatory requirements applying to the handling of these specific wastes, which

otherwise would be subject to full hazardous waste regulation under RCRA. This in turn serves as an incentive to channel these wastes into collection and recycling programs, diverting them from less environmentally desirable modes of disposal such as landfilling or incineration. They include spent batteries, certain types of lamps, and mercury containing devices or equipment. All universal waste containers must be labeled clearly with the appropriate label when waste is first added. Universal Waste labels are available at no cost from the EHS Office.

Universal wastes must be stored for no longer than one (1) year before being shipped to a permitted recycling facility.

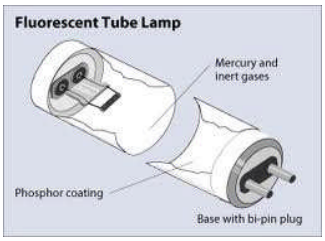
5.2.1 Batteries – Alkaline batteries may be disposed of in the trash as their carbon footprint is small due to the availability of alkaline materials, and because heavy metals or other toxics are not used in their manufacture. Large storage batteries and other batteries which contain hazardous metals such as mercury, lithium, lead, silver, cadmium, nickel, and hydrides must be collected by the BSU EHS Office for recycling. The most common batteries collected for recycling include the following:

- Lead-acid (common in vehicles and large electronic and mechanical devices);
- Lithium (laptop computers and other electronics)
- Nickel-Cadmium or NiCad (power tools and portable devices)
- Silver oxide (watches, toys, medical devices – contain mercury)
- Nickel-metal hydride or NiMH (Hybrid vehicles, tools)

All used battery containers must be clearly labeled using one of the following phrases: “Universal Waste—Battery(ies),” or “Waste Battery(ies),” or “Used Battery(ies).” The electric terminals of the batteries must also be taped or the batteries placed in individual bags or containers to prevent “short-circuiting” and potential fires during storage or transport.

Battery collection containers are available for offices or shops by contacting the EHS Office and staff of that office will retrieve the batteries when the containers are full for proper storage and recycling.

5.2.2 Light bulbs (Lamps) - fluorescent and high-intensity discharge (HID) bulbs contain mercury or other heavy metals and must be handled as Universal Waste. Other specialty bulbs which may contain mercury or other heavy metals (UltraViolet, High Intensity Discharge) must be handled by EHS as well for recycling. Departments which accumulate large quantities of bulbs may deliver them to BSU Central Receiving in the Service and Stores Building (Dock #4). Lamp boxes are also available at that location. Otherwise, BSU Facilities Management custodial staff can pick up exhausted bulbs from the buildings if they are containerized and accompanied by the red pickup form. All spent lamps must be packaged, preferably in the cardboard shipping containers in which they were received, and labeled clearly using one of the following phrases: "Universal Waste—Lamp(s)," or "Waste Lamp(s)," or "Used Lamp(s)".



It is important to remember that any bulbs intentionally broken must then be handled and disposed as a hazardous waste rather than a universal waste.

5.2.3 Mercury Containing Equipment – There are many types of electrical, temperature, and pressure sensing equipment that contain elemental mercury. Before disposing of any of these types of equipment, you should verify that they do not contain mercury. All used mercury containing equipment must be labeled clearly as "Universal Waste—Mercury Containing Equipment," "Waste Mercury-Containing Equipment," or "Used Mercury-Containing Equipment."

Examples include:

- Heating and air conditioning thermostats
- Tilt switches used in silent light switches, washing machine lids, chest type freezers

- Pressure gauges, displacement/plunger relays
- Sump pump float switches
- Thermometers, manometers, barometers

The mercury containing device should be packaged carefully to avoid breakage. It may be preferable to notify the EHS Office to pick up the device and that should always be done if there is any breakage or release of mercury to the environment. The EHS Office should be contacted immediately for assistance in the event of a mercury release.

6.0 CHEMICAL WASTE PICK-UP PROCEDURES

A. The EHS Office arranges for hazardous waste pickups on a quarterly basis, normally on the following schedule:
   - Two (2) weeks prior to the start of Fall Classes;
   - During Winter Break
   - During Spring Break
   - Following Spring Dismissal in late May or early June.

   Some wastes (used oils, lamps, biowastes) are shipped for off-site disposal more frequently based on generation rates and storage capacity.

B. In order to have hazardous waste picked-up from your accumulation area, you should contact the BSU Environmental Specialist (285-2807) prior to one of the scheduled quarterly waste pickups. Most Departments are notified approximately one (1) month in advance of the waste pickups and requested to identify the wastes to be picked up, the quantities, and their location.

C. Provide as much information about the contents of each waste or container as possible. As a minimum, the chemicals' names, the number of containers, and the total volume should be listed.

D. Be prepared to direct EHS personnel to the satellite accumulation area or waste location when they arrive to pick up the waste. The EHS Office may pick up waste prior to or between the quarterly removal times in order to aggregate and consolidate the waste materials in one of BSU's hazardous waste accumulation areas.

E. If the waste needs to be picked up before, or more frequently than, the scheduled quarterly pickup dates, feel free to contact the BSU Environmental Specialist. Often, the waste(s) can be removed from the shop, laboratory, or other area and stored temporarily in one of our hazardous waste accumulation areas pending the scheduled waste pickup.

7.0 SPILL RESPONSE AND CLEAN-UP PROCEDURES

This Section first briefly summarizes the necessary response to spills occurring on the general use buildings, areas, and grounds of the BSU Campus, and then provides greater detail on the response to spills in laboratory or chemical handling situations.

7.1 General Spill Response Procedures

A response to a release of petroleum compounds on the BSU campus should follow the procedures established in the *BSU Spill Prevention Control and Countermeasures (SPCC) Plan* . The response to the release of other chemicals or biological contaminants should be performed in accordance with the *BSU Spill Response Plan*.

In general, if there is an immediate danger to health, life, property, or risk of an environmental release (major spill), evacuate the area and contact emergency personnel immediately. Contact emergency authorities and response at (28)5-1111 or 911. Contact EHS at (28)5-2807. All spills occurring after normal working hours should be reported to the University Police Department (UPD) at (28)5-1111. A UPD representative will contact the necessary response agencies or an EHS representative if necessary.

In the event of a spill which does not meet the above major release criteria; stop the spill, contain the spill, notify other's in the area, and clean up the release immediately. All flames should be extinguished and spark-producing equipment turned off. All non-essential personnel should be evacuated. Each Department, shop, or laboratory should have a spill kit and personnel trained for response to minor or incidental spills. Personnel should have received training for response to minor releases through their OSHA Hazard Communication or Chemical Hygiene Plan training.

After cleaning up the spill, place the chemical and absorbents in a container with a *Hazardous Waste* label on it and contact the EHS Office.

The steps for immediate response and reporting of a spill are illustrated on the following page.

Do not attempt to clean up a chemical spill unless you are familiar with the chemical and have the training, personal protection, and spill control equipment to safely do so safely!

Chemical Spill Emergency Response

The following steps should be taken in the event of a chemical spill:

Evacuate:

- Alert others in the area and direct / assist them in leaving.
- Without endangering yourself: Remove injured to fresh air, remove contaminated clothing and flush contaminated skin and eyes with water for 15 minutes. If anyone has been injured or exposed to toxic chemicals or vapors, call **911 or 5-1111** and seek medical attention immediately.
- Leave the spill area.

Confine:

- Close all doors and isolate the area
- Ventilate the area if safe to do so
- Prevent people from entering the spill area.

Report:

- From a safe place call **911 or 5-1111**
- Report the emergency and give:

  - ✓ Your name, location and phone number
  - ✓ Location of the spill
  - ✓ The name and amount of the material spilled
  - ✓ The extent of the injuries
  - ✓ The safest route to the spill

Stay by that phone.

- Emergency services will respond to stabilize spills or clean up and provide medical attention.

Secure:

- Until emergency response personnel arrive; block off the areas leading to the spill.
- Post personnel near commonly-used entrances to the area to direct people to use other routes.
- Notify your supervisor.

Emergency Response

Call 911 or 5–111

7.1 Laboratory Spills

Possible Situations:
A minor or major spill of a known or unknown substance (toxic, radioactive, biohazardous, or flammable) is witnessed, observed, or reported. The spill is in your laboratory, on your floor, in another part of the building, or in a location that could affect the general area.

Definitions:

A ***minor spill*** is characterized by the confidence and capability of the staff to clean up the spill and return the area to normal working conditions without the assistance of emergency personnel. The individual or clean-up crew must be properly trained under OSHA *Hazard Communication* or *Laboratory Safety Program* standards, must don the appropriate personal protective gear, and must use suitable equipment and supplies.

A ***major chemical spill*** requires the assistance of emergency personnel from outside the Department - the Office of Environmental Health & Safety, or Police and/or Fire Departments. This may be necessary due to the location, quantity, toxicity, or physical hazards of the spill, the exposure of individuals, or any combination of those factors that prohibit or make it inadvisable or ineffective for the immediately available staff to confine or remediate the release.

SPILL ASSESSMENT:

Assess the severity of the spill and take the appropriate action: Does the material pose a substantial hazard to human health or is there immediate danger of fire or reaction? Identify the material and its hazards from its container. Send for or locate the material MSDS.

- Avoid prolonged exposure to all vapors, fumes, and smoke during assessment;
- Remove all ignition sources from the area;
- Evacuate all students and unnecessary personnel from the area.

SPILL RESPONSE:

Response to a chemical spill occurs at several levels. For many employees and students, spills may be cleaned up at the first level - theirs. The Office of Environmental Health & Safety may need to be called to manage other spills, or outside authorities such as the Muncie Fire Department, Delaware County Emergency Management Agency, or private contractors may be necessary.

When is a spill really a spill?

A ***spill*** is defined as "*a material out of control*." In a particular sense, the quantity of material is not important. The essential issue is whether the hazards, the location, and the quantity cause the situation to be beyond the laboratory worker's capabilities, or beyond the intended use by a student.

Experience provides some guidelines whether a spill should be cleaned-up by laboratory personnel or by spill response personnel. For convenience and safety, a minimum quantity has been established beyond, which all spills, regardless of the substance, must be reported. All spills greater than 1 quart (1 liter) must be reported to the Environmental Health & Safety Office at 285-2807, or to Dispatch at 285-5081 during normal business hours or to the University Police at 285-1111, or 911. While this may seem overly stringent to some, experience indicates that over-reporting is preferable to under-reporting.

In addition to the minimum quantity, the following types of spills must be reported, regardless of the quantity:

- All spills of extremely flammable materials (flash point less than 20 degrees F);
- All spills of extremely toxic materials (5mg/kg LD50);
- All mercury spills;
- All personal contamination or exposure above OSHA, NIOSH, or ACGIH exposure limits;
- All leaking containers; and
- All uncontrolled compressed gas releases

Laboratories and personnel are responsible to have procedures to clean spills that are below the reportable level. The following must be addressed:

Personal Safety

The primary consideration for laboratory personnel when a material is spilled is safety. Safety for every person in the laboratory and in the building is of paramount importance.

If the spill could potentially harm someone, call 285-2807 or Dispatch at 285-5081. If after hours, call the University Police at 285-1111 or 911. Otherwise, the laboratory that will clean up the spill must follow specific procedures to do so safely and effectively.

Personal Protective Equipment (PPE)

Before attempting to clean up a spill, the lab responder must put on a minimum amount of personal protective equipment (PPE).

- Chemical safety goggles
- Lab Coat
- Nitrile or neoprene gloves (other glove materials based on the chemical involved)

Other or additional PPE (respirator, chemically resistant apron) may be necessary for response to certain chemical releases or situations to prevent exposure to the responder.

Clean-up Materials

Laboratories must have certain supplies available before attempting to clean a spill. The actual materials to be used will depend upon the hazards posed by the spilled material. The following is a recommended minimum list of supplies:

- Absorbent pads (for oil, water, coolant, solvents)
- Absorbent socks (for oil, water, coolant, solvents)
- Acid neutralizer
- Activated carbon
- Caustic neutralizer
- Dust pan & brush
- Heavy duty plastic trash bags
- Laboratory tongs
- One gallon or five gallon plastic bucket with lid
- Hazard labels for the recovered waste.

If materials such as hydrofluoric acid, glutaldehyde, or formaldehyde are present in the laboratory, specific absorbent or containment media for those chemicals must be available.

Note: This procedure is not applicable to spills of Mercury, PCBs or radioactive materials.

LABORATORY SPILL CLEANUP PROCEDURE:

Personal Protective Equipment (PPE)

Use the appropriate PPE. If, during the spill or subsequent actions, any person comes in contact with a chemical, refer to the manufacturers *Material Safety Data Sheet* (MSDS) for First Aid guidance.

Control

Control the source of the spill, if it is still present. For example, a bottle which was knocked over may still have some material in it. The responder should carefully upright the container, place it on an absorbent pad in safe location, and replace the lid on the container. Any spread of spilled material must also be controlled. This is best done by placing absorbent pads or socks around and on the spill. Many laboratory spills involve broken glass. The spill responder must take precautions to avoid getting cut.

Absorb/Remove Liquids

Acid, Caustic, or other Non-Flammable Liquids

These are the most easily absorbed with polypropylene absorbent pads and socks. Neutralizing powders and liquids are also commercially available. Place used absorbent pads and socks in a trash bag. Frequently, laboratory spills will spread into drawers and behind or under equipment. The responder must be careful to locate all such contaminated areas.

Flammable Liquids

Flammable liquids should be absorbed on activated carbon or absorbent polypropylene pads and socks. Use approximately 2 pounds of activated carbon per pint (0.5 liters) of liquid. Use the dust brush or spatula to thoroughly mix the activated carbon with the liquid. Neutralizing powders are also commercially available. Use the dustpan and the brush to collect all residue. Remove large pieces of broken glass as described in step 4 and place all other debris in a plastic trash bag or appropriate container.

Liquids in General

Cover the liquid with a spill mix of vermiculite or equivalent absorbent to contain and absorb the material. A 1:1:1 mixture by weight of soda ash (sodium carbonate, Na_2CO_3), cla cat litter (bentonite) and sand is very effective in rapidly absorbing liquids, in neutralizing acids, in controlling fumes, and in

moderating the hazard due to reactive materials. The liquid spill is covered with the mix and, after the liquid has been absorbed, the solid is collected into a heavy-walled plastic bag or container. Commercial powders for absorption of solvent spills are also available. The spill residue container is secured and labeled as material for disposal. Numerous manufactured loose absorbents, absorbent pads and socks are now available for response to oil, coolant, contaminated water, and solvent releases.

Handling Solids

Solid Caustic Alkalies

Recover the dry material using dry techniques for reuse if possible. The remaining dry, solid material should be carefully swept up, collected, and then dissolved in a beaker, neutralized with an acid in a controlled manner, and then flushed into the sink drain with large amounts of water. Delay in clean-up may allow absorption of moisture from the atmosphere and increase the difficulties of clean-up. Flush contaminated areas with water and neutralize with dilute acid, preferably acetic acid. Neutralizing liquids are available commercially that neutralize the pH to reduce the hazard and for ease of cleanup.

Solids Acids

Dry solid material may be carefully collected when possible for reuse as intended. The EHS Office can then be called to remove this material. Flush contaminated areas with water and neutralize with sodium bicarbonate or sodium carbonate. Neutralizing liquids are available commercially that can be applied to the spilled material to neutralize the pH for cleanup.

Remove broken glass

Using tongs, dustpan and brush, or by carefully using gloved fingers, remove all large pieces of glass and place them in a “broken glass” container for safe disposal.

Decontaminate

Acidic Liquids

Apply acid neutralizer on all surfaces affected by the spill. Soak up the neutralizer and apply fresh neutralizer. Remove the residue with absorbent pads or paper towels. Thoroughly wash the affected area with hot soapy water. Use absorbent pads to finish cleaning the area.

Caustic Liquids

Apply caustic neutralizer on all surfaces affected by the spill. Soak up the neutralizer and apply fresh neutralizer. Remove the residues with absorbent pads or paper towels. Thoroughly wash the affected area with hot soapy water. Use absorbent pads to finish cleaning the area.

Flammable Liquids

Thoroughly wash the area with hot soapy water. Use absorbent pads to finish cleaning the area.

Container

Use absorbent pads, neutralizers, and hot soapy water, as needed, to remove all traces of spilled material from the container. Remember to clean the bottom of the container.

Inspect

Carefully check the entire affected area for spilled residue, hidden contamination, or unsafe conditions, and act accordingly.

Package Spill Residues

Place all spill residues and contaminated PPE in plastic bags. Seal the bags and place in a bucket or other appropriate container. Attach the necessary hazard and waste identity labels on the outside of the container. Place the bucket in the Satellite Accumulation Area. Contact the BSU Environmental Specialist 285-2807 for removal.

Restock Spill Supplies

Gather and restock supplies as needed.

Evacuation Policy for Hazardous Material Spills:

- Evacuations are rarely needed in minor spills.
- Workers who are not involved in the minor clean up of the affected areas may simply vacate the premises for a brief period.
- Evacuation of rooms, floors, or even buildings is usually necessary in major spills.

The decision to evacuate is made jointly between the Department and the Office of Environmental Health and Safety. Should the Fire Department or Police Department respond, the decision to evacuate or restrict access will be up to the Incident Commander. Be certain to alert all persons in the affected area to evacuate to the assembly area or to an alternate location if the assembly area is in the danger zone. Secure the area and control the perimeter to restrict access into or through the affected area. Delegate a person knowledgeable about the spill to coordinate with arriving emergency personnel. These procedures should be established in the laboratory's *Chemical Hygiene Plan*.

SAMPLE SCRIPT: *We have had a hazardous spill in your building. Evacuate to _____ immediately. Turn*

off all equipment. Take your personal belongings. Do not return to the building until you are notified that the spill is cleaned up.

8.0 WASTE MINIMIZATION

Waste minimization is any action that reduces the amount and/or toxicity of chemical wastes that must be shipped off-site for disposal as hazardous waste. The success of any waste minimization program is dependent on the conscientious participation of every individual at Ball State University. There are three methods of waste minimization:

8.1 Source Elimination (Reduce)

Remove the source of the waste by eliminating the process or practice or by substituting another process that does not generate a waste, or generates only a secondary material that can be used as a raw material in another process. For example, some laboratory demonstrations necessitate the use of chemicals that are toxic or inherently dangerous to handle. Sometimes these demonstrations can be eliminated, reproduced by other means, or video demonstrations utilized rather than performing laboratory displays that generate hazardous wastes requiring disposal.

Do not dispose of chemicals unnecessarily. If you have no further need of a chemical, paint, oil, or reagent, determine if another Department or your colleagues can use it. Do not mix waste chemicals of different hazards or types. For example mixing of halogenated solvents with non-halogenated solvents reduces the amount of materials that may be reused or redistributed and increases disposal costs. If at all possible, do not combine other chemicals with organic solvents. Acids, bases, heavy metals, carcinogens, oxidizers, cyanides, sulfides, pesticides, and especially halogenated organic solvents (chloroform, methylene chloride, etc.) should be collected in separate, labeled, and dated waste containers.

8.2 Source Reduction (Reuse)

The second most desirable method of waste minimization is source reduction. This is any activity that reduces the generation of chemical hazardous waste at the source. This can be accomplished by good materials management, substitution of less hazardous materials, and good laboratory procedures. Examples include:

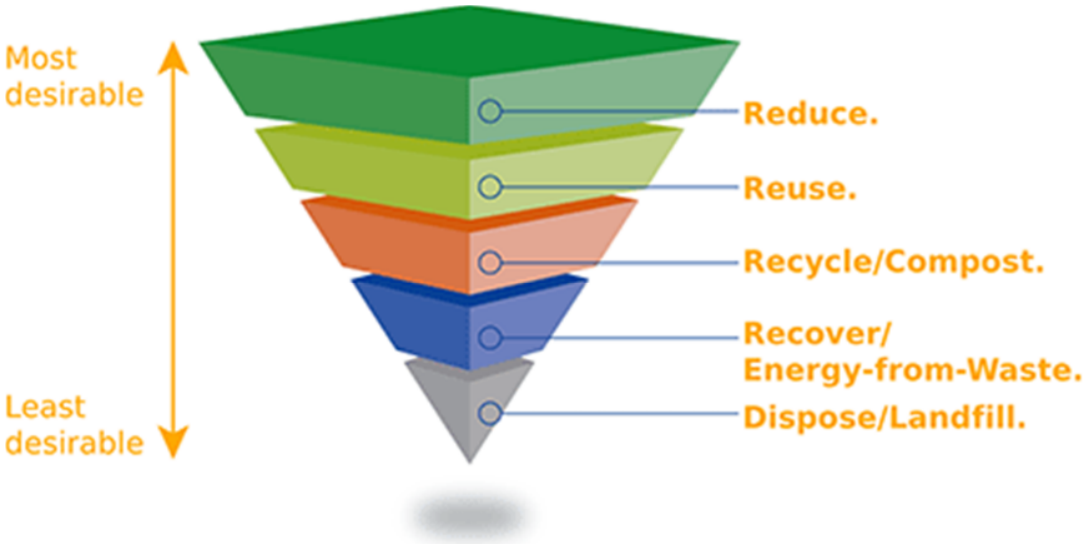
- Implement a waste minimization policy and train all employees and students.
- Re-evaluate procedures to see if a less hazardous or non-hazardous reagent could be used.
- Centralize purchasing of chemicals through one person in the department or laboratory.
- Date chemical containers when received so that older ones will be used first.
- Keep MSDS's for chemicals on file.
- Inventory chemicals and identify their location at least once a year.
- Perform laboratory experiments or demonstrations on a smaller or micro-scale.
- Update inventory when chemicals are purchased or used up.
- Purchase chemicals in the smallest quantities needed.

- Label all chemical containers to prevent the generation of unknowns.
- When considering a new procedure, obtain the chemicals needed from another lab or purchase small quantities initially.
- Consider the use of pre-weighed or pre-measured reagent packets where waste generation is high.
- Avoid the use of reagents containing arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver.
- Eliminate the use of chromic acid cleaning solutions altogether. Use non-hazardous solutions such as Alconox and Pierce RBS35.
- Substitute red liquid (spirit-filled), digital, or thermocouple thermometers for mercury thermometers when it is feasible.
- Consider using detergent and hot water or citrus based products for cleaning parts instead of solvents.
- Use latex-based paints which are typically non-hazardous. Excess latex paints should be recycled. Excess non-latex paints must be handled by EHS as a hazardous waste.
- Utilize vendors that will recycle used antifreeze. Some vendors will recycle the antifreeze on site so the antifreeze never leaves the site.

8.3 Recycling

The third most desirable approach is recycling. When a waste material is used for another purpose, treated and reused in the same process, or reclaimed for another process, it is considered recycling. Examples include:

- When solvent is used for cleaning purposes, use contaminated solvent for initial cleaning and fresh solvent for final cleaning.
- If possible, with organic solvents, recover, redistill, and reuse your solvents.
- Purchase compressed gas cylinders (including lecture bottles) only from manufacturers who will accept empty cylinders.
- Return excess pesticides to the distributor.
- Have a silver recovery unit installed in photography laboratories. The unit removes the silver from the fixer solution.
- Do not contaminate used oil with solvents because this prevents the oil from being recycled.
- Increase solvent reuse through the use of solvent redistillation.
- Recirculate unused or excess chemicals within the department.
- Collect metallic mercury for reclamation.

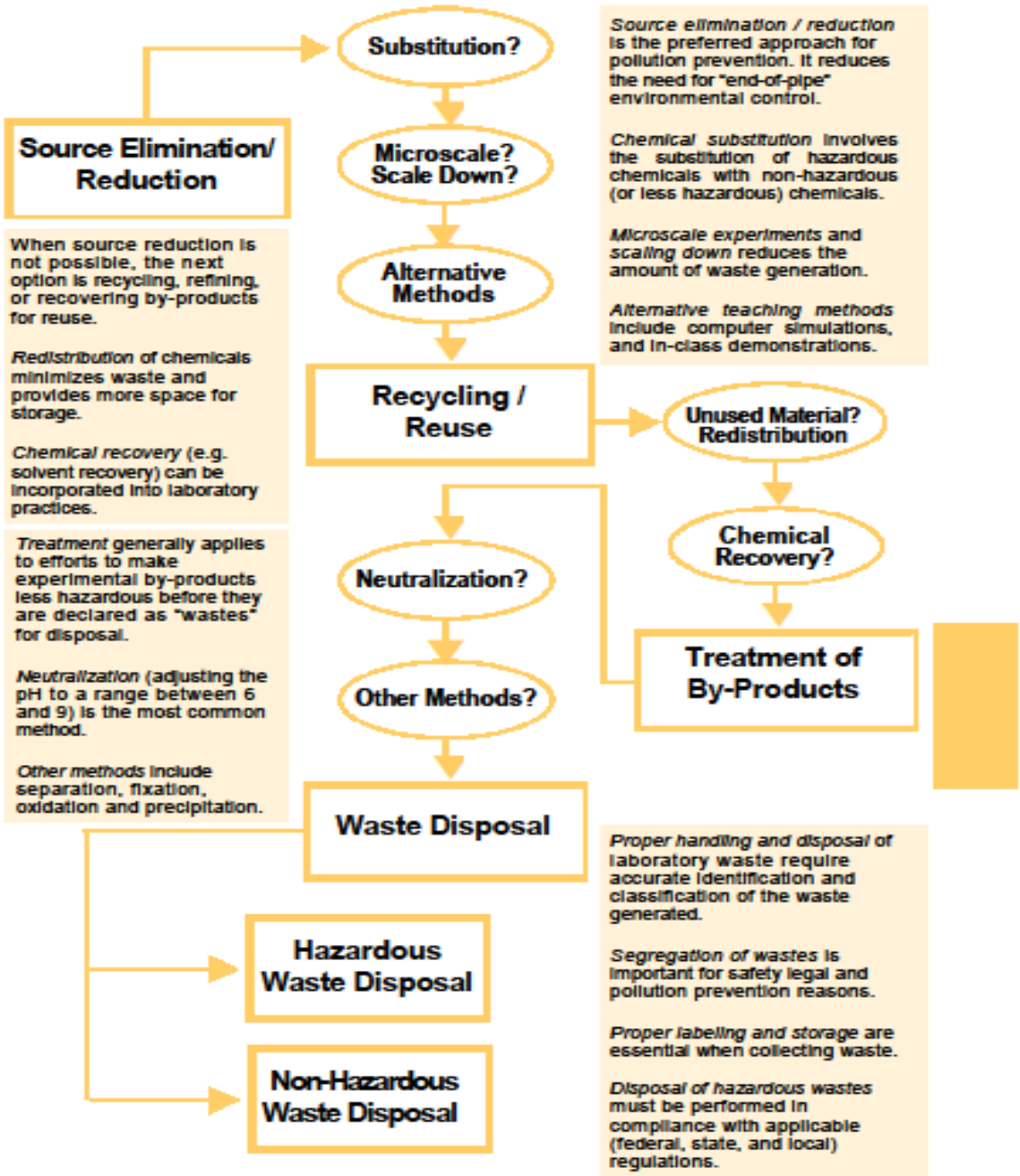


8.4 Laboratory Waste Minimization

The diagram on the following page applies these general waste minimization methods to a laboratory pollution prevention scenario.

Laboratory Pollution Prevention

The following diagram presents a methodology for development of pollution prevention alternatives. For more information on Pollution Prevention, please contact the BSU EHS Office



Appendices

Appendix A: TOXICITY CHARACTERISTICS (TCLP)

EPA HW #	Contaminant	Regulated Level (mg/l)
D004	Arsenic (As)	5.0
D005	Barium (Ba)	100.0
D018	Benzene	0.5
D006	Cadmium (Cd)	1.0
D019	Carbon Tetrachloride	0.5
D020	Chlordane	0.03
D021	Chlorobenzene	100.0
D022	Chloroform	6.0
D007	Chromium (Cr)	5.0
D023	o-Cresol	200.0
D024	m-Cresol	200.0
D025	p-Cresol	200.0
D026	Cresol	200.0
D016	2,4-D	10.0
D027	1,4-Dichlorobenzene	7.5
D028	1,2-Dichloroethane	0.5
D029	1,1-Dichloroethylene	0.7
D030	2,4-Dinitrotoluene	0.13
D012	Endrin	0.02
D031	Heptachlor	0.008
D032	Hexachlorobenzene	0.13

D033	Hexachlorobutadiene	0.5
D034	Hexachloroethane	3.0
D008	Lead (Pb)	5.0
D013	Lindane	0.4
D009	Mercury (Hg)	0.2
D014	Methoxychlor	10.0
D035	Methyl ethyl ketone	200.0
D036	Nitrobenzene	2.0
D037	Pentachlorophenol	100.0
D038	Pyridine	5.0
D010	Selenium (Se)	1.0
D011	Silver (Ag)	5.0
D039	Tetrachloroethylene	0.7
D015	Toxaphene	0.5
D040	Trichloroethylene	0.5
D041	2,4, 5-Trichlorophenol	400.0
D042	2,4,6-Trichlorophenol	2.0
D017	2,4,5-TP (Silvex)	1.0
D043	Vinyl Chloride	0.2

Appendix B: LISTED HAZARDOUS WASTES (F List –partial)

I – Ignitability T - Toxicity

F001	The following spent halogenated solvents used in degreasing: Tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those solvents listed in F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F002	The following spent halogenated solvents: Tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, trichlorofluoromethane, and 1,1,2-trichloroethane; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above halogenated solvents or those listed in F001, F004, or F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F003	The following spent non-halogenated solvents: Xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; all spent solvent mixtures/blends containing, before use, only the above spent non-halogenated solvents; and all spent solvent mixtures/blends containing, before use, one or more of the above non-halogenated solvents, and, a total of ten percent or more (by volume) of one or more of those solvents listed in F001, F002, F004, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(I)*
F004	The following spent non-halogenated solvents: Cresols and cresylic acid, and nitrobenzene; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, and F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	(T)
F005	The following spent non-halogenated solvents: Toluene, methyl ethyl ketone, carbon disulfide, isobutanol, pyridine, benzene, 2-ethoxyethanol, and 2-nitropropane; all spent	(I,T)

	solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the above non-halogenated solvents or those solvents listed in F001, F002, or F004; and still bottoms from the recovery of these spent solvents and spent solvent mixtures	

Regulated Solvents (from above F-Listed):

F-Listed Non-Halogenated Solvents
Solvent Name
Acetone
Benzene
n-Butyl Alcohol
Carbon Disulfide
o-Cresol
m-Cresol
p-Cresol
Cyclohexanone
Ethyl Acetate
Ethyl Benzene
Ethyl Ether
2-Ethoxyethanol
Ethylene Glycol Monoethyl Ether
Isobutyl Alcohol
Methanol
Methyl Ethyl Ketone

F-Listed Halogenated Solvents
Solvent Name
Carbon Tetrachloride
Chlorinated Fluorocarbons (CFCs)
Chlorobenzene
Chloroform
1,2-Dichlorobenzene
1,2-Dichloroethane
1,1-Dichloroethylene
Methylene Chloride (Dichloromethane)
Tetrachloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
1,1,2-Trichloro-1,2,2-Trifluoroethane
Trichlorofluoromethane (Freon-11)

Methyl Isobutyl Ketone
Nitrobenzene
2-Nitropropane
Pyridine
Toluene
Xylene

Common Solvents and Liquids that Contain the Above Regulated Chemicals:

Aromatic Hydrocarbons	Jet Fuels	Petroleum Ether
Creosote	Kerosene	Petroleum Naphtha
Degreaser Solvents	Lacquer Thinner	Stoddard Solvent
Diesel Fuel	Mineral Spirits	Thinner
Duplicating Fluid	Naphtha	Turpentine
Dry Cleaning Fluids	Oleum	Varsol
Fuel Oil	Paint Thinner	White Spirits
Gasoline	Petroleum Distillates	Spent Fixer & Developer

P-Listed Wastes

These wastes and their corresponding EPA Hazardous Waste Numbers are:

Hazardous Waste No.	Chemical abstracts No.	Substance
P023	107–20–0	Acetaldehyde, chloro-
P002	591–08–2	Acetamide, N-(aminothioxomethyl)-
P057	640–19–7	Acetamide, 2-fluoro-
P058	62–74–8	Acetic acid, fluoro-, sodium salt
P002	591–08–2	1-Acetyl-2-thiourea
P003	107–02–8	Acrolein
P070	116–06–3	Aldicarb
P203	1646–88–4	Aldicarb sulfone.
P004	309–00–2	Aldrin
P005	107–18–6	Allyl alcohol
P006	20859–73–8	Aluminum phosphide (R,T)
P007	2763–96–4	5-(Aminomethyl)-3-isoxazolol

P008	504–24–5	4-Aminopyridine
P009	131–74–8	Ammonium picrate (R)
P119	7803–55–6	Ammonium vanadate
P099	506–61–6	Argentate(1-), bis(cyano-C)-, potassium
P010	7778–39–4	Arsenic acid H_3AsO_4
P012	1327–53–3	Arsenic oxide As_2O_3
P011	1303–28–2	Arsenic oxide As_2O_5
P011	1303–28–2	Arsenic pentoxide
P012	1327–53–3	Arsenic trioxide
P038	692–42–2	Arsine, diethyl-
P036	696–28–6	Arsonous dichloride, phenyl-
P054	151–56–4	Aziridine
P067	75–55–8	Aziridine, 2-methyl-
P013	542–62–1	Barium cyanide
P024	106–47–8	Benzenamine, 4-chloro-
P077	100–01–6	Benzenamine, 4-nitro-
P028	100–44–7	Benzene, (chloromethyl)-
P042	51–43–4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-

P046	122–09–8	Benzeneethanamine, alpha,alpha-dimethyl-
P014	108–98–5	Benzenethiol
P127	1563–66–2	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.
P188	57–64–7	Benzoic acid, 2-hydroxy-, compd. with (3aS-cis)-1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo[2,3-b]indol-5-yl methylcarbamate ester (1:1).
P001	[1]81–81–2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%
P028	100–44–7	Benzyl chloride
P015	7440–41–7	Beryllium powder
P017	598–31–2	Bromoacetone
P018	357–57–3	Brucine
P045	39196–18–4	2-Butanone, 3,3-dimethyl-1-(methylthio)-, O-[(methylamino)carbonyl] oxime
P021	592–01–8	Calcium cyanide
P021	592–01–8	Calcium cyanide $Ca(CN)_2$
P189	55285–14–8	Carbamic acid, [(dibutylamino)- thio]methyl-, 2,3-dihydro-2,2-dimethyl- 7-benzofuranyl ester.
P191	644–64–4	Carbamic acid, dimethyl-, 1-[(dimethyl-amino)carbonyl]- 5-methyl-1H- pyrazol-3-yl ester.

P192	119–38–0	Carbamic acid, dimethyl-, 3-methyl-1- (1-methylethyl)-1H- pyrazol-5-yl ester.
P190	1129–41–5	Carbamic acid, methyl-, 3-methylphenyl ester.
P127	1563–66–2	Carbofuran.
P022	75–15–0	Carbon disulfide
P095	75–44–5	Carbonic dichloride
P189	55285–14–8	Carbosulfan.
P023	107–20–0	Chloroacetaldehyde
P024	106–47–8	p-Chloroaniline
P026	5344–82–1	1-(o-Chlorophenyl)thiourea
P027	542–76–7	3-Chloropropionitrile
P029	544–92–3	Copper cyanide
P029	544–92–3	Copper cyanide Cu(CN)
P202	64–00–6	m-Cumenyl methylcarbamate.
P030		Cyanides (soluble cyanide salts), not otherwise specified
P031	460–19–5	Cyanogen
P033	506–77–4	Cyanogen chloride
P033	506–77–4	Cyanogen chloride (CN)Cl
P034	131–89–5	2-Cyclohexyl-4,6-dinitrophenol

P016	542–88–1	Dichloromethyl ether
P036	696–28–6	Dichlorophenylarsine
P037	60–57–1	Dieldrin
P038	692–42–2	Diethylarsine
P041	311–45–5	Diethyl-p-nitrophenyl phosphate
P040	297–97–2	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	55–91–4	Diisopropylfluorophosphate (DFP)
P004	309–00–2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a,-hexahydro-, (1alpha,4alpha,4abeta,5alpha,8alpha,8abeta)-
P060	465–73–6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abeta,5beta,8beta,8abeta)-
P037	60–57–1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta,7aalpha)-
P051	[1]72–20–8	2,7:3,6-Dimethanonaphth [2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7aalpha)-, & metabolites
P044	60–51–5	Dimethoate
P046	122–09–8	alpha,alpha-Dimethylphenethylamine

P191	644–64–4	Dimetilan.
P047	[1]534–52–1	4,6-Dinitro-o-cresol, & salts
P048	51–28–5	2,4-Dinitrophenol
P020	88–85–7	Dinoseb
P085	152–16–9	Diphosphoramide, octamethyl-
P111	107–49–3	Diphosphoric acid, tetraethyl ester
P039	298–04–4	Disulfoton
P049	541–53–7	Dithiobiuret
P185	26419–73–8	1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O-[(methylamino)- carbonyl]oxime.
P050	115–29–7	Endosulfan
P088	145–73–3	Endothall
P051	72–20–8	Endrin
P051	72–20–8	Endrin, & metabolites
P042	51–43–4	Epinephrine
P031	460–19–5	Ethanedinitrile
P194	23135–22–0	Ethanimidothioic acid, 2-(dimethylamino)-N-[[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester.
P066	16752–77–5	Ethanimidothioic acid, N-[[(methylamino)carbonyl]oxy]-, methyl ester

P101	107–12–0	Ethyl cyanide
P054	151–56–4	Ethyleneimine
P097	52–85–7	Famphur
P056	7782–41–4	Fluorine
P057	640–19–7	Fluoroacetamide
P058	62–74–8	Fluoroacetic acid, sodium salt
P198	23422–53–9	Formetanate hydrochloride.
P197	17702–57–7	Formparanate.
P065	628–86–4	Fulminic acid, mercury(2+) salt (R,T)
P059	76–44–8	Heptachlor
P062	757–58–4	Hexaethyl tetraphosphate
P116	79–19–6	Hydrazinecarbothioamide
P068	60–34–4	Hydrazine, methyl-
P063	74–90–8	Hydrocyanic acid
P063	74–90–8	Hydrogen cyanide
P096	7803–51–2	Hydrogen phosphide
P060	465–73–6	Isodrin
P192	119–38–0	Isolan.
P202	64–00–6	3-Isopropylphenyl N-methylcarbamate.

P007	2763–96–4	3(2H)-Isoxazolone, 5-(aminomethyl)-
P196	15339–36–3	Manganese, bis(dimethylcarbamodithioato-S,S')-,
P196	15339–36–3	Manganese dimethyldithiocarbamate.
P092	62–38–4	Mercury, (acetato-O)phenyl-
P065	628–86–4	Mercury fulminate (R,T)
P082	62–75–9	Methanamine, N-methyl-N-nitroso-
P064	624–83–9	Methane, isocyanato-
P016	542–88–1	Methane, oxybis[chloro-
P112	509–14–8	Methane, tetranitro- (R)
P118	75–70–7	Methanethiol, trichloro-
P198	23422–53–9	Methanimidamide, N,N-dimethyl-N'-[3-[[(methylamino)-carbonyl]oxy]phenyl]-, monohydrochloride.
P197	17702–57–7	Methanimidamide, N,N-dimethyl-N'-[2-methyl-4-[[(methylamino)carbonyl]oxy]phenyl]-
P050	115–29–7	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
P059	76–44–8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P199	2032–65–7	Methiocarb.
P066	16752–77–5	Methomyl

P068	60–34–4	Methyl hydrazine
P064	624–83–9	Methyl isocyanate
P069	75–86–5	2-Methyllactonitrile
P071	298–00–0	Methyl parathion
P190	1129–41–5	Metolcarb.
P128	315–8–4	Mexacarbate.
P072	86–88–4	alpha-Naphthylthiourea
P073	13463–39–3	Nickel carbonyl
P073	13463–39–3	Nickel carbonyl $Ni(CO)_4$, (T-4)-
P074	557–19–7	Nickel cyanide
P074	557–19–7	Nickel cyanide $Ni(CN)_2$
P075	[1]54–11–5	Nicotine, & salts
P076	10102–43–9	Nitric oxide
P077	100–01–6	p-Nitroaniline
P078	10102–44–0	Nitrogen dioxide
P076	10102–43–9	Nitrogen oxide NO
P078	10102–44–0	Nitrogen oxide NO_2
P081	55–63–0	Nitroglycerine (R)
P082	62–75–9	N-Nitrosodimethylamine

P084	4549–40–0	N-Nitrosomethylvinylamine
P085	152–16–9	Octamethylpyrophosphoramide
P087	20816–12–0	Osmium oxide OsO_4, (T-4)-
P087	20816–12–0	Osmium tetroxide
P088	145–73–3	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
P194	23135–22–0	Oxamyl.
P089	56–38–2	Parathion
P034	131–89–5	Phenol, 2-cyclohexyl-4,6-dinitro-
P048	51–28–5	Phenol, 2,4-dinitro-
P047	[1]534–52–1	Phenol, 2-methyl-4,6-dinitro-, & salts
P020	88–85–7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
P009	131–74–8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P128	315–18–4	Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester).
P199	2032–65–7	Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate
P202	64–00–6	Phenol, 3-(1-methylethyl)-, methyl carbamate.
P201	2631–37–0	Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate.
P092	62–38–4	Phenylmercury acetate

P093	103–85–5	Phenylthiourea
P094	298–02–2	Phorate
P095	75–44–5	Phosgene
P096	7803–51–2	Phosphine
P041	311–45–5	Phosphoric acid, diethyl 4-nitrophenyl ester
P039	298–04–4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
P094	298–02–2	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
P044	60–51–5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl] ester
P043	55–91–4	Phosphorofluoridic acid, bis(1-methylethyl) ester
P089	56–38–2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P040	297–97–2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P097	52–85–7	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P071	298–00–0	Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester
P204	57–47–6	Physostigmine.
P188	57–64–7	Physostigmine salicylate.

P110	78–00–2	Plumbane, tetraethyl-
P098	151–50–8	Potassium cyanide
P098	151–50–8	Potassium cyanide K(CN)
P099	506–61–6	Potassium silver cyanide
P201	2631–37–0	Promecarb
P070	116–06–3	Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
P203	1646–88–4	Propanal, 2-methyl-2-(methyl-sulfonyl)-, O-[(methylamino)carbonyl] oxime.
P101	107–12–0	Propanenitrile
P027	542–76–7	Propanenitrile, 3-chloro-
P069	75–86–5	Propanenitrile, 2-hydroxy-2-methyl-
P081	55–63–0	1,2,3-Propanetriol, trinitrate (R)
P017	598–31–2	2-Propanone, 1-bromo-
P102	107–19–7	Propargyl alcohol
P003	107–02–8	2-Propenal
P005	107–18–6	2-Propen-1-ol
P067	75–55–8	1,2-Propylenimine
P102	107–19–7	2-Propyn-1-ol
P008	504–24–5	4-Pyridinamine

P075	[1]54–11–5	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts
P204	57–47–6	Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethyl-, methylcarbamate (ester), (3aS-cis)-.
P114	12039–52–0	Selenious acid, dithallium(1+) salt
P103	630–10–4	Selenourea
P104	506–64–9	Silver cyanide
P104	506–64–9	Silver cyanide Ag(CN)
P105	26628–22–8	Sodium azide
P106	143–33–9	Sodium cyanide
P106	143–33–9	Sodium cyanide Na(CN)
P108	[1]57–24–9	Strychnidin-10-one, & salts
P018	357–57–3	Strychnidin-10-one, 2,3-dimethoxy-
P108	[1]57–24–9	Strychnine, & salts
P115	7446–18–6	Sulfuric acid, dithallium(1+) salt
P109	3689–24–5	Tetraethyldithiopyrophosphate
P110	78–00–2	Tetraethyl lead
P111	107–49–3	Tetraethyl pyrophosphate
P112	509–14–8	Tetranitromethane (R)
P062	757–58–4	Tetraphosphoric acid, hexaethyl ester

P113	1314–32–5	Thallic oxide
P113	1314–32–5	Thallium oxide Tl_2O_3
P114	12039–52–0	Thallium(I) selenite
P115	7446–18–6	Thallium(I) sulfate
P109	3689–24–5	Thiodiphosphoric acid, tetraethyl ester
P045	39196–18–4	Thiofanox
P049	541–53–7	Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$
P014	108–98–5	Thiophenol
P116	79–19–6	Thiosemicarbazide
P026	5344–82–1	Thiourea, (2-chlorophenyl)-
P072	86–88–4	Thiourea, 1-naphthalenyl-
P093	103–85–5	Thiourea, phenyl-
P185	26419–73–8	Tirpate.
P123	8001–35–2	Toxaphene
P118	75–70–7	Trichloromethanethiol
P119	7803–55–6	Vanadic acid, ammonium salt
P120	1314–62–1	Vanadium oxide V_2O_5
P120	1314–62–1	Vanadium pentoxide
P084	4549–40–0	Vinylamine, N-methyl-N-nitroso-

P001	[1]81–81–2	Warfarin, & salts, when present at concentrations greater than 0.3%
P205	137–30–4	Zinc, bis(dimethylcarbamodithioato-S,S')-,
P121	557–21–1	Zinc cyanide
P121	557–21–1	Zinc cyanide $Zn(CN)_2$
P122	1314–84–7	Zinc phosphide Zn_3P_2, when present at concentrations greater than 10% (R,T)
P205	137–30–4	Ziram.
P001	[1]81–81–2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenylbutyl)-, & salts, when present at concentrations greater than 0.3%
P001	[1]81–81–2	Warfarin, & salts, when present at concentrations greater than 0.3%
P002	591–08–2	Acetamide, -(aminothioxomethyl)-
P002	591–08–2	1-Acetyl-2-thiourea
P003	107–02–8	Acrolein
P003	107–02–8	2-Propenal
P004	309–00–2	Aldrin
P004	309–00–2	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a,-hexahydro-, (1alpha,4alpha,4abeta,5alpha,8alpha,8abeta)-
P005	107–18–6	Allyl alcohol

P005	107–18–6	2-Propen-1-ol
P006	20859–73–8	Aluminum phosphide (R,T)
P007	2763–96–4	5-(Aminomethyl)-3-isoxazolol
P007	2763–96–4	3(2H)-Isoxazolone, 5-(aminomethyl)-
P008	504–24–5	4-Aminopyridine
P008	504–24–5	4-Pyridinamine
P009	131–74–8	Ammonium picrate (R)
P009	131–74–8	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P010	7778–39–4	Arsenic acid H_3AsO_4
P011	1303–28–2	Arsenic oxide As_2O_5
P011	1303–28–2	Arsenic pentoxide
P012	1327–53–3	Arsenic oxide As_2O_3
P012	1327–53–3	Arsenic trioxide
P013	542–62–1	Barium cyanide
P014	108–98–5	Benzenethiol
P014	108–98–5	Thiophenol
P015	7440–41–7	Beryllium powder
P016	542–88–1	Dichloromethyl ether
P016	542–88–1	Methane, oxybis[chloro-

P017	598–31–2	Bromoacetone
P017	598–31–2	2-Propanone, 1-bromo-
P018	357–57–3	Brucine
P018	357–57–3	Strychnidin-10-one, 2,3-dimethoxy-
P020	88–85–7	Dinoseb
P020	88–85–7	Phenol, 2-(1-methylpropyl)-4,6-dinitro-
P021	592–01–8	Calcium cyanide
P021	592–01–8	Calcium cyanide $Ca(CN)_2$
P022	75–15–0	Carbon disulfide
P023	107–20–0	Acetaldehyde, chloro-
P023	107–20–0	Chloroacetaldehyde
P024	106–47–8	Benzenamine, 4-chloro-
P024	106–47–8	p-Chloroaniline
P026	5344–82–1	1-(o-Chlorophenyl)thiourea
P026	5344–82–1	Thiourea, (2-chlorophenyl)-
P027	542–76–7	3-Chloropropionitrile
P027	542–76–7	Propanenitrile, 3-chloro-
P028	100–44–7	Benzene, (chloromethyl)-
P028	100–44–7	Benzyl chloride

P029	544–92–3	Copper cyanide
P029	544–92–3	Copper cyanide Cu(CN)
P030		Cyanides (soluble cyanide salts), not otherwise specified
P031	460–19–5	Cyanogen
P031	460–19–5	Ethanedinitrile
P033	506–77–4	Cyanogen chloride
P033	506–77–4	Cyanogen chloride (CN)Cl
P034	131–89–5	2-Cyclohexyl-4,6-dinitrophenol
P034	131–89–5	Phenol, 2-cyclohexyl-4,6-dinitro-
P036	696–28–6	Arsonous dichloride, phenyl-
P036	696–28–6	Dichlorophenylarsine
P037	60–57–1	Dieldrin
P037	60–57–1	2,7:3,6-Dimethanonaphth[2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2aalpha,3beta,6beta,6aalpha,7beta,7aalpha)-
P038	692–42–2	Arsine, diethyl-
P038	692–42–2	Diethylarsine
P039	298–04–4	Disulfoton

P039	298–04–4	Phosphorodithioic acid, O,O-diethyl S-[2-(ethylthio)ethyl] ester
P040	297–97–2	O,O-Diethyl O-pyrazinyl phosphorothioate
P040	297–97–2	Phosphorothioic acid, O,O-diethyl O-pyrazinyl ester
P041	311–45–5	Diethyl-p-nitrophenyl phosphate
P041	311–45–5	Phosphoric acid, diethyl 4-nitrophenyl ester
P042	51–43–4	1,2-Benzenediol, 4-[1-hydroxy-2-(methylamino)ethyl]-, (R)-
P042	51–43–4	Epinephrine
P043	55–91–4	Diisopropylfluorophosphate (DFP)
P043	55–91–4	Phosphorofluoridic acid, bis(1-methylethyl) ester
P044	60–51–5	Dimethoate
P044	60–51–5	Phosphorodithioic acid, O,O-dimethyl S-[2-(methyl amino)-2-oxoethyl] ester
P045	39196–18–4	2-Butanone, 3,3-dimethyl-1-(methylthio)-, O-[(methylamino)carbonyl] oxime
P045	39196–18–4	Thiofanox
P046	122–09–8	Benzeneethanamine, alpha,alpha-dimethyl-
P046	122–09–8	alpha,alpha-Dimethylphenethylamine
P047	[1]534–52–1	4,6-Dinitro-o-cresol, & salts
P047	[1]534–52–1	Phenol, 2-methyl-4,6-dinitro-, & salts

P048	51–28–5	2,4-Dinitrophenol
P048	51–28–5	Phenol, 2,4-dinitro-
P049	541–53–7	Dithiobiuret
P049	541–53–7	Thioimidodicarbonic diamide $[(H_2N)C(S)]_2NH$
P050	115–29–7	Endosulfan
P050	115–29–7	6,9-Methano-2,4,3-benzodioxathiepin, 6,7,8,9,10,10-hexachloro-1,5,5a,6,9,9a-hexahydro-, 3-oxide
P051	[1]72–20–8	2,7:3,6-Dimethanonaphth [2,3-b]oxirene, 3,4,5,6,9,9-hexachloro-1a,2,2a,3,6,6a,7,7a-octahydro-, (1aalpha,2beta,2abeta,3alpha,6alpha,6abeta,7beta,7aalpha)-, & metabolites
P051	72–20–8	Endrin
P051	72–20–8	Endrin, & metabolites
P054	151–56–4	Aziridine
P054	151–56–4	Ethyleneimine
P056	7782–41–4	Fluorine
P057	640–19–7	Acetamide, 2-fluoro-
P057	640–19–7	Fluoroacetamide
P058	62–74–8	Acetic acid, fluoro-, sodium salt
P058	62–74–8	Fluoroacetic acid, sodium salt

P059	76–44–8	Heptachlor
P059	76–44–8	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P060	465–73–6	1,4,5,8-Dimethanonaphthalene, 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-, (1alpha,4alpha,4abeta,5beta,8beta,8abeta)-
P060	465–73–6	Isodrin
P062	757–58–4	Hexaethyl tetraphosphate
P062	757–58–4	Tetraphosphoric acid, hexaethyl ester
P063	74–90–8	Hydrocyanic acid
P063	74–90–8	Hydrogen cyanide
P064	624–83–9	Methane, isocyanato-
P064	624–83–9	Methyl isocyanate
P065	628–86–4	Fulminic acid, mercury(2+) salt (R,T)
P065	628–86–4	Mercury fulminate (R,T)
P066	16752–77–5	Ethanimidothioic acid, N-[[(methylamino)carbonyl]oxy]-, methyl ester
P066	16752–77–5	Methomyl
P067	75–55–8	Aziridine, 2-methyl-
P067	75–55–8	1,2-Propylenimine
P068	60–34–4	Hydrazine, methyl-

P068	60–34–4	Methyl hydrazine
P069	75–86–5	2-Methyllactonitrile
P069	75–86–5	Propanenitrile, 2-hydroxy-2-methyl-
P070	116–06–3	Aldicarb
P070	116–06–3	Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
P071	298–00–0	Methyl parathion
P071	298–00–0	Phosphorothioic acid, O,O,-dimethyl O-(4-nitrophenyl) ester
P072	86–88–4	alpha-Naphthylthiourea
P072	86–88–4	Thiourea, 1-naphthalenyl-
P073	13463–39–3	Nickel carbonyl
P073	13463–39–3	Nickel carbonyl $Ni(CO)_4$, (T-4)-
P074	557–19–7	Nickel cyanide
P074	557–19–7	Nickel cyanide $Ni(CN)_2$
P075	[1]54–11–5	Nicotine, & salts
P075	[1]54–11–5	Pyridine, 3-(1-methyl-2-pyrrolidinyl)-, (S)-, & salts
P076	10102–43–9	Nitric oxide
P076	10102–43–9	Nitrogen oxide NO
P077	100–01–6	Benzenamine, 4-nitro-

P077	100–01–6	p-Nitroaniline
P078	10102–44–0	Nitrogen dioxide
P078	10102–44–0	Nitrogen oxide NO_2
P081	55–63–0	Nitroglycerine (R)
P081	55–63–0	1,2,3-Propanetriol, trinitrate (R)
P082	62–75–9	Methanamine, -methyl-N-nitroso-
P082	62–75–9	N-Nitrosodimethylamine
P084	4549–40–0	N-Nitrosomethylvinylamine
P084	4549–40–0	Vinylamine, -methyl-N-nitroso-
P085	152–16–9	Diphosphoramide, octamethyl-
P085	152–16–9	Octamethylpyrophosphoramide
P087	20816–12–0	Osmium oxide OsO_4, (T-4)-
P087	20816–12–0	Osmium tetroxide
P088	145–73–3	Endothall
P088	145–73–3	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
P089	56–38–2	Parathion
P089	56–38–2	Phosphorothioic acid, O,O-diethyl O-(4-nitrophenyl) ester
P092	62–38–4	Mercury, (acetato-O)phenyl-

P092	62–38–4	Phenylmercury acetate
P093	103–85–5	Phenylthiourea
P093	103–85–5	Thiourea, phenyl-
P094	298–02–2	Phorate
P094	298–02–2	Phosphorodithioic acid, O,O-diethyl S-[(ethylthio)methyl] ester
P095	75–44–5	Carbonic dichloride
P095	75–44–5	Phosgene
P096	7803–51–2	Hydrogen phosphide
P096	7803–51–2	Phosphine
P097	52–85–7	Famphur
P097	52–85–7	Phosphorothioic acid, O-[4-[(dimethylamino)sulfonyl]phenyl] O,O-dimethyl ester
P098	151–50–8	Potassium cyanide
P098	151–50–8	Potassium cyanide K(CN)
P099	506–61–6	Argentate(1-), bis(cyano-C)-, potassium
P099	506–61–6	Potassium silver cyanide
P101	107–12–0	Ethyl cyanide
P101	107–12–0	Propanenitrile

P102	107–19–7	Propargyl alcohol
P102	107–19–7	2-Propyn-1-ol
P103	630–10–4	Selenourea
P104	506–64–9	Silver cyanide
P104	506–64–9	Silver cyanide Ag(CN)
P105	26628–22–8	Sodium azide
P106	143–33–9	Sodium cyanide
P106	143–33–9	Sodium cyanide Na(CN)
P108	[1]157–24–9	Strychnidin-10-one, & salts
P108	[1]157–24–9	Strychnine, & salts
P109	3689–24–5	Tetraethyldithiopyrophosphate
P109	3689–24–5	Thiodiphosphoric acid, tetraethyl ester
P110	78–00–2	Plumbane, tetraethyl-
P110	78–00–2	Tetraethyl lead
P111	107–49–3	Diphosphoric acid, tetraethyl ester
P111	107–49–3	Tetraethyl pyrophosphate
P112	509–14–8	Methane, tetranitro-(R)
P112	509–14–8	Tetranitromethane (R)
P113	1314–32–5	Thallic oxide

P113	1314–32–5	Thallium oxide Tl_2O_3
P114	12039–52–0	Selenious acid, dithallium(1+) salt
P114	12039–52–0	Tetraethyldithiopyrophosphate
P115	7446–18–6	Thiodiphosphoric acid, tetraethyl ester
P115	7446–18–6	Plumbane, tetraethyl-
P116	79–19–6	Tetraethyl lead
P116	79–19–6	Thiosemicarbazide
P118	75–70–7	Methanethiol, trichloro-
P118	75–70–7	Trichloromethanethiol
P119	7803–55–6	Ammonium vanadate
P119	7803–55–6	Vanadic acid, ammonium salt
P120	1314–62–1	Vanadium oxide V_2O_5
P120	1314–62–1	Vanadium pentoxide
P121	557–21–1	Zinc cyanide
P121	557–21–1	Zinc cyanide $Zn(CN)_2$
P122	1314–84–7	Zinc phosphide Zn_3P_2, when present at concentrations greater than 10% (R,T)
P123	8001–35–2	Toxaphene
P127	1563–66–2	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-, methylcarbamate.

P127	1563–66–2	Carbofuran
P128	315–8–4	Mexacarbate
P128	315–18–4	Phenol, 4-(dimethylamino)-3,5-dimethyl-, methylcarbamate (ester)
P185	26419–73–8	1,3-Dithiolane-2-carboxaldehyde, 2,4-dimethyl-, O-[(methylamino)-carbonyl]oxime.
P185	26419–73–8	Tirpate
P188	57–64–7	Benzoic acid, 2-hydroxy-, compd. with (3aS-cis)-1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethylpyrrolo[2,3-b]indol-5-yl methylcarbamate ester (1:1)
P188	57–64–7	Physostigmine salicylate
P189	55285–14–8	Carbamic acid, [(dibutylamino)-thio]methyl-, 2,3-dihydro-2,2-dimethyl-7-benzofuranyl ester
P189	55285–14–8	Carbosulfan
P190	1129–41–5	Carbamic acid, methyl-, 3-methylphenyl ester
P190	1129–41–5	Metolcarb
P191	644–64–4	Carbamic acid, dimethyl-, 1-[(dimethyl-amino)carbonyl]-5-methyl-1H-pyrazol-3-yl ester
P191	644–64–4	Dimetilan
P192	119–38–0	Carbamic acid, dimethyl-, 3-methyl-1-(1-methylethyl)-1H-pyrazol-5-yl ester
P192	119–38–0	Isolan

P194	23135–22–0	Ethanimidthioic acid, 2-(dimethylamino)-N-[[(methylamino) carbonyl]oxy]-2-oxo-, methyl ester
P194	23135–22–0	Oxamyl
P196	15339–36–3	Manganese, bis(dimethylcarbamodithioato-S,S')-,
P196	15339–36–3	Manganese dimethyldithiocarbamate
P197	17702–57–7	Formparanate
P197	17702–57–7	Methanimidamide, N,N-dimethyl-N'-[2-methyl-4-[[(methylamino)carbonyl]oxy]phenyl]-
P198	23422–53–9	Formetanate hydrochloride
P198	23422–53–9	Methanimidamide, N,N-dimethyl-N'-[3-[[(methylamino)-carbonyl]oxy]phenyl]-monohydrochloride
P199	2032–65–7	Methiocarb
P199	2032–65–7	Phenol, (3,5-dimethyl-4-(methylthio)-, methylcarbamate
P201	2631–37–0	Phenol, 3-methyl-5-(1-methylethyl)-, methyl carbamate
P201	2631–37–0	Promecarb
P202	64–00–6	m-Cumenyl methylcarbamate
P202	64–00–6	3-Isopropylphenyl N-methylcarbamate
P202	64–00–6	Phenol, 3-(1-methylethyl)-, methyl carbamate
P203	1646–88–4	Aldicarb sulfone

P203	1646–88–4	Propanal, 2-methyl-2-(methyl-sulfonyl)-, O-[(methylamino)carbonyl] oxime
P204	57–47–6	Physostigmine
P204	57–47–6	Pyrrolo[2,3-b]indol-5-ol, 1,2,3,3a,8,8a-hexahydro-1,3a,8-trimethyl-, methylcarbamate (ester), (3aS-cis)-
P205	137–30–4	Zinc, bis(dimethylcarbamodithioato-S,S')-,
P205	137–30–4	Ziram

U-Listed Wastes

These wastes and their corresponding EPA Hazardous Waste Numbers are:

Hazardous Waste No.	Chemical abstracts No.	Substance
U394	30558–43–1	A2213.
U001	75–07–0	Acetaldehyde (I)
U034	75–87–6	Acetaldehyde, trichloro-
U187	62–44–2	Acetamide, N-(4-ethoxyphenyl)-
U005	53–96–3	Acetamide, N-9H-fluoren-2-yl-
U240	[1]94–75–7	Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
U112	141–78–6	Acetic acid ethyl ester (I)
U144	301–04–2	Acetic acid, lead(2+) salt
U214	563–68–8	Acetic acid, thallium(1+) salt
see F027	93–76–5	Acetic acid, (2,4,5-trichlorophenoxy)-
U002	67–64–1	Acetone (I)
U003	75–05–8	Acetonitrile (I,T)
U004	98–86–2	Acetophenone
U005	53–96–3	2-Acetylaminofluorene
U006	75–36–5	Acetyl chloride (C,R,T)

U007	79–06–1	Acrylamide
U008	79–10–7	Acrylic acid (I)
U009	107–13–1	Acrylonitrile
U011	61–82–5	Amitrole
U012	62–53–3	Aniline (I,T)
U136	75–60–5	Arsinic acid, dimethyl-
U014	492–80–8	Auramine
U015	115–02–6	Azaserine
U010	50–07–7	Azirino[2',3':3,4]pyrrolo[1,2-a]indole-4,7-dione, 6-amino-8-[[(aminocarbonyl)oxy]methyl]-1,1a,2,8,8a,8b-hexahydro-8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta,8aalpha,8balpha)]-
U280	101–27–9	Barban.
U278	22781–23–3	Bendiocarb.
U364	22961–82–6	Bendiocarb phenol.
U271	17804–35–2	Benomyl.
U157	56–49–5	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-
U016	225–51–4	Benz[c]acridine
U017	98–87–3	Benzal chloride
U192	23950–58–5	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-

U018	56–55–3	Benz[a]anthracene
U094	57–97–6	Benz[a]anthracene, 7,12-dimethyl-
U012	62–53–3	Benzenamine (I,T)
U014	492–80–8	Benzenamine, 4,4’-carbonimidoylbis[N,N-dimethyl-
U049	3165–93–3	Benzenamine, 4-chloro-2-methyl-, hydrochloride
U093	60–11–7	Benzenamine, N,N-dimethyl-4-(phenylazo)-
U328	95–53–4	Benzenamine, 2-methyl-
U353	106–49–0	Benzenamine, 4-methyl-
U158	101–14–4	Benzenamine, 4,4’-methylenebis[2-chloro-
U222	636–21–5	Benzenamine, 2-methyl-, hydrochloride
U181	99–55–8	Benzenamine, 2-methyl-5-nitro-
U019	71–43–2	Benzene (I,T)
U038	510–15–6	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester
U030	101–55–3	Benzene, 1-bromo-4-phenoxy-
U035	305–03–3	Benzenebutanoic acid, 4-[bis(2-chloroethyl)amino]-
U037	108–90–7	Benzene, chloro-
U221	25376–45–8	Benzenediamine, ar-methyl-
U028	117–81–7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester

U069	84–74–2	1,2-Benzenedicarboxylic acid, dibutyl ester
U088	84–66–2	1,2-Benzenedicarboxylic acid, diethyl ester
U102	131–11–3	1,2-Benzenedicarboxylic acid, dimethyl ester
U107	117–84–0	1,2-Benzenedicarboxylic acid, dioctyl ester
U070	95–50–1	Benzene, 1,2-dichloro-
U071	541–73–1	Benzene, 1,3-dichloro-
U072	106–46–7	Benzene, 1,4-dichloro-
U060	72–54–8	Benzene, 1,1'-(2,2-dichloroethylidene)bis[4-chloro-
U017	98–87–3	Benzene, (dichloromethyl)-
U223	26471–62–5	Benzene, 1,3-diisocyanatomethyl- (R,T)
U239	1330–20–7	Benzene, dimethyl- (I)
U201	108–46–3	1,3-Benzenediol
U127	118–74–1	Benzene, hexachloro-
U056	110–82–7	Benzene, hexahydro- (I)
U220	108–88–3	Benzene, methyl-
U105	121–14–2	Benzene, 1-methyl-2,4-dinitro-
U106	606–20–2	Benzene, 2-methyl-1,3-dinitro-
U055	98–82–8	Benzene, (1-methylethyl)- (I)
U169	98–95–3	Benzene, nitro-

U183	608–93–5	Benzene, pentachloro-
U185	82–68–8	Benzene, pentachloronitro-
U020	98–09–9	Benzenesulfonic acid chloride (C,R)
U020	98–09–9	Benzenesulfonyl chloride (C,R)
U207	95–94–3	Benzene, 1,2,4,5-tetrachloro-
U061	50–29–3	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-chloro-
U247	72–43–5	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-methoxy-
U023	98–07–7	Benzene, (trichloromethyl)-
U234	99–35–4	Benzene, 1,3,5-trinitro-
U021	92–87–5	Benzidine
U278	22781–23–3	1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methyl carbamate.
U364	22961–82–6	1,3-Benzodioxol-4-ol, 2,2-dimethyl-,
U203	94–59–7	1,3-Benzodioxole, 5-(2-propenyl)-
U141	120–58–1	1,3-Benzodioxole, 5-(1-propenyl)-
U367	1563–38–8	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-
U090	94–58–6	1,3-Benzodioxole, 5-propyl-
U064	189–55–9	Benzo[rst]pentaphene

U248	[1]81–81–2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U022	50–32–8	Benzo[a]pyrene
U197	106–51–4	p-Benzoquinone
U023	98–07–7	Benzotrichloride (C,R,T)
U085	1464–53–5	2,2′-Bioxirane
U021	92–87–5	[1,1′-Biphenyl]-4,4′-diamine
U073	91–94–1	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dichloro-
U091	119–90–4	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dimethoxy-
U095	119–93–7	[1,1′-Biphenyl]-4,4′-diamine, 3,3′-dimethyl-
U225	75–25–2	Bromoform
U030	101–55–3	4-Bromophenyl phenyl ether
U128	87–68–3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U172	924–16–3	1-Butanamine, N-butyl-N-nitroso-
U031	71–36–3	1-Butanol (I)
U159	78–93–3	2-Butanone (I,T)
U160	1338–23–4	2-Butanone, peroxide (R,T)
U053	4170–30–3	2-Butenal
U074	764–41–0	2-Butene, 1,4-dichloro- (I,T)

U143	303–34–4	2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]-2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester, [1S-[1alpha(Z),7(2S*,3R*),7aalpha]]-
U031	71–36–3	n-Butyl alcohol (I)
U136	75–60–5	Cacodylic acid
U032	13765–19–0	Calcium chromate
U372	10605–21–7	Carbamic acid, 1H-benzimidazol-2-yl, methyl ester.
U271	17804–35–2	Carbamic acid, [1-[(butylamino)carbonyl]-1H-benzimidazol-2-yl]-, methyl ester.
U280	101–27–9	Carbamic acid, (3-chlorophenyl)-, 4-chloro-2-butynyl ester.
U238	51–79–6	Carbamic acid, ethyl ester
U178	615–53–2	Carbamic acid, methylnitroso-, ethyl ester
U373	122–42–9	Carbamic acid, phenyl-, 1-methylethyl ester.
U409	23564–05–8	Carbamic acid, [1,2-phenylenebis (iminocarbonothioyl)]bis-, dimethyl ester.
U097	79–44–7	Carbamic chloride, dimethyl-
U389	2303–17–5	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3,3-trichloro-2-propenyl) ester.
U387	52888–80–9	Carbamothioic acid, dipropyl-, S-(phenylmethyl) ester.

U114	[1]111–54–6	Carbamodithioic acid, 1,2-ethanediylbis-, salts & esters
U062	2303–16–4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-dichloro-2-propenyl) ester
U279	63–25–2	Carbaryl.
U372	10605–21–7	Carbendazim.
U367	1563–38–8	Carbofuran phenol.
U215	6533–73–9	Carbonic acid, dithallium(1+) salt
U033	353–50–4	Carbonic difluoride
U156	79–22–1	Carbonochloridic acid, methyl ester (I,T)
U033	353–50–4	Carbon oxyfluoride (R,T)
U211	56–23–5	Carbon tetrachloride
U034	75–87–6	Chloral
U035	305–03–3	Chlorambucil
U036	57–74–9	Chlordane, alpha & gamma isomers
U026	494–03–1	Chlornaphazin
U037	108–90–7	Chlorobenzene
U038	510–15–6	Chlorobenzilate
U039	59–50–7	p-Chloro-m-cresol
U042	110–75–8	2-Chloroethyl vinyl ether

U044	67–66–3	Chloroform
U046	107–30–2	Chloromethyl methyl ether
U047	91–58–7	beta-Chloronaphthalene
U048	95–57–8	o-Chlorophenol
U049	3165–93–3	4-Chloro-o-toluidine, hydrochloride
U032	13765–19–0	Chromic acid H_2CrO_4, calcium salt
U050	218–01–9	Chrysene
U051		Creosote
U052	1319–77–3	Cresol (Cresylic acid)
U053	4170–30–3	Crotonaldehyde
U055	98–82–8	Cumene (I)
U246	506–68–3	Cyanogen bromide (CN)Br
U197	106–51–4	2,5-Cyclohexadiene-1,4-dione
U056	110–82–7	Cyclohexane (I)
U129	58–89–9	Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1alpha,2alpha,3beta,4alpha,5alpha,6beta)-
U057	108–94–1	Cyclohexanone (I)
U130	77–47–4	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U058	50–18–0	Cyclophosphamide

U240	[1]94–75–7	2,4-D, salts & esters
U059	20830–81–3	Daunomycin
U060	72–54–8	DDD
U061	50–29–3	DDT
U062	2303–16–4	Diallate
U063	53–70–3	Dibenz[a,h]anthracene
U064	189–55–9	Dibenzo[a,i]pyrene
U066	96–12–8	1,2-Dibromo-3-chloropropane
U069	84–74–2	Dibutyl phthalate
U070	95–50–1	o-Dichlorobenzene
U071	541–73–1	m-Dichlorobenzene
U072	106–46–7	p-Dichlorobenzene
U073	91–94–1	3,3'-Dichlorobenzidine
U074	764–41–0	1,4-Dichloro-2-butene (I,T)
U075	75–71–8	Dichlorodifluoromethane
U078	75–35–4	1,1-Dichloroethylene
U079	156–60–5	1,2-Dichloroethylene
U025	111–44–4	Dichloroethyl ether
U027	108–60–1	Dichloroisopropyl ether

U024	111–91–1	Dichloromethoxy ethane
U081	120–83–2	2,4-Dichlorophenol
U082	87–65–0	2,6-Dichlorophenol
U084	542–75–6	1,3-Dichloropropene
U085	1464–53–5	1,2:3,4-Diepoxybutane (I,T)
U108	123–91–1	1,4-Diethyleneoxide
U028	117–81–7	Diethylhexyl phthalate
U395	5952–26–1	Diethylene glycol, dicarbamate.
U086	1615–80–1	N,N'-Diethylhydrazine
U087	3288–58–2	O,O-Diethyl S-methyl dithiophosphate
U088	84–66–2	Diethyl phthalate
U089	56–53–1	Diethylstilbesterol
U090	94–58–6	Dihydrosafrole
U091	119–90–4	3,3'-Dimethoxybenzidine
U092	124–40–3	Dimethylamine (I)
U093	60–11–7	p-Dimethylaminoazobenzene
U094	57–97–6	7,12-Dimethylbenz[a]anthracene
U095	119–93–7	3,3'-Dimethylbenzidine
U096	80–15–9	alpha,alpha-Dimethylbenzylhydroperoxide (R)

U097	79–44–7	Dimethylcarbamoyl chloride
U098	57–14–7	1,1-Dimethylhydrazine
U099	540–73–8	1,2-Dimethylhydrazine
U101	105–67–9	2,4-Dimethylphenol
U102	131–11–3	Dimethyl phthalate
U103	77–78–1	Dimethyl sulfate
U105	121–14–2	2,4-Dinitrotoluene
U106	606–20–2	2,6-Dinitrotoluene
U107	117–84–0	Di-n-octyl phthalate
U108	123–91–1	1,4-Dioxane
U109	122–66–7	1,2-Diphenylhydrazine
U110	142–84–7	Dipropylamine (I)
U111	621–64–7	Di-n-propylnitrosamine
U041	106–89–8	Epichlorohydrin
U001	75–07–0	Ethanal (I)
U404	121–44–8	Ethanamine, N,N-diethyl-
U174	55–18–5	Ethanamine, N-ethyl-N-nitroso-
U155	91–80–5	1,2-Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2-thienylmethyl)-

U067	106–93–4	Ethane, 1,2-dibromo-
U076	75–34–3	Ethane, 1,1-dichloro-
U077	107–06–2	Ethane, 1,2-dichloro-
U131	67–72–1	Ethane, hexachloro-
U024	111–91–1	Ethane, 1,1’-[methylenebis(oxy)]bis[2-chloro-
U117	60–29–7	Ethane, 1,1’-oxybis-(I)
U025	111–44–4	Ethane, 1,1’-oxybis[2-chloro-
U184	76–01–7	Ethane, pentachloro-
U208	630–20–6	Ethane, 1,1,1,2-tetrachloro-
U209	79–34–5	Ethane, 1,1,2,2-tetrachloro-
U218	62–55–5	Ethanethioamide
U226	71–55–6	Ethane, 1,1,1-trichloro-
U227	79–00–5	Ethane, 1,1,2-trichloro-
U410	59669–26–0	Ethanimidothioic acid, N,N’-[thiobis[(methylimino)carbonyloxy]]bis-, dimethyl ester
U394	30558–43–1	Ethanimidothioic acid, 2-(dimethylamino)-N-hydroxy-2-oxo-, methyl ester.
U359	110–80–5	Ethanol, 2-ethoxy-
U173	1116–54–7	Ethanol, 2,2’-(nitrosoimino)bis-

U395	5952–26–1	Ethanol, 2,2’-oxybis-, dicarbamate.
U004	98–86–2	Ethanone, 1-phenyl-
U043	75–01–4	Ethene, chloro-
U042	110–75–8	Ethene, (2-chloroethoxy)-
U078	75–35–4	Ethene, 1,1-dichloro-
U079	156–60–5	Ethene, 1,2-dichloro-, (E)-
U210	127–18–4	Ethene, tetrachloro-
U228	79–01–6	Ethene, trichloro-
U112	141–78–6	Ethyl acetate (I)
U113	140–88–5	Ethyl acrylate (I)
U238	51–79–6	Ethyl carbamate (urethane)
U117	60–29–7	Ethyl ether (I)
U114	[1]111–54–6	Ethylenebisdithiocarbamic acid, salts & esters
U067	106–93–4	Ethylene dibromide
U077	107–06–2	Ethylene dichloride
U359	110–80–5	Ethylene glycol monoethyl ether
U115	75–21–8	Ethylene oxide (I,T)
U116	96–45–7	Ethylenethiourea
U076	75–34–3	Ethylidene dichloride

U118	97–63–2	Ethyl methacrylate
U119	62–50–0	Ethyl methanesulfonate
U120	206–44–0	Fluoranthene
U122	50–00–0	Formaldehyde
U123	64–18–6	Formic acid (C,T)
U124	110–00–9	Furan (I)
U125	98–01–1	2-Furancarboxaldehyde (I)
U147	108–31–6	2,5-Furandione
U213	109–99–9	Furan, tetrahydro-(I)
U125	98–01–1	Furfural (I)
U124	110–00–9	Furfuran (I)
U206	18883–66–4	Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-, D-
U206	18883–66–4	D-Glucose, 2-deoxy-2-[[(methylnitrosoamino)-carbonyl]amino]-
U126	765–34–4	Glycidylaldehyde
U163	70–25–7	Guanidine, N-methyl-N'-nitro-N-nitroso-
U127	118–74–1	Hexachlorobenzene
U128	87–68–3	Hexachlorobutadiene
U130	77–47–4	Hexachlorocyclopentadiene

U131	67–72–1	Hexachloroethane
U132	70–30–4	Hexachlorophene
U243	1888–71–7	Hexachloropropene
U133	302–01–2	Hydrazine (R,T)
U086	1615–80–1	Hydrazine, 1,2-diethyl-
U098	57–14–7	Hydrazine, 1,1-dimethyl-
U099	540–73–8	Hydrazine, 1,2-dimethyl-
U109	122–66–7	Hydrazine, 1,2-diphenyl-
U134	7664–39–3	Hydrofluoric acid (C,T)
U134	7664–39–3	Hydrogen fluoride (C,T)
U135	7783–06–4	Hydrogen sulfide
U135	7783–06–4	Hydrogen sulfide H_2S
U096	80–15–9	Hydroperoxide, 1-methyl-1-phenylethyl- (R)
U116	96–45–7	2-Imidazolidinethione
U137	193–39–5	Indeno[1,2,3-cd]pyrene
U190	85–44–9	1,3-Isobenzofurandione
U140	78–83–1	Isobutyl alcohol (I,T)
U141	120–58–1	Isosafrole
U142	143–50–0	Kepone

U143	303–34–4	Lasiocarpine
U144	301–04–2	Lead acetate
U146	1335–32–6	Lead, bis(acetato-O)tetrahydroxytri-
U145	7446–27–7	Lead phosphate
U146	1335–32–6	Lead subacetate
U129	58–89–9	Lindane
U163	70–25–7	MNNG
U147	108–31–6	Maleic anhydride
U148	123–33–1	Maleic hydrazide
U149	109–77–3	Malononitrile
U150	148–82–3	Melphalan
U151	7439–97–6	Mercury
U152	126–98–7	Methacrylonitrile (I, T)
U092	124–40–3	Methanamine, N-methyl- (I)
U029	74–83–9	Methane, bromo-
U045	74–87–3	Methane, chloro- (I, T)
U046	107–30–2	Methane, chloromethoxy-
U068	74–95–3	Methane, dibromo-
U080	75–09–2	Methane, dichloro-

U075	75–71–8	Methane, dichlorodifluoro-
U138	74–88–4	Methane, iodo-
U119	62–50–0	Methanesulfonic acid, ethyl ester
U211	56–23–5	Methane, tetrachloro-
U153	74–93–1	Methanethiol (I, T)
U225	75–25–2	Methane, tribromo-
U044	67–66–3	Methane, trichloro-
U121	75–69–4	Methane, trichlorofluoro-
U036	57–74–9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-
U154	67–56–1	Methanol (I)
U155	91–80–5	Methapyrilene
U142	143–50–0	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-
U247	72–43–5	Methoxychlor
U154	67–56–1	Methyl alcohol (I)
U029	74–83–9	Methyl bromide
U186	504–60–9	1-Methylbutadiene (I)
U045	74–87–3	Methyl chloride (I,T)
U156	79–22–1	Methyl chlorocarbonate (I,T)

U226	71–55–6	Methyl chloroform
U157	56–49–5	3-Methylcholanthrene
U158	101–14–4	4,4′-Methylenebis(2-chloroaniline)
U068	74–95–3	Methylene bromide
U080	75–09–2	Methylene chloride
U159	78–93–3	Methyl ethyl ketone (MEK) (I,T)
U160	1338–23–4	Methyl ethyl ketone peroxide (R,T)
U138	74–88–4	Methyl iodide
U161	108–10–1	Methyl isobutyl ketone (I)
U162	80–62–6	Methyl methacrylate (I,T)
U161	108–10–1	4-Methyl-2-pentanone (I)
U164	56–04–2	Methylthiouracil
U010	50–07–7	Mitomycin C
U059	20830–81–3	5,12-Naphthacenedione, 8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-, (8S-cis)-
U167	134–32–7	1-Naphthalenamine
U168	91–59–8	2-Naphthalenamine
U026	494–03–1	Naphthalenamine, N,N′-bis(2-chloroethyl)-

U165	91–20–3	Naphthalene
U047	91–58–7	Naphthalene, 2-chloro-
U166	130–15–4	1,4-Naphthalenedione
U236	72–57–1	2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl[1,1'-biphenyl]-4,4'-diyl)bis(azo)bis[5-amino-4-hydroxy]-, tetrasodium salt
U279	63–25–2	1-Naphthalenol, methylcarbamate.
U166	130–15–4	1,4-Naphthoquinone
U167	134–32–7	alpha-Naphthylamine
U168	91–59–8	beta-Naphthylamine
U217	10102–45–1	Nitric acid, thallium(1+) salt
U169	98–95–3	Nitrobenzene (I,T)
U170	100–02–7	p-Nitrophenol
U171	79–46–9	2-Nitropropane (I,T)
U172	924–16–3	N-Nitrosodi-n-butylamine
U173	1116–54–7	N-Nitrosodiethanolamine
U174	55–18–5	N-Nitrosodiethylamine
U176	759–73–9	N-Nitroso-N-ethylurea
U177	684–93–5	N-Nitroso-N-methylurea
U178	615–53–2	N-Nitroso-N-methylurethane

U179	100–75–4	N-Nitrosopiperidine
U180	930–55–2	N-Nitrosopyrrolidine
U181	99–55–8	5-Nitro-o-toluidine
U193	1120–71–4	1,2-Oxathiolane, 2,2-dioxide
U058	50–18–0	2H-1,3,2-Oxazaphosphorin-2-amine, N,N-bis(2-chloroethyl)tetrahydro-, 2-oxide
U115	75–21–8	Oxirane (I,T)
U126	765–34–4	Oxiranecarboxyaldehyde
U041	106–89–8	Oxirane, (chloromethyl)-
U182		Paraldehyde
U183	608–93–5	Pentachlorobenzene
U184	76–01–7	Pentachloroethane
U185	82–68–8	Pentachloronitrobenzene (PCNB)
See F027	87–86–5	Pentachlorophenol
U161	108–10–1	Pentanol, 4-methyl-
U186	504–60–9	1,3-Pentadiene (I)

U187	62–44–2	Phenacetin
U188	108–95–2	Phenol
U048	95–57–8	Phenol, 2-chloro-
U039	59–50–7	Phenol, 4-chloro-3-methyl-
U081	120–83–2	Phenol, 2,4-dichloro-
U082	87–65–0	Phenol, 2,6-dichloro-
U089	56–53–1	Phenol, 4,4′-(1,2-diethyl-1,2-ethenediyl)bis-, (E)-
U101	105–67–9	Phenol, 2,4-dimethyl-
U052	1319–77–3	Phenol, methyl-
U132	70–30–4	Phenol, 2,2′-methylenebis[3,4,6-trichloro-
U411	114–26–1	Phenol, 2-(1-methylethoxy)-, methylcarbamate.
U170	100–02–7	Phenol, 4-nitro-
See F027	87–86–5	Phenol, pentachloro-
See F027	58–90–2	Phenol, 2,3,4,6-tetrachloro-
See F027	95–95–4	Phenol, 2,4,5-trichloro-
See F027	88–06–2	Phenol, 2,4,6-trichloro-
U150	148–82–3	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-
U145	7446–27–7	Phosphoric acid, lead(2+) salt (2:3)
U087	3288–58–2	Phosphorodithioic acid, O,O-diethyl S-methyl ester

U189	1314–80–3	Phosphorus sulfide (R)
U190	85–44–9	Phthalic anhydride
U191	109–06–8	2-Picoline
U179	100–75–4	Piperidine, 1-nitroso-
U192	23950–58–5	Pronamide
U194	107–10–8	1-Propanamine (I,T)
U111	621–64–7	1-Propanamine, N-nitroso-N-propyl-
U110	142–84–7	1-Propanamine, N-propyl- (I)
U066	96–12–8	Propane, 1,2-dibromo-3-chloro-
U083	78–87–5	Propane, 1,2-dichloro-
U149	109–77–3	Propanedinitrile
U171	79–46–9	Propane, 2-nitro- (I,T)
U027	108–60–1	Propane, 2,2’-oxybis[2-chloro-
U193	1120–71–4	1,3-Propane sultone
See F027	93–72–1	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
U235	126–72–7	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U140	78–83–1	1-Propanol, 2-methyl- (I,T)
U002	67–64–1	2-Propanone (I)
U007	79–06–1	2-Propenamide

U084	542–75–6	1-Propene, 1,3-dichloro-
U243	1888–71–7	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	107–13–1	2-Propenenitrile
U152	126–98–7	2-Propenenitrile, 2-methyl- (I,T)
U008	79–10–7	2-Propenoic acid (I)
U113	140–88–5	2-Propenoic acid, ethyl ester (I)
U118	97–63–2	2-Propenoic acid, 2-methyl-, ethyl ester
U162	80–62–6	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U373	122–42–9	Propham.
U411	114–26–1	Propoxur.
U387	52888–80–9	Prosulfocarb.
U194	107–10–8	n-Propylamine (I,T)
U083	78–87–5	Propylene dichloride
U148	123–33–1	3,6-Pyridazinedione, 1,2-dihydro-
U196	110–86–1	Pyridine
U191	109–06–8	Pyridine, 2-methyl-
U237	66–75–1	2,4-(1H,3H)-Pyrimidinedione, 5-[bis(2-chloroethyl)amino]-
U164	56–04–2	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-

U180	930–55–2	Pyrrolidine, 1-nitroso-
U200	50–55–5	Reserpine
U201	108–46–3	Resorcinol
U203	94–59–7	Safrole
U204	7783–00–8	Selenious acid
U204	7783–00–8	Selenium dioxide
U205	7488–56–4	Selenium sulfide
U205	7488–56–4	Selenium sulfide SeS_2(R,T)
U015	115–02–6	L-Serine, diazoacetate (ester)
See F027	93–72–1	Silvex (2,4,5-TP)
U206	18883–66–4	Streptozotocin
U103	77–78–1	Sulfuric acid, dimethyl ester
U189	1314–80–3	Sulfur phosphide (R)
See F027	93–76–5	2,4,5-T
U207	95–94–3	1,2,4,5-Tetrachlorobenzene
U208	630–20–6	1,1,1,2-Tetrachloroethane
U209	79–34–5	1,1,2,2-Tetrachloroethane
U210	127–18–4	Tetrachloroethylene
See F027	58–90–2	2,3,4,6-Tetrachlorophenol

U213	109–99–9	Tetrahydrofuran (I)
U214	563–68–8	Thallium(I) acetate
U215	6533–73–9	Thallium(I) carbonate
U216	7791–12–0	Thallium(I) chloride
U216	7791–12–0	thallium chloride TlCl
U217	10102–45–1	Thallium(I) nitrate
U218	62–55–5	Thioacetamide
U410	59669–26–0	Thiodicarb.
U153	74–93–1	Thiomethanol (I,T)
U244	137–26–8	Thioperoxydicarbonic diamide $[(H_2N)C(S)]_2S_2$, tetramethyl-
U409	23564–05–8	Thiophanate-methyl.
U219	62–56–6	Thiourea
U244	137–26–8	Thiram
U220	108–88–3	Toluene
U221	25376–45–8	Toluenediamine
U223	26471–62–5	Toluene diisocyanate (R,T)
U328	95–53–4	o-Toluidine
U353	106–49–0	p-Toluidine

U222	636–21–5	o-Toluidine hydrochloride
U389	2303–17–5	Triallate.
U011	61–82–5	1H-1,2,4-Triazol-3-amine
U226	71–55–6	1,1,1-Trichloroethane
U227	79–00–5	1,1,2-Trichloroethane
U228	79–01–6	Trichloroethylene
U121	75–69–4	Trichloromonofluoromethane
See F027	95–95–4	2,4,5-Trichlorophenol
See F027	88–06–2	2,4,6-Trichlorophenol
U404	121–44–8	Triethylamine.
U234	99–35–4	1,3,5-Trinitrobenzene (R,T)
U182	123–63–7	1,3,5-Trioxane, 2,4,6-trimethyl-
U235	126–72–7	Tris(2,3-dibromopropyl) phosphate
U236	72–57–1	Trypan blue
U237	66–75–1	Uracil mustard
U176	759–73–9	Urea, N-ethyl-N-nitroso-
U177	684–93–5	Urea, N-methyl-N-nitroso-
U043	75–01–4	Vinyl chloride

U248	[1]81–81–2	Warfarin, & salts, when present at concentrations of 0.3% or less
U239	1330–20–7	Xylene (I)
U200	50–55–5	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester, (3beta,16beta,17alpha,18beta,20alpha)-
U249	1314–84–7	Zinc phosphide Zn_3P_2, when present at concentrations of 10% or less
U001	75–07–0	Acetaldehyde (I)
U001	75–07–0	Ethanal (I)
U002	67–64–1	Acetone (I)
U002	67–64–1	2-Propanone (I)
U003	75–05–8	Acetonitrile (I,T)
U004	98–86–2	Acetophenone
U004	98–86–2	Ethanone, 1-phenyl-
U005	53–96–3	Acetamide, -9H-fluoren-2-yl-
U005	53–96–3	2-Acetylaminofluorene
U006	75–36–5	Acetyl chloride (C,R,T)
U007	79–06–1	Acrylamide
U007	79–06–1	2-Propenamide
U008	79–10–7	Acrylic acid (I)

U008	79–10–7	2-Propenoic acid (I)
U009	107–13–1	Acrylonitrile
U009	107–13–1	2-Propenenitrile
U010	50–07–7	Azirino[2',3':3,4]pyrrolo[1,2-a]indole-4,7-dione, 6-amino-8-[[(aminocarbonyl)oxy]methyl]-1,1a,2,8,8a,8b-hexahydro-8a-methoxy-5-methyl-, [1aS-(1aalpha, 8beta,8aalpha,8balpha)]-
U010	50–07–7	Mitomycin C
U011	61–82–5	Amitrole
U011	61–82–5	1H-1,2,4-Triazol-3-amine
U012	62–53–3	Aniline (I,T)
U012	62–53–3	Benzenamine (I,T)
U014	492–80–8	Auramine
U014	492–80–8	Benzenamine, 4,4'-carbonimidoylbis[N,N-dimethyl-
U015	115–02–6	Azaserine
U015	115–02–6	L-Serine, diazoacetate (ester)
U016	225–51–4	Benz[c]acridine
U017	98–87–3	Benzal chloride
U017	98–87–3	Benzene, (dichloromethyl)-
U018	56–55–3	Benz[a]anthracene

U019	71–43–2	Benzene (I,T)
U020	98–09–9	Benzenesulfonic acid chloride (C,R)
U020	98–09–9	Benzenesulfonyl chloride (C,R)
U021	92–87–5	Benzidine
U021	92–87–5	[1,1'-Biphenyl]-4,4'-diamine
U022	50–32–8	Benzo[a]pyrene
U023	98–07–7	Benzene, (trichloromethyl)-
U023	98–07–7	Benzotrichloride (C,R,T)
U024	111–91–1	Dichloromethoxy ethane
U024	111–91–1	Ethane, 1,1'-[methylenebis(oxy)]bis[2-chloro-
U025	111–44–4	Dichloroethyl ether
U025	111–44–4	Ethane, 1,1'-oxybis[2-chloro-
U026	494–03–1	Chlornaphazin
U026	494–03–1	Naphthalenamine, N,N'-bis(2-chloroethyl)-
U027	108–60–1	Dichloroisopropyl ether
U027	108–60–1	Propane, 2,2'-oxybis[2-chloro-
U028	117–81–7	1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester
U028	117–81–7	Diethylhexyl phthalate
U029	74–83–9	Methane, bromo-

U029	74–83–9	Methyl bromide
U030	101–55–3	Benzene, 1-bromo-4-phenoxy-
U030	101–55–3	4-Bromophenyl phenyl ether
U031	71–36–3	1-Butanol (I)
U031	71–36–3	n-Butyl alcohol (I)
U032	13765–19–0	Calcium chromate
U032	13765–19–0	Chromic acid H_2CrO_4, calcium salt
U033	353–50–4	Carbonic difluoride
U033	353–50–4	Carbon oxyfluoride (R,T)
U034	75–87–6	Acetaldehyde, trichloro-
U034	75–87–6	Chloral
U035	305–03–3	Benzenebutanoic acid, 4-[bis(2-chloroethyl)amino]-
U035	305–03–3	Chlorambucil
U036	57–74–9	Chlordane, alpha & gamma isomers
U036	57–74–9	4,7-Methano-1H-indene, 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-
U037	108–90–7	Benzene, chloro-
U037	108–90–7	Chlorobenzene
U038	510–15–6	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy-, ethyl ester

U038	510–15–6	Chlorobenzilate
U039	59–50–7	p-Chloro-m-cresol
U039	59–50–7	Phenol, 4-chloro-3-methyl-
U041	106–89–8	Epichlorohydrin
U041	106–89–8	Oxirane, (chloromethyl)-
U042	110–75–8	2-Chloroethyl vinyl ether
U042	110–75–8	Ethene, (2-chloroethoxy)-
U043	75–01–4	Ethene, chloro-
U043	75–01–4	Vinyl chloride
U044	67–66–3	Chloroform
U044	67–66–3	Methane, trichloro-
U045	74–87–3	Methane, chloro- (I,T)
U045	74–87–3	Methyl chloride (I,T)
U046	107–30–2	Chloromethyl methyl ether
U046	107–30–2	Methane, chloromethoxy-
U047	91–58–7	beta-Chloronaphthalene
U047	91–58–7	Naphthalene, 2-chloro-
U048	95–57–8	o-Chlorophenol
U048	95–57–8	Phenol, 2-chloro-

U049	3165–93–3	Benzenamine, 4-chloro-2-methyl-, hydrochloride
U049	3165–93–3	4-Chloro-o-toluidine, hydrochloride
U050	218–01–9	Chrysene
U051		Creosote
U052	1319–77–3	Cresol (Cresylic acid)
U052	1319–77–3	Phenol, methyl-
U053	4170–30–3	2-Butenal
U053	4170–30–3	Crotonaldehyde
U055	98–82–8	Benzene, (1-methylethyl)-(I)
U055	98–82–8	Cumene (I)
U056	110–82–7	Benzene, hexahydro-(I)
U056	110–82–7	Cyclohexane (I)
U057	108–94–1	Cyclohexanone (I)
U058	50–18–0	Cyclophosphamide
U058	50–18–0	2H-1,3,2-Oxazaphosphorin-2-amine, N,N-bis(2-chloroethyl)tetrahydro-, 2-oxide
U059	20830–81–3	Daunomycin
U059	20830–81–3	5,12-Naphthacenedione, 8-acetyl-10-[(3-amino-2,3,6-trideoxy)-alpha-L-lyxo-hexopyranosyl)oxy]-7,8,9,10-tetrahydro-6,8,11-trihydroxy-1-methoxy-, (8S-cis)-

U060	72–54–8	Benzene, 1,1'-(2,2-dichloroethylidene)bis[4-chloro-
U060	72–54–8	DDD
U061	50–29–3	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-chloro-
U061	50–29–3	DDT
U062	2303–16–4	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3-di chloro-2-propenyl) ester
U062	2303–16–4	Diallate
U063	53–70–3	Dibenz[a,h]anthracene
U064	189–55–9	Benzo[rst]pentaphene
U064	189–55–9	Dibenzo[a,i]pyrene
U066	96–12–8	1,2-Dibromo-3-chloropropane
U066	96–12–8	Propane, 1,2-dibromo-3-chloro-
U067	106–93–4	Ethane, 1,2-dibromo-
U067	106–93–4	Ethylene dibromide
U068	74–95–3	Methane, dibromo-
U068	74–95–3	Methylene bromide
U069	84–74–2	1,2-Benzenedicarboxylic acid, dibutyl ester
U069	84–74–2	Dibutyl phthalate
U070	95–50–1	Benzene, 1,2-dichloro-

U070	95–50–1	o-Dichlorobenzene
U071	541–73–1	Benzene, 1,3-dichloro-
U071	541–73–1	m-Dichlorobenzene
U072	106–46–7	Benzene, 1,4-dichloro-
U072	106–46–7	p-Dichlorobenzene
U073	91–94–1	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dichloro-
U073	91–94–1	3,3'-Dichlorobenzidine
U074	764–41–0	2-Butene, 1,4-dichloro-(I,T)
U074	764–41–0	1,4-Dichloro-2-butene (I,T)
U075	75–71–8	Dichlorodifluoromethane
U075	75–71–8	Methane, dichlorodifluoro-
U076	75–34–3	Ethane, 1,1-dichloro-
U076	75–34–3	Ethylidene dichloride
U077	107–06–2	Ethane, 1,2-dichloro-
U077	107–06–2	Ethylene dichloride
U078	75–35–4	1,1-Dichloroethylene
U078	75–35–4	Ethene, 1,1-dichloro-
U079	156–60–5	1,2-Dichloroethylene
U079	156–60–5	Ethene, 1,2-dichloro-, (E)-

U080	75–09–2	Methane, dichloro-
U080	75–09–2	Methylene chloride
U081	120–83–2	2,4-Dichlorophenol
U081	120–83–2	Phenol, 2,4-dichloro-
U082	87–65–0	2,6-Dichlorophenol
U082	87–65–0	Phenol, 2,6-dichloro-
U083	78–87–5	Propane, 1,2-dichloro-
U083	78–87–5	Propylene dichloride
U084	542–75–6	1,3-Dichloropropene
U084	542–75–6	1-Propene, 1,3-dichloro-
U085	1464–53–5	2,2'-Bioxirane
U085	1464–53–5	1,2:3,4-Diepoxybutane (I,T)
U086	1615–80–1	N,N'-Diethylhydrazine
U086	1615–80–1	Hydrazine, 1,2-diethyl-
U087	3288–58–2	O,O-Diethyl S-methyl dithiophosphate
U087	3288–58–2	Phosphorodithioic acid, O,O-diethyl S-methyl ester
U088	84–66–2	1,2-Benzenedicarboxylic acid, diethyl ester
U088	84–66–2	Diethyl phthalate
U089	56–53–1	Diethylstilbesterol

U089	56–53–1	Phenol, 4,4'-(1,2-diethyl-1,2-ethenediyl)bis-, (E)-
U090	94–58–6	1,3-Benzodioxole, 5-propyl-
U090	94–58–6	Dihydrosafrole
U091	119–90–4	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethoxy-
U091	119–90–4	3,3'-Dimethoxybenzidine
U092	124–40–3	Dimethylamine (I)
U092	124–40–3	Methanamine, -methyl-(I)
U093	60–11–7	Benzenamine, N,N-dimethyl-4-(phenylazo)-
U093	60–11–7	p-Dimethylaminoazobenzene
U094	57–97–6	Benz[a]anthracene, 7,12-dimethyl-
U094	57–97–6	7,12-Dimethylbenz[a]anthracene
U095	119–93–7	[1,1'-Biphenyl]-4,4'-diamine, 3,3'-dimethyl-
U095	119–93–7	3,3'-Dimethylbenzidine
U096	80–15–9	alpha,alpha-Dimethylbenzylhydroperoxide (R)
U096	80–15–9	Hydroperoxide, 1-methyl-1-phenylethyl-(R)
U097	79–44–7	Carbamic chloride, dimethyl-
U097	79–44–7	Dimethylcarbamoyl chloride
U098	57–14–7	1,1-Dimethylhydrazine
U098	57–14–7	Hydrazine, 1,1-dimethyl-

U099	540–73–8	1,2-Dimethylhydrazine
U099	540–73–8	Hydrazine, 1,2-dimethyl-
U101	105–67–9	2,4-Dimethylphenol
U101	105–67–9	Phenol, 2,4-dimethyl-
U102	131–11–3	1,2-Benzenedicarboxylic acid, dimethyl ester
U102	131–11–3	Dimethyl phthalate
U103	77–78–1	Dimethyl sulfate
U103	77–78–1	Sulfuric acid, dimethyl ester
U105	121–14–2	Benzene, 1-methyl-2,4-dinitro-
U105	121–14–2	2,4-Dinitrotoluene
U106	606–20–2	Benzene, 2-methyl-1,3-dinitro-
U106	606–20–2	2,6-Dinitrotoluene
U107	117–84–0	1,2-Benzenedicarboxylic acid, dioctyl ester
U107	117–84–0	Di-n-octyl phthalate
U108	123–91–1	1,4-Diethyleneoxide
U108	123–91–1	1,4-Dioxane
U109	122–66–7	1,2-Diphenylhydrazine
U109	122–66–7	Hydrazine, 1,2-diphenyl-
U110	142–84–7	Dipropylamine (I)

U110	142–84–7	1-Propanamine, N-propyl-(I)
U111	621–64–7	Di-n-propylnitrosamine
U111	621–64–7	1-Propanamine, N-nitroso-N-propyl-
U112	141–78–6	Acetic acid ethyl ester (I)
U112	141–78–6	Ethyl acetate (I)
U113	140–88–5	Ethyl acrylate (I)
U113	140–88–5	2-Propenoic acid, ethyl ester (I)
U114	[1]111–54–6	Carbamodithioic acid, 1,2-ethanediylbis-, salts & esters
U114	[1]111–54–6	Ethylenebisdithiocarbamic acid, salts & esters
U115	75–21–8	Ethylene oxide (I,T)
U115	75–21–8	Oxirane (I,T)
U116	96–45–7	Ethylenethiourea
U116	96–45–7	2-Imidazolidinethione
U117	60–29–7	Ethane, 1,1'-oxybis-(I)
U117	60–29–7	Ethyl ether (I)
U118	97–63–2	Ethyl methacrylate
U118	97–63–2	2-Propenoic acid, 2-methyl-, ethyl ester
U119	62–50–0	Ethyl methanesulfonate

U119	62–50–0	Methanesulfonic acid, ethyl ester
U120	206–44–0	Fluoranthene
U121	75–69–4	Methane, trichlorofluoro-
U121	75–69–4	Trichloromonofluoromethane
U122	50–00–0	Formaldehyde
U123	64–18–6	Formic acid (C,T)
U124	110–00–9	Furan (I)
U124	110–00–9	Furfuran (I)
U125	98–01–1	2-Furancarboxaldehyde (I)
U125	98–01–1	Furfural (I)
U126	765–34–4	Glycidylaldehyde
U126	765–34–4	Oxiranecarboxyaldehyde
U127	118–74–1	Benzene, hexachloro-
U127	118–74–1	Hexachlorobenzene
U128	87–68–3	1,3-Butadiene, 1,1,2,3,4,4-hexachloro-
U128	87–68–3	Hexachlorobutadiene
U129	58–89–9	Cyclohexane, 1,2,3,4,5,6-hexachloro-, (1alpha,2alpha,3beta,4alpha,5alpha,6beta)-
U129	58–89–9	Lindane

U130	77–47–4	1,3-Cyclopentadiene, 1,2,3,4,5,5-hexachloro-
U130	77–47–4	Hexachlorocyclopentadiene
U131	67–72–1	Ethane, hexachloro-
U131	67–72–1	Hexachloroethane
U132	70–30–4	Hexachlorophene
U132	70–30–4	Phenol, 2,2'-methylenebis[3,4,6-trichloro-
U133	302–01–2	Hydrazine (R,T)
U134	7664–39–3	Hydrofluoric acid (C,T)
U134	7664–39–3	Hydrogen fluoride (C,T)
U135	7783–06–4	Hydrogen sulfide
U135	7783–06–4	Hydrogen sulfide H_2S
U136	75–60–5	Arsinic acid, dimethyl-
U136	75–60–5	Cacodylic acid
U137	193–39–5	Indeno[1,2,3-cd]pyrene
U138	74–88–4	Methane, iodo-
U138	74–88–4	Methyl iodide
U140	78–83–1	Isobutyl alcohol (I,T)
U140	78–83–1	1-Propanol, 2-methyl- (I,T)
U141	120–58–1	1,3-Benzodioxole, 5-(1-propenyl)-

U141	120–58–1	Isosafrole
U142	143–50–0	Kepone
U142	143–50–0	1,3,4-Metheno-2H-cyclobuta[cd]pentalen-2-one, 1,1a,3,3a,4,5,5,5a,5b,6-decachlorooctahydro-
U143	303–34–4	2-Butenoic acid, 2-methyl-, 7-[[2,3-dihydroxy-2-(1-methoxyethyl)-3-methyl-1-oxobutoxy]methyl]-2,3,5,7a-tetrahydro-1H-pyrrolizin-1-yl ester, [1S-[1alpha(Z),7(2S*,3R*),7aalpha]]-
U143	303–34–4	Lasiocarpine
U144	301–04–2	Acetic acid, lead(2+) salt
U144	301–04–2	Lead acetate
U145	7446–27–7	Lead phosphate
U145	7446–27–7	Phosphoric acid, lead(2+) salt (2:3)
U146	1335–32–6	Lead, bis(acetato-O)tetrahydroxytri-
U146	1335–32–6	Lead subacetate
U147	108–31–6	2,5-Furandione
U147	108–31–6	Maleic anhydride
U148	123–33–1	Maleic hydrazide
U148	123–33–1	3,6-Pyridazinedione, 1,2-dihydro-
U149	109–77–3	Malononitrile
U149	109–77–3	Propanedinitrile

U150	148–82–3	Melphalan
U150	148–82–3	L-Phenylalanine, 4-[bis(2-chloroethyl)amino]-
U151	7439–97–6	Mercury
U152	126–98–7	Methacrylonitrile (I,T)
U152	126–98–7	2-Propenenitrile, 2-methyl- (I,T)
U153	74–93–1	Methanethiol (I,T)
U153	74–93–1	Thiomethanol (I,T)
U154	67–56–1	Methanol (I)
U154	67–56–1	Methyl alcohol (I)
U155	91–80–5	1,2-Ethanediamine, N,N-dimethyl-N'-2-pyridinyl-N'-(2-thienylmethyl)-
U155	91–80–5	Methapyrilene
U156	79–22–1	Carbonochloridic acid, methyl ester (I,T)
U156	79–22–1	Methyl chlorocarbonate (I,T)
U157	56–49–5	Benz[j]aceanthrylene, 1,2-dihydro-3-methyl-
U157	56–49–5	3-Methylcholanthrene
U158	101–14–4	Benzenamine, 4,4'-methylenebis[2-chloro-
U158	101–14–4	4,4'-Methylenebis(2-chloroaniline)
U159	78–93–3	2-Butanone (I,T)

U159	78–93–3	Methyl ethyl ketone (MEK) (I,T)
U160	1338–23–4	2-Butanone, peroxide (R,T)
U160	1338–23–4	Methyl ethyl ketone peroxide (R,T)
U161	108–10–1	Methyl isobutyl ketone (I)
U161	108–10–1	4-Methyl-2-pentanone (I)
U161	108–10–1	Pentanol, 4-methyl-
U162	80–62–6	Methyl methacrylate (I,T)
U162	80–62–6	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U163	70–25–7	Guanidine, -methyl-N'-nitro-N-nitroso-
U163	70–25–7	MNNG
U164	56–04–2	Methylthiouracil
U164	56–04–2	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U165	91–20–3	Naphthalene
U166	130–15–4	1,4-Naphthalenedione
U166	130–15–4	1,4-Naphthoquinone
U167	134–32–7	1-Naphthalenamine
U167	134–32–7	alpha-Naphthylamine
U168	91–59–8	2-Naphthalenamine
U168	91–59–8	beta-Naphthylamine

U169	98–95–3	Benzene, nitro-
U169	98–95–3	Nitrobenzene (I,T)
U170	100–02–7	p-Nitrophenol
U170	100–02–7	Phenol, 4-nitro-
U171	79–46–9	2-Nitropropane (I,T)
U171	79–46–9	Propane, 2-nitro- (I,T)
U172	924–16–3	1-Butanamine, N-butyl-N-nitroso-
U172	924–16–3	N-Nitrosodi-n-butylamine
U173	1116–54–7	Ethanol, 2,2'-(nitrosoimino)bis-
U173	1116–54–7	N-Nitrosodiethanolamine
U174	55–18–5	Ethanamine, -ethyl-N-nitroso-
U174	55–18–5	N-Nitrosodiethylamine
U176	759–73–9	N-Nitroso-N-ethylurea
U176	759–73–9	Urea, N-ethyl-N-nitroso-
U177	684–93–5	N-Nitroso-N-methylurea
U177	684–93–5	Urea, N-methyl-N-nitroso-
U178	615–53–2	Carbamic acid, methylnitroso-, ethyl ester
U178	615–53–2	N-Nitroso-N-methylurethane
U179	100–75–4	N-Nitrosopiperidine

U179	100–75–4	Piperidine, 1-nitroso-
U180	930–55–2	N-Nitrosopyrrolidine
U180	930–55–2	Pyrrolidine, 1-nitroso-
U181	99–55–8	Benzenamine, 2-methyl-5-nitro-
U181	99–55–8	5-Nitro-o-toluidine
U182	123–63–7	1,3,5-Trioxane, 2,4,6-trimethyl-
U182	123–63–7	Paraldehyde
U183	608–93–5	Benzene, pentachloro-
U183	608–93–5	Pentachlorobenzene
U184	76–01–7	Ethane, pentachloro-
U184	76–01–7	Pentachloroethane
U185	82–68–8	Benzene, pentachloronitro-
U185	82–68–8	Pentachloronitrobenzene (PCNB)
U186	504–60–9	1-Methylbutadiene (I)
U186	504–60–9	1,3-Pentadiene (I)
U187	62–44–2	Acetamide, -(4-ethoxyphenyl)-
U187	62–44–2	Phenacetin
U188	108–95–2	Phenol
U189	1314–80–3	Phosphorus sulfide (R)

U189	1314–80–3	Sulfur phosphide (R)
U190	85–44–9	1,3-Isobenzofurandione
U190	85–44–9	Phthalic anhydride
U191	109–06–8	2-Picoline
U191	109–06–8	Pyridine, 2-methyl-
U192	23950–58–5	Benzamide, 3,5-dichloro-N-(1,1-dimethyl-2-propynyl)-
U192	23950–58–5	Pronamide
U193	1120–71–4	1,2-Oxathiolane, 2,2-dioxide
U193	1120–71–4	1,3-Propane sultone
U194	107–10–8	1-Propanamine (I,T)
U194	107–10–8	n-Propylamine (I,T)
U196	110–86–1	Pyridine
U197	106–51–4	p-Benzoquinone
U197	106–51–4	2,5-Cyclohexadiene-1,4-dione
U200	50–55–5	Reserpine
U200	50–55–5	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxybenzoyl)oxy]-, methyl ester,(3beta,16beta,17alpha,18beta,20alpha)-
U201	108–46–3	1,3-Benzenediol

U201	108–46–3	Resorcinol
U203	94–59–7	1,3-Benzodioxole, 5-(2-propenyl)-
U203	94–59–7	Safrole
U204	7783–00–8	Selenious acid
U204	7783–00–8	Selenium dioxide
U205	7488–56–4	Selenium sulfide
U205	7488–56–4	Selenium sulfide SeS_2(R,T)
U206	18883–66–4	Glucopyranose, 2-deoxy-2-(3-methyl-3-nitrosoureido)-, D-
U206	18883–66–4	D-Glucose, 2-deoxy-2-[[(methylnitrosoamino)-carbonyl]amino]-
U206	18883–66–4	Streptozotocin
U207	95–94–3	Benzene, 1,2,4,5-tetrachloro-
U207	95–94–3	1,2,4,5-Tetrachlorobenzene
U208	630–20–6	Ethane, 1,1,1,2-tetrachloro-
U208	630–20–6	1,1,1,2-Tetrachloroethane
U209	79–34–5	Ethane, 1,1,2,2-tetrachloro-
U209	79–34–5	1,1,2,2-Tetrachloroethane
U210	127–18–4	Ethene, tetrachloro-
U210	127–18–4	Tetrachloroethylene

U211	56–23–5	Carbon tetrachloride
U211	56–23–5	Methane, tetrachloro-
U213	109–99–9	Furan, tetrahydro-(I)
U213	109–99–9	Tetrahydrofuran (I)
U214	563–68–8	Acetic acid, thallium(1+) salt
U214	563–68–8	Thallium(I) acetate
U215	6533–73–9	Carbonic acid, dithallium(1+) salt
U215	6533–73–9	Thallium(I) carbonate
U216	7791–12–0	Thallium(I) chloride
U216	7791–12–0	Thallium chloride TlCl
U217	10102–45–1	Nitric acid, thallium(1+) salt
U217	10102–45–1	Thallium(I) nitrate
U218	62–55–5	Ethanethioamide
U218	62–55–5	Thioacetamide
U219	62–56–6	Thiourea
U220	108–88–3	Benzene, methyl-
U220	108–88–3	Toluene
U221	25376–45–8	Benzenediamine, ar-methyl-
U221	25376–45–8	Toluenediamine

U222	636–21–5	Benzenamine, 2-methyl-, hydrochloride
U222	636–21–5	o-Toluidine hydrochloride
U223	26471–62–5	Benzene, 1,3-diisocyanatomethyl- (R,T)
U223	26471–62–5	Toluene diisocyanate (R,T)
U225	75–25–2	Bromoform
U225	75–25–2	Methane, tribromo-
U226	71–55–6	Ethane, 1,1,1-trichloro-
U226	71–55–6	Methyl chloroform
U226	71–55–6	1,1,1-Trichloroethane
U227	79–00–5	Ethane, 1,1,2-trichloro-
U227	79–00–5	1,1,2-Trichloroethane
U228	79–01–6	Ethene, trichloro-
U228	79–01–6	Trichloroethylene
U234	99–35–4	Benzene, 1,3,5-trinitro-
U234	99–35–4	1,3,5-Trinitrobenzene (R,T)
U235	126–72–7	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U235	126–72–7	Tris(2,3-dibromopropyl) phosphate
U236	72–57–1	2,7-Naphthalenedisulfonic acid, 3,3'-[(3,3'-dimethyl[1,1'-biphenyl]-4,4'-diyl)bis(azo)bis[5-amino-4-hydroxy]-, tetrasodium salt

U236	72–57–1	Trypan blue
U237	66–75–1	2,4-(1H,3H)-Pyrimidinedione, 5-[bis(2-chloroethyl)amino]-
U237	66–75–1	Uracil mustard
U238	51–79–6	Carbamic acid, ethyl ester
U238	51–79–6	Ethyl carbamate (urethane)
U239	1330–20–7	Benzene, dimethyl- (I,T)
U239	1330–20–7	Xylene (I)
U240	[1]94–75–7	Acetic acid, (2,4-dichlorophenoxy)-, salts & esters
U240	[1]94–75–7	2,4-D, salts & esters
U243	1888–71–7	Hexachloropropene
U243	1888–71–7	1-Propene, 1,1,2,3,3,3-hexachloro-
U244	137–26–8	Thioperoxydicarbonic diamide $[(H_2N)C(S)]_2S_2$, tetramethyl-
U244	137–26–8	Thiram
U246	506–68–3	Cyanogen bromide (CN)Br
U247	72–43–5	Benzene, 1,1'-(2,2,2-trichloroethylidene)bis[4-methoxy-
U247	72–43–5	Methoxychlor

U248	[1]81–81–2	2H-1-Benzopyran-2-one, 4-hydroxy-3-(3-oxo-1-phenyl-butyl)-, & salts, when present at concentrations of 0.3% or less
U248	[1]81–81–2	Warfarin, & salts, when present at concentrations of 0.3% or less
U249	1314–84–7	Zinc phosphide Zn_3P_2, when present at concentrations of 10% or less
U271	17804–35–2	Benomyl
U271	17804–35–2	Carbamic acid, [1-[(butylamino)carbonyl]-1H-benzimidazol-2-yl]-, methyl ester
U278	22781–23–3	Bendiocarb
U278	22781–23–3	1,3-Benzodioxol-4-ol, 2,2-dimethyl-, methyl carbamate
U279	63–25–2	Carbaryl
U279	63–25–2	1-Naphthalenol, methylcarbamate
U280	101–27–9	Barban
U280	101–27–9	Carbamic acid, (3-chlorophenyl)-, 4-chloro-2-butynyl ester
U328	95–53–4	Benzenamine, 2-methyl-
U328	95–53–4	o-Toluidine
U353	106–49–0	Benzenamine, 4-methyl-
U353	106–49–0	p-Toluidine

U359	110–80–5	Ethanol, 2-ethoxy-
U359	110–80–5	Ethylene glycol monoethyl ether
U364	22961–82–6	Bendiocarb phenol
U364	22961–82–6	1,3-Benzodioxol-4-ol, 2,2-dimethyl-,
U367	1563–38–8	7-Benzofuranol, 2,3-dihydro-2,2-dimethyl-
U367	1563–38–8	Carbofuran phenol
U372	10605–21–7	Carbamic acid, 1H-benzimidazol-2-yl, methyl ester
U372	10605–21–7	Carbendazim
U373	122–42–9	Carbamic acid, phenyl-, 1-methylethyl ester
U373	122–42–9	Propham
U387	52888–80–9	Carbamothioic acid, dipropyl-, S-(phenylmethyl) ester
U387	52888–80–9	Prosulfocarb
U389	2303–17–5	Carbamothioic acid, bis(1-methylethyl)-, S-(2,3,3-trichloro-2-propenyl) ester
U389	2303–17–5	Triallate
U394	30558–43–1	A2213
U394	30558–43–1	Ethanimidothioic acid, 2-(dimethylamino)-N-hydroxy-2-oxo-, methyl ester
U395	5952–26–1	Diethylene glycol, dicarbamate

U395	5952–26–1	Ethanol, 2,2'-oxybis-, dicarbamate
U404	121–44–8	Ethanamine, N,N-diethyl-
U404	121–44–8	Triethylamine
U409	23564–05–8	Carbamic acid, [1,2-phenylenebis (iminocarbonothioyl)]bis-, dimethyl ester
U409	23564–05–8	Thiophanate-methyl
U410	59669–26–0	Ethanimidothioic acid, N,N'-[thiobis[(methylimino)carbonyloxy]]bis-, dimethyl ester
U410	59669–26–0	Thiodicarb
U411	114–26–1	Phenol, 2-(1-methylethoxy)-, methylcarbamate
U411	114–26–1	Propoxur
See F027	93–76–5	Acetic acid, (2,4,5-trichlorophenoxy)-
See F027	87–86–5	Pentachlorophenol
See F027	87–86–5	Phenol, pentachloro-
See F027	58–90–2	Phenol, 2,3,4,6-tetrachloro-
See F027	95–95–4	Phenol, 2,4,5-trichloro-
See F027	88–06–2	Phenol, 2,4,6-trichloro-
See F027	93–72–1	Propanoic acid, 2-(2,4,5-trichlorophenoxy)-
See F027	93–72–1	Silvex (2,4,5-TP)

See F027	93–76–5	2,4,5-T
See F027	58–90–2	2,3,4,6-Tetrachlorophenol
See F027	95–95–4	2,4,5-Trichlorophenol
See F027	88–06–2	2,4,6-Trichlorophenol

[1]CAS Number given for parent compound only.

The primary hazardous properties of these materials have been indicated by the letters T (Toxicity), and R (Reactivity). Absence of a letter indicates that the compound only is listed for acute toxicity. Wastes are first listed in alphabetical order by substance and then listed again in numerical order by Hazardous Waste Number.]

Appendix C: HAZARDOUS WASTE SATELLITE ACCUMULATION AREA REQUIREMENTS

1. **Mark** all waste containers with the words "**Hazardous Waste**."
2. **Label** all waste containers accurately indicating the contents.
3. **Limit** the satellite area waste volume to no more than 55 gallons of waste, or one quart of a "P" waste at any one time. For assistance in identifying waste types contact the EHS Environmental Specialist.
4. **Close** all containers during accumulation except when necessary to add or remove wastes. Do not overfill containers. Leave adequate headspace for expansion.
5. **Funnels** must be removed from containers when not in immediate use. All waste must be collected in sealable containers.
6. **Seal** all containers tightly. No beakers or open containers shall be used for waste accumulation.
7. **Ensure** waste is compatible with other wastes in the container, and with the type of container it is stored in. The exterior of the container must be free of chemical contamination; leaking containers must be over-packed. Segregate containers of incompatible waste to prevent reactions.
8. **Biohazard** waste, radioactive waste, and hazardous waste must not be mixed.
9. **Keep** the waste containers near the process generating the waste - within the same laboratory and under the control of the waste generator.
10. **Inform** all students and employees of waste accumulation site requirements.
11. **Know** the location of your spill kit, emergency shower, fire extinguisher, and exits.

Clean up any spillage immediately. Contact the BSU Environmental Specialist (28)5-2807 if assistance is needed. Call (28)5-1111 for outside emergency assistance if warranted by the nature of the chemical spill, exposed persons, or sensitive location of the release.

Laboratory Hazardous Waste Accumulation Area

Laboratory Hazardous Waste Accumulation Area: An area in the laboratory where small quantities of hazardous waste are temporarily stored prior to collection for disposal by the BSU EHS Office. Laboratory Hazardous Waste Accumulation Area could be a room, a bench top, or a laboratory hood.

Such accumulation areas are regulated by federal and state law. To ensure compliance with these regulations and the College's requirements, the following conditions must be met:

- Mark with the words "HAZARDOUS WASTE ACCUMULATION AREA."
- Locate in the laboratory and under the control of the person generating the waste.

- All containers must meet the container and labeling requirements outlined in this BSU guidance.
- Segregate incompatible substances; do not mix in the same container.
- Liquid waste containers should have secondary containment.
- No more than one container of each type of hazardous waste generated should be in use at one time.
- No more than 55 gallons of hazardous waste or one (1) quart of acutely hazardous (P-listed) waste can be stored at one time.
- Emergency response information must be posted:
  - emergency phone numbers
  - location of fire extinguishers and fire alarms
  - location of spill control materials and MSDSs
- Must contain appropriate spill control kits for chemicals used in that laboratory.

APPENDIX D: WASTE INCOMPATIBILITY

Source: EPA's RCRA Chemical Waste Compatibility List

The mixing of Group A materials with Group B materials may have the potential consequences noted.

Group 1-A	Group 1-B
Acetylene sludge	Acid sludge
Alkaline caustic liquids	Acid and water
Alkaline cleaner	Battery acid
Alkaline corrosive liquids	Chemical cleaners
Alkaline corrosive battery fluid	Electrolyte, acid
Caustic wastewater	Etching acid liquid or solvent
Lime sludge and other corrosive alkalis	Pickling liquor & other corrosive acids
Lime wastewater	Spent acid
Lime and water	Spent mixed acid
Spent caustic	Spent sulfuric acid

Potential consequences: Heat generation; violent reaction

Group 2-A	Group 2-B
Aluminum	Any waste in Group 1-A or 1-B
Beryllium Calcium	
Lithium	
Magnesium Potassium sodium	
Zinc powder	
Other reactive metals and metal hydroxides	

Potential consequences: Fire or explosion; generation of flammable hydrogen gas

Group 3-A	Group 3-B
Alcohols	Any concentrated waste in Groups1A or 1B
Water	Calcium
	Lithium
	Metal hydrides
	Potassium
	SO_2Cl_2, $SOCl_2$, PCl_3, CH_3SiCl_3 Other water-reactive waste

Potential consequences: Fire, explosion, or heat generation; generation of flammable or toxic gases

Group 4-A	Group 4-B
Alcohols	Concentrated Group 1-A or 1-B wastes
Aldehydes	Group 2-A wastes
Halogenated hydrocarbons	
Nitrated hydrocarbons	
Unsaturated hydrocarbons	
Other reactive organic compounds & solvents	

Potential consequences: Fire, explosion, or violent reaction

Group 5-A	Group 5-B
Spent cyanide and sulfide solutions	Group 1-B wastes

Potential consequences: Generation of toxic hydrogen cyanide or hydrogen sulfide gas

Group 6-A	Group 6-B
Chlorates	Acetic acid and other organic acids
Chlorine	Concentrated mineral acids
Chlorites	Group 2-A wastes
Chromic acid	Group 5-A wastes
Hypochlorites	Other flammable and combustible wastes
Nitrates	
Nitric acid, fuming	
Perchlorates	
Permanganates	
Peroxides	
Other strong oxidizers	
Potential consequences:	**Fire, explosion, or violent reaction**

Note: Numerous other chemical compatibility charts are available if none of the waste compounds or categories of concern are included above. MSDSs and other references should also be consulted if there are any doubts as to chemical compatibilities. For some waste mixtures of unknown ingredients or concentrations, bench scale testing may be necessary to verify waste characteristics and compatibilities.

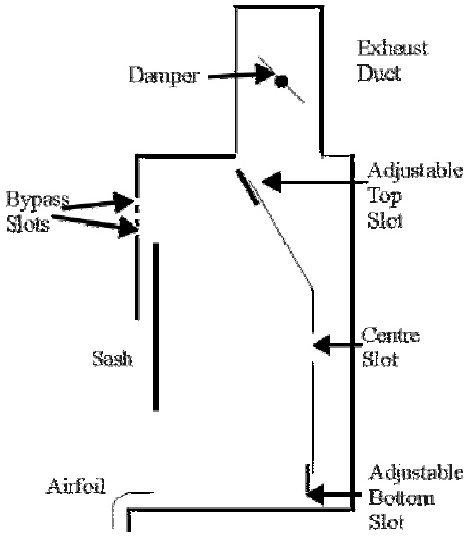
34.0 FUME HOOD INSPECTION PROTOCOL

Ball State University
Laboratory Chemical Fume Hood Survey Protocol

1.0 Application

This Laboratory *Chemical Fume Hood Survey Protocol* is one component of the Ball State University *Chemical Hygiene Plan* as required by 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*.

- Laboratory fume hoods are used to prevent harmful exposure to hazardous substances.
- This protocol is to be used by Ball State University (BSU) in-house personnel (e.g., BSU EHS Office, Environmental Control, Laboratory Managers) for the routine evaluation of the function and safety of operation of chemical fume hoods.
- New fume hood installations must be certified by the manufacturer/contractor as compliant with applicable ASTM, OSHA, ANSI and ASHRAE standards for fume hood construction, installation, and performance.
- This document does not apply to biosafety, glovebox, or radiological enclosure cabinets or other exhausted enclosures.



Cross-Section of Typical Fume Hood

2.0 Definitions

Laboratory-Type Hood: A device enclosed except for necessary exhaust purposes on 3 sides and top and bottom, designed to draw air inward by means of mechanical ventilation, operated with insertion of only the hands and arms of the user and used to contain hazardous substances and reactions.

Hazardous Substance: One which by reason of being explosive, flammable, poisonous, an irritant or otherwise harmful is likely to cause injury or illness or exposure above recommended or permissible exposure levels.

3.0 Use

Observation of the laboratory hood environment, maintenance, and work practices can provide an indication of proper exposure control performance. For example, if the sash(es) of the hood are left wide open during operation of the research, production, or demonstration activity, the hood is likely to reduce its functional effectiveness. Laboratory fume hood performance or safety can also be compromised by the following factors:

- Equipment or chemical containers blocking airflow to slots in baffle
- Equipment placed within 6" from the plane of hood face
- Hood sash or panels not replaced after equipment setup completed
- Cross drafts – due to room ventilation, pressure differentials, or traffic
- Maladjustment of exhaust dampers
- Misplacement of sash heights
- Worker leaning into the hood
- Malfunction of exhaust system
- Leaks in exhaust ducting or hood
- Turning off the hood fan during actual hood use
- Defeating or failure of flow indicators

4.0 Performance Criteria

To ensure proper laboratory fume hood exposure control performance, each of the following criteria must be observed:

4.1 Quantitative Assessment Criteria

Laboratory fume hoods should provide a minimum average effective face velocity of 100 feet per minute (FPM), with a minimum of 70 fpm at any point. Acceptable average ranges are from 80-120 fpm.

4.2 Qualitative Assessment Criteria

Laboratory fume hoods shall maintain an inward flow of air at all openings, which shall be demonstrated using smoke tubes or other suitable qualitative methods.

4.3 Installed Air Flow Indicator Requirement

- A quantitative airflow monitor shall be provided on all new fume hoods installed.

- At a minimum, a qualitative airflow indicator must be installed and maintained on all fume hoods that lack a quantitative air flow monitor.
- The indicator must be located so that it is visible from the front of the fume hood.
- The airflow monitors, lights, or other function indicators must be maintained in an operable and accurate condition.
- The manufacturer's procedures for calibration during installation must be followed and periodic calibration and maintenance of the indicators must be performed in accordance with the manufacturer's recommended schedules.
- Performance criteria for various airflow indicators are as follows:
    - **FPM Readout:** Average readout is 80 fpm.
    - **Airflow alarm system** (with audio or visual alarms): Go into alarm mode if average face velocity drops to 70 fpm.
    - **Visual Qualitative Indicators:** Must verify flow is occurring in the hood.
    - **Consult with EHS Office on performance criteria for other acceptable devices.**

5.0 Frequency of Surveys

Laboratory fume hoods used to prevent harmful exposures are required to be surveyed or certified:

- Semie-annually, at a minimum
- Whenever a laboratory fume hood has been modified
- Whenever the exhaust duct system connected to a hood has been modified
- Following incidents of performance failure or requests by users or laboratory managers

6.0 Equipment/Materials Required For Surveys

- Thermal anemometer or microanemometer (calibrated as specified by manufacturer)
- Smoke tube, powder disperser, dry ice in water, or other means of generating smoke or visualizing airflow
- Tape measure
- *Laboratory Fume Hood Survey* form(s)

7.0 Survey Procedure

To attain certification or approval for use, a laboratory fume hood must pass both the quantitative and qualitative evaluation and have a functioning airflow indicator.

7.1 Qualitative Evaluation – "Smoke Test"

a) Position the sash at a 12" height or hood sash design or previous test height:
b) Generate "smoke" in direction perpendicular to exhaust flow from locations of containment;

c) Generate “smoke” around the perimeter of the designated face, and any other location within the fume hood where turbulent airflow is thought to exist (i.e., around equipment or obstructions);

d) If the smoke is contained within and exhausted from the fume hood, the unit has PASSED the qualitative evaluation.

7.2 Quantitative Evaluation – Face Velocity Measurement

a) Position the sash at the 12” height, the indicated hood sash design height, or previous test height (*note:* if the hood does not meet the standard below, the sash height may be adjusted to the height where it meets the 80 fpm standard, but that sash height must then be clearly marked on the fume hood;
b) Set a simple grid pattern with grid intervals of 1 foot or less;
c) Locate anemometer at center of every segment and measure/record velocity;
d) Calculate average face velocity and identify minimum value;
e) If average face velocity is greater than or equal to 80 fpm, but less than 120 fpm, with a minimum of 70 fpm at any measurement point -- the unit has PASSED the quantitative evaluation;
f) Record all collected data on Laboratory Fume Hood Survey Form or equivalent.

7.3 Air Flow Indicator

a) Record the type and condition of airflow indicator on the Laboratory Fume Hood Survey Form;
b) If the air velocity indicator is missing, not functioning, or out of range, contact the Laboratory Manager or submit a Work Request for replacement or repair;

7.4 Operational Criteria

a) Verify the function of all switches and lights directing or indicating the function of the hood and exhaust blower;
b) Verify that the sash(es) and any adjustable slots, baffles, or airfoils are operational and in the correct position;
c) If excessive equipment, chemicals, or other objects are located on the work surface such that they obstruct or interfere with testing or the airflow in the fume hood, contact the Laboratory Manager for correction so that testing may be completed.
d) Confirm that sash working height indicator, and other signs, markings, or instructions for the proper operation of the hood or airflow monitoring equipment are present.

8.0 Survey Determination

8.1 For Units that PASS the Quantitative, Qualitative, and Operational Evaluations and have a *functioning* Air Flow Indicator:

a) Document that the unit has passed performance inspection on the Survey Form and affix a survey sticker.
b) Mark sash position at the 12” height, or other height, at which the hood performance was tested and found to be acceptable (minimum average of 80 fpm).

8.2 For Units that FAIL any of the Section 7 criteria, immediately:

a) Inform users, and the Laboratory Manager, that the unit has FAILED performance inspection and CANNOT be used for containment of hazardous materials until the unit has been repaired, re-inspected, and certified as compliant.
b) Document that the unit has failed performance inspection on the Survey Form;
c) Affix signage to hood stating that it CANNOT be used for preventing harmful exposures to hazardous chemicals and/or use barricade tape around the fume hood. (see label example on last page of this Appendix Section.
d) If the fume hood appears to have failed certification due to improper hood use/setup (i.e., due to equipment blocking baffles), indicate such on the Survey Form and communicate to the Laboratory Manager for correction prior to any retesting.
e) If fume hood appears to have failed certification due to mechanical deficiencies, have the Laboratory Manager call or submit a Work Request to Environmental Control for repairs.
f) Repeat the performance evaluation after all necessary corrections have been made following notification by the Laboratory Safety Officer or BSU Environmental Control

Ball State Laboratory Fume Hood Survey Form

Date:	**Fume Hood Information:**
EHS Technician:	Fume Hood ID:
Survey Equipment:	Building, Room Number:
Anemometer Model :	Make/Model of Fume Hood:
Calibration:	BSU Program:
Comments:	

Qualitative: Smoke Test:

Smoke generated around face of hood perimeter contained? ☐ Yes ☐ No Cross-currents or interfering ventilation: ☐ Yes ☐ No **Comments:**

Quantitative: Velocity Measurement Summary (notes on back of form)**:**

Average Velocity (fpm)	Minimum Velocity (fpm):	Acceptable: ☐ Yes ☐ No	**Comments:**

Air Flow Indicator:

Type of Indicator (check)		**Identify /Describe Status**	**Comments:**
FPM Readout		fpm:	
Audio Alarm		Alarm sounds: ☐ Yes ☐ No	
Visual Alarm		☐ Green mode or ☐ Red mode	
Flow Ribbon		Present: ☐ Yes ☐ No	
Other:			

Operation:

Electric / Mechanical:	**Sash/Baffle Condition:**	**Obstructions:**	**Markings:**	**Other** (see comments)
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No
Comments:				

Fume Hood Survey: ☐ PASS ☐ FAIL **IF FAIL: Complete or perform the following:**

Notify Lab Manager	**Signature/Title:**		**Date:**
Hood Tagged not to be used	**☐ Yes ☐ No**		
Work control to be contacted?	**☐ Yes ☐ No**	**By?**	
Follow up Scheduled?	**☐ Yes ☐ No**	**Date Planned:**	

Report Copy Distribution	Name:	Name:
	Department:	Department:

BSU Fume Hood Worksheet (reverse side of Survey Form)

A	B	C
___ fpm	___ fpm	___ fpm

three 1-foot square grid (1 ft x 3 ft sash opening or smaller)

A fpm + B fpm + C fpm = _____ average face velocity (fpm)
3

A	B	C
___ fpm	___ fpm	___ fpm
D	**E**	**F**
___ fpm	___ fpm	___ fpm

six 1-foot square grid (2 ft x 3 ft sash opening or smaller)

A fpm + B fpm + C fpm + D fpm + E fpm + F fpm = _____ average face velocity (fpm)
6

A	B	C
___ fpm	___ fpm	___ fpm
D	**E**	**F**
___ fpm	___ fpm	___ fpm
G	**H**	**I**
___ fpm	___ fpm	___ fpm

nine 1-foot square grid (3 ft x 3 ft sash opening or smaller)

A fpm + B fpm + C fpm + D fpm + E fpm + F fpm + G fpm + H fpm + I fpm = _____ average face velocity (fpm)

Unless an averaging digital anemometer is used at least three (3) measurements should be made from each grid square. That average value should then be used to represent the average flow rate for that particular grid square in calculating the average face velocity.

DANGER – UNSAFE CONDITION

This fume hood has been placed *OUT OF SERVICE* by the Environmental Health and Safety Office (EHS).

- **Inspection by EHS has determined that the hood *DOES NOT MEET* the university minimum standard for face velocity airflow of 70 feet per minute (fpm).**
- **This hood *SHALL NOT BE USED* until repairs have been made, EHS has been notified, and re-inspection has been completed.**
- **Environmental Control of Facilities Planning and Management has been notified of the need for repairs.**
- **The workspace may be used only for activities or the handling of substances that do not allow an emission, vapor, fume, or other hazard to the student, worker, or researcher.**
- **Questions should be directed to EHS at 5-2807.**
- ***Date Posted:* _____**

35.0 LABORATORY SAFETY AND PREGNANCY

Laboratory Safety and Health During Pregnancy

Introduction

Pregnant women should avoid unnecessary exposure to chemicals at home—and while at work. Since the beginning of the 20th century, thousands of new synthetic chemicals have been developed, and only a small portion of these chemicals have been adequately studied to determine whether they pose a risk of cancer or birth defects. Therefore, it is particularly advisable to limit any unnecessary chemical exposure during pregnancy.

Certain chemicals are known or suspected to harm fetuses or the reproductive health of adults. The first trimester of pregnancy is a period of high susceptibility and often a woman does not know that she is pregnant during part of this period. Individuals of childbearing potential are warned to be especially cautious when working with such reproductive toxins. These individuals must use appropriate protective apparel to prevent skin contact, injection, or inhalation of these toxic or infectious substances.

While the BSU *Chemical Hygiene* (laboratory safety) *Plans* are designed to protect all laboratory workers from exposure to chemical, biological, radiological, and physical hazards--particular care, practices, or enhanced procedures may be advisable for pregnant employees in some laboratory settings.

Pregnant women and those intending to become pregnant should seek advice from knowledgeable sources before working with substances that are suspected to be reproductive toxins. These sources include, but are not limited to, their health care provider, their Laboratory Supervisor or Principal Investigator, Material Safety Data Sheets (MSDS), and the BSU Environmental Health and Safety office. Supervisors and the EHS Office should always be notified of any orders from the employee's health care provider, and of any incidents of exposure or spills involving these, or other substances or hazardous materials.

By using prudent work practices, most laboratory workers who are pregnant or planning pregnancy can work safely in research laboratories without exposing themselves or the fetus to potentially harmful chemicals.

Reproductive Hazards in the Laboratory

Basic laboratory chemical hygiene practices for everyone (such as wearing protective gloves and washing hands frequently), as established in the BSU *Chemical Hygiene Plan*, are always important when working with hazardous materials-including chemicals, biologic

agents, and radiation. These practices are even more important for women who work in laboratories while they are pregnant or attempting to become pregnant. Some university laboratories may contain a number of dangerous chemicals or other agents, some of which may harm the reproductive system or pose a hazard to a developing fetus if exposure is not adequately controlled.

Reproductive toxins are chemicals which affect the reproductive system, including mutagens (those which cause chromosomal damage) and embryotoxins. Embryotoxins (or fetotoxins) may be lethal to the fertilized egg, embryo or fetus, may be teratogenic (able to cause fetal malformations), may retard growth, or may cause post-natal functional deficiencies. Other reproductive toxins may cause sterility or may affect sperm motility. Radiation, some chemicals, certain drugs (legal and illegal), cigarettes, some viruses, and alcohol are other examples of reproductive hazards.

Some chemicals may cross the placenta, exposing the fetus. A developing fetus may be more sensitive to some chemicals than its pregnant mother, particularly during the first twelve weeks of pregnancy, when the mother may not know she is pregnant. Proper handling of chemicals and use of protective equipment is especially important to reduce fetal exposure to chemicals.

A few examples of known or suspected reproductive toxins include: anesthetic gases, arsenic and certain arsenic compounds, benzene, cadmium and certain cadmium compounds, carbon disulfide, ethylene glycol monomethyl and ethyl ethers, ethylene oxide, lead compounds, organic mercury compounds, toluene, vinyl chloride, xylene, and formamide. It should also be noted that some substances may cause adverse reproductive effects in males, including 1,2-dibromo-3-chloropropane, cadmium, mercury, boron, lead, and some pesticides. A more complete, though still partial, list of known or likely reproductive toxins is provided in **Table 1** accompanying this Fact Sheet (*source-Ohio State University*). Adequate protection from exposure to the vast majority of those constituents is already provided through the protective precautions established in the BSU *Chemical Hygiene Plan*.

Infectious agents that pose minimal risk to otherwise healthy individuals also pose a higher risk to pregnant women or their babies due to changes in immune response as a result of pregnancy. It may take up to 6 weeks after the end of pregnancy for the maternal immune system to return to normal. For example, pregnant women exposed to Listeria have a much higher chance of developing listeriosis. Also, many common infectious agents pose significant risks to the developing fetus. The most commonly cited examples of infectious agents/diseases is abbreviated by the acronym TORCH: toxoplasmosis, other infections (e.g. Hepatitis B, syphilis, Varicella-Zoster, HIV, Parvovirus B19, Listeria, E. coli and group B streptococci), Rubella, Cytomegalovirus, and Herpes simplex. Exposure to live vaccine material is another source of potential exposure to pregnant women.

A zoonotic disease is one that can be transmitted from animals to humans. Almost any of the zoonotic disease agents that can infect healthy people pose more of a risk of infection for people who are pregnant. If you have questions regarding the species you are working with, or any potential exposure risks, please inquire with your Department, or contact the BSU EHS Office to investigate.

Pregnant employees who work with radiation should inform the Principal Investigator, or their supervisor, as soon as they know they are pregnant in order to further minimize

radiation exposure. This notification is best provided in writing and should be immediately forwarded to the BSU Radiation Safety Officer. The *BSU Radiation Safety Plan* addresses additional precautions for pregnant employees.

Reproductive Health and Pregnancy Safety: Resources

Pregnant laboratory workers should discuss the work they perform and the hazardous materials they handle with their personal health care provider to determine what, if any, work restrictions are needed. In some cases, certain chemicals may need to be substituted for other reagents in the laboratory-alternate work assignments established-or- certain activities curtailed -for the duration of the pregnancy. Any restrictions requested by the physician should be promptly discussed with the laboratory's Principal Investigator, Laboratory Supervisor, or the BSU Chemical Hygiene Officer.

There are several campus resources available to assist your personal physician in making these evaluations, including the EHS Office and physicians at the BSU Health Center (285-8431). However, normally the supervisor or Principal Investigator of the laboratory in which you work will have the most complete and immediate knowledge of any substances or conditions in their laboratory that may present a particular exposure risk during pregnancy. If you provide the EHS Office with a list of the specific chemicals you use, microbiological specimens you handle, or physical exposures (radioactive sources, nanoparticles, etc.), and provide the Health Center with the name of your obstetrician or health care provider, we can help evaluate appropriate exposure-control measures.

Specific federal and state regulations apply to pregnant workers' exposure to radiation. If you work with radiation-producing machines or radioactive materials, the BSU Radiation Safety Officer (Saiful Islam, 285-8086) can provide information on exposure precautions and regulatory limits during pregnancy.

Faculty members and laboratory supervisors are responsible for training and instructing laboratory personnel in the appropriate ways to protect themselves from hazards in the laboratory. Students, employees, guests and visitors are responsible for learning about the hazards in the workplace, using personal protective equipment, and following proper work practices. This instruction must be protective of pregnant employees--as well as other laboratory workers.

Standard Precautions

Women who are pregnant or attempting to become pregnant should follow all protocols under the BSU *Chemical Hygiene Plan* and strictly apply the following standard exposure-control practices whenever they are working in a campus laboratory. These same precautions will help protect men from chemical exposures that might affect the male reproductive system and will help prevent contaminants being brought home to spouses on clothing.

1. Prevent accidental chemical ingestion or contamination by practicing basic hygiene in the laboratory. Never eat, drink, chew gum, apply cosmetics, or make other hand-to-mouth

contact in the laboratory. Always wash your hands with soap and water after handling chemicals and when leaving the laboratory.

2. Always handle volatile chemicals at least six inches inside a properly operating chemical fume hood with the sash placed between you and the material. Biosafety cabinets should be used when designated for the biological work being performed. Radiation sources should be handled only as directed. Normally, the recommended radiation exposure for pregnant workers is limited to one-tenth ($1/10^{th}$) that allowable for employees who are not pregnant.

3. Wear appropriate personal protective equipment including a laboratory coat, closed-toe shoes, disposable impermeable gloves, and safety glasses (or goggles when using liquids). The specific protective equipment worn should be tailored to the task that is being performed. For example, face shields, rubber aprons, and heavy-duty gloves should be used for strong corrosives. For assistance in selecting the proper personal protective equipment, refer to the appropriate Material Safety Data Sheet, the *Chemical Hygiene Plan* for the particular laboratory or procedure, or contact the BSU Environmental Health and Safety Office (285-2807).

4. Take a fresh look at the safety precautions spelled out in your laboratory's *Chemical Hygiene Plan*. The procedures and equipment established in the Plan were developed to also provide adequate protection, in most circumstances, to persons who are or may be pregnant.

5. Discuss any concerns you, or your health care provider, may have about potentially hazardous laboratory operations or conditions with your Principal Investigator (PI), Supervisor, or Department Head. If your concerns are not adequately addressed, contact the BSU Environmental Health and Safety Office.

Special Precautions for Pregnant Laboratory Workers

Please remember that particular reproductive risks and hazards may exist within certain BSU laboratory facilities and that you are a critical component in safeguarding your reproductive health--this applies to both men and women. In addition, laboratory workers who are pregnant or attempting to become pregnant need to take extra precautions to promote the best possible outcome of the pregnancy. The following guidelines are highly recommended to protect you and the developing embryo or fetus:

1. Consult with your personal physician about your work conditions and activities in order to plan a safe course of action pre-conception, during pregnancy, and post-partum. Any restrictions placed by the physician should be immediately brought to the attention of the Principal Investigator, Laboratory Supervisor, or Department Head; and, if necessary, the BSU EHS Office.

2. Clear communication and cooperation among the laboratory worker, the Principal Investigator or Laboratory Supervisor, and the BSU EHS Office are necessary to conduct a thorough hazard assessment of laboratory operations and conditions, which may otherwise put the developing embryo or fetus at risk. In cases where a pregnancy is planned, the laboratory worker should initiate the hazard assessment prior to conception because certain chemical exposures may affect fertility success or critical fetal development in the earliest stages. At a minimum, the hazard

assessment should include a review of those chemicals present in the laboratory that may be reproductive toxins and other fundamental risks such as working with or around infectious or radioactive materials.

3. In addition, this same group (worker, supervisor and safety personnel) may need to work together in developing a plan and finding creative solutions to ensure a safe work environment during the pregnancy. In some cases, work activities and conditions may need to be modified - such as working in a separate laboratory, substituting extremely hazardous reagents with less harmful ones, or focusing on a different aspect of research (e.g. theoretical instead of synthetic).

4. For the health of the developing embryo or fetus, the pregnant individual and laboratory coworkers must strictly adhere to the safety guidelines in the BSU *Chemical Hygiene Plan*.

Remember, it is **always** important to follow proper laboratory safety practices to prevent unsafe chemical exposures. For women of childbearing age, it is particularly important because fetal damage from chemical exposure may occur prior to a woman realizing she is pregnant. If you would like further assistance in establishing safe chemical handling practices in your laboratory, contact the BSU EHS Office.

Any laboratory worker or student safety concerns should first be discussed with the Laboratory Supervisor or Principal Investigator. If you feel that your concerns are not adequately recognized, evaluated, or addressed, please contact the Department Head or the BSU Environmental Health and Safety Office (765-285-2807).

Associated Document: *Table 1—Partial List of Reproductive Toxins (OSU); or Table 11, Appendix 3, of the BSU Chemical Hygiene Plan*

36.0 DISPOSAL OF LABORATORY WASTES TO SINKS AND DRAINS

Disposal of Laboratory Wastes:

Requirements for Chemical Disposal to Sinks and Drains

Prepared by the:

Environmental Health and Safety Office

Ball State University

November 2011

DISPOSAL OF LABORATORY WASTES

Requirements for Chemical Disposal to Drains

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DISPOSAL OF LABORATORY WASTES TO SANITARY SEWER

Requirements for Chemical Disposal to Drains

1.0 INTRODUCTION

Some aqueous chemicals or solutions that are not defined as hazardous wastes, and that are either simple inorganic salts or organic materials readily digestible by the microorganisms in a water treatment plant, can generally be disposed of down the drain in limited and controlled quantities.

Since any material poured down a drain eventually flows into the Muncie Wastewater Treatment Facility, and ultimately the White River, the University is regulated by the City of Muncie Sewer Ordinances and the Muncie Bureau of Water Quality (MBWQ) concerning the types and quantities of materials that can enter the sewer system. Beyond the legal requirements, the University also has ethical obligations to protect our environment.

Certain criteria must be met in order for materials to be safely poured down the drain, including low toxicity, high water solubility, and moderate pH. Only small quantities are allowed in the system at any time and the chemicals must be degradable by the wastewater treatment (a biological process). Large quantities, or highly concentrated stock solutions, of these materials should be packaged for pick up and disposal through the Ball State University Environmental Health and Safety (EHS) Office.

Only aqueous solutions of these chemicals can go down the lab drain; solid forms must use other disposal routes (normal trash or pick-up by EHS). The *BSU Waste Management Guide* should be consulted for disposal of solid, hazardous, and other special wastes that due to their identity, nature, or physical characteristics may not be disposed to the municipal sanitary sewerage system.

While this guidance specifically addresses teaching and research laboratories, it also applies to other entities or departments (Art, Fine Arts, Applied Technology, etc.) that may generate liquid wastes requiring disposal.

Staff of the City of Muncie Bureau of Water Quality (MBWQ) were consulted in developing these guidelines to assure that local government regulations and guidelines are followed and treatment capacities can be accommodated. *Prudent Practices in the Laboratory (National Research Council, 2008)* is another information source.

2.0 RESPONSIBILITIES

Within individual laboratories, authorization for specific operations, delineation of appropriate safety procedures, and instruction about these procedures, is a responsibility of the principal investigator, teaching faculty, or academic department.

It is the responsibility of each BSU laboratory worker to be sure that chemical waste generated from their activities is disposed of properly. Some materials can be safely let into the sanitary sewer, while unapproved disposal can cause damage to health, the environment, or the functioning of the sewerage collection system or the wastewater treatment facility itself.

Inappropriate chemicals put down the drain may also be incorporated into sludge formed in wastewater treatment, contaminating it enough to limit its subsequent use where otherwise it might have been recycled. After treated waste water leaves the plant, it flows to the White River, a major scenic, recreational, and drinking water resource for this area. The stewardship of this important natural resource is our collective responsibility.

Laboratory workers, and all BSU employees, should consult this guide before allowing or undertaking drain disposal of any lab chemicals. Adherence to this guidance will be evaluated during laboratory and facility inspections conducted by the BSU EHS Office as recommended by the BSU *Chemical Hygiene Plan*.

3.0 GENERAL SEWER DISPOSAL GUIDELINES

Materials discharged to a laboratory sink drain on campus enter the Muncie sanitary sewer system where it is mixed with sewage and other wastewater from area households and businesses and flows to the Muncie Wastewater Treatment Facility. At the waste treatment plant the waste is subjected to bacterial degradation. Non-degradable chemicals, such as metals, are adsorbed in the sludge or potentially discharged to surface waters. The drain disposal guidelines outlined below must be followed to prevent toxic concentrations of metals or organic compounds from reaching surface waters, accumulating in the sludge, or disrupting the sewage treatment process.

What May Be Disposed?

Generally, materials suitable for sewer disposal in limited quantities must meet the following physical and chemical criteria:

- They are liquids and readily water soluble (at least 3% soluble)
- Easily biodegradable or amenable to treatment by the waste water treatment process
- Are simple salt solutions of low toxicity inorganic substances

- Are dilute organic substances of low aquatic toxicity and low concentration
- Have a pH between 5.5 and 9.0

Chemicals that can be safely disposed down the drain include biological compounds and cellular constituents such as proteins, nucleic acids, carbohydrates, sugars, amino acids amines, nutrients, surfactants, and many metabolic intermediates. Other compounds include soluble salt combinations of low toxicity ions and dilute (less than 10%) aqueous solutions of low molecular weight biodegradable organic chemicals such as alcohols, aldehydes, ketones, amines, ethers, cellosolves, nitriles, esters and nitroalkanes.

Send down the drain only those materials found on the **Safe List** that follows. Compounds not listed are not suitable for drain disposal unless specifically approved by the BSU EHS Office following consultation with the MBWQ.

Where May Disposal Occur?

Drain disposal must only be used when the drain flows to a sanitary sewer system* which eventually goes to the waste water treatment plant. Storm drain systems flow directly into surface water (Cardinal Creek, or via storm sewers to the White River, for example) and should NEVER be used for chemical disposal. Floor drains may flow to storm sewers and should also never be used for disposal. Laboratory sinks should be used for disposal of chemicals on the Safe List as discussed below, and proper procedures followed in discharging the wastes to the sink drain.

How Much May be Disposed?

Quantities of chemical waste for drain disposal should be limited generally to a few hundred grams or milliliters or less per day. Larger amounts should have prior approval from EHS. Materials listed as safe for drain disposal in this document are approved for drain disposal in quantities up to 100 grams or 100 milliliter per discharge. Disposal should be followed by flushing with at least 100-fold excess of water at the sink. (That means for 100 ml of chemical disposed, run the water for about two minutes at maximum flow.)

Note: Sulfuric, hydrochloric, acetic and phosphoric acids may be discharged in larger quantities since they are to be neutralized to a pH of between 5.5 and 9.0 before they may be drain disposed to the sanitary sewer (see **Appendix A**).

**Sanitary sewer is the system of sinks, toilets, drains and associated pipes that send waste water to a treatment plant where it is biologically and chemically treated before discharge into the environment. Under no circumstances should chemical wastes be discharged to storm sewer systems.*

Safety Concerns?

Understand the hazards and toxicity of the materials you work with by consulting Safety Data Sheets (available in every department workplace, on the Internet, or through EHS). First, verify that the chemical or solution may be disposed to the sanitary sewer in accordance with these requirements and guidelines. During the disposal process, work slowly to avoid splashes and wear the proper protective equipment (lab coat, goggles, face shield, gloves). Consult the *BSU Chemical Hygiene Plan* for proper handling procedures for chemicals.

Chemicals that are not appropriate for drain disposal are to be collected by the Environmental Health and Safety Office for disposal as hazardous, special, or solid wastes. These procedures are provided in the *BSU Waste Management Guide*.

4.0 CHEMICALS NOT SAFE FOR DRAIN DISPOSAL

THE FOLLOWING TYPES OF MATERIALS ARE PROHIBITED FROM DRAIN DISPOSAL BY THE CITY OF MUNCIE AND BSU:

- Ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, feathers, tar, plastics, wood, manure, hair and fleshings, entrails, paint residues, solid or viscous substances capable of causing obstruction to the flow of sewers.
- Oil, grease, petroleum, or other water insoluble chemicals
- Materials that are not biodegradable or would pass through the sewage treatment plant into the White River and be toxic to aquatic organisms or accumulate in sediments.
- Materials that could interfere with the biological processes of sewage treatment or would contaminate the sludge-making disposal or reuse through the normal methods difficult or impossible.
- All compounds that could result in the presence of toxic gases or vapors within the POTW in a quantity that may cause acute worker health and safety problems
- Infectious substances
- Hazardous Wastes – either listed or characteristic hazardous wastes
- Some general types of chemicals that are not appropriate for drain disposal (unless otherwise allowed in this guidance) include:
    - Halogenated hydrocarbons (exceeding the concentrations in the tables below);
    - Nitro compounds (organic compounds that contain one or more nitro functional groups (-NO2) and are often explosive;
    - Mercaptans (thiols);
    - Flammables (immiscible in water) or at concentrations of concern;
    - Explosives such as azides and peroxides;

- Water soluble polymers that could form gels in the sewer system;
- Water reactive materials;
- Malodorous chemicals;
- Toxic chemicals such as carcinogens, mutagens, teratogens;
- Nanomaterials

- Substances that boil below 50° C (122°F);
- Solid or viscous substances in amounts that will cause obstruction of the flow in the sewerage system;
- Flammable and combustible solvents (flashpoints less than 140°F) (unless sufficiently diluted in water as part of the laboratory process such that the solution has a residual flashpoint greater than 140°F);
- Discharges with a pH below 5.5 or higher than 9.0;
- Mixtures that have a component not found on the Safe List;
- Any discharges that would cause violation of the numerical or discharge quality limits imposed by the City of Muncie Bureau of Water Quality General or Industrial Pretreatment Ordinances;
- Malodorous compounds or volatile organic chemicals that can escape from the plumbing system (such as dry traps) causing exposures or obnoxious odors (such as mercaptans or thiols);
- Any wastes that could impart color that cannot be removed by the MBWQ treatment process – i.e., dye wastes, stains;
- Metallic ions and salts of the heavy metals in solutions or suspension in concentrations exceeding the following:

Element	Concentration (Mg/l)
Arsenic	0.20
Barium	2.0
Boron	5.0
Cadmium	0.2
Chromium	2.0
Copper	2.0
Cyanide	1.0
Element	**Concentration (Mg/l)**
Lead	2.0
Manganese	1.0
Mercury	0.01
Nickel	2.0
Selenium	0.02

Silver	2.5
Zinc	4.0

Note: *Above limits are derived from the Muncie Industrial Pretreatment Ordinance and other local ordinances.*

Organic compounds in solutions or suspension in concentrations exceeding the following:

Element	Concentration (Mg/l)
Benzene	0.5 (EPA)
Carbon tetrachloride	0.5 (EPA)
Chlorobenzene	100 (EPA)
Chloroform	100 (EPA)
Cresol (or total of o-, m- and p-Cresol)	200 (EPA)
1 ,4-Dichlorobenzene	7.5 (EPA)
1 ,2-Dichloroethane	0.5 (EPA)
1,1 -Dichloroethylene	0.7 (EPA)
2,4-Dinitrotoluene	0.13 (EPA)
Hexachlorobenzene	0.013 (EPA)
Hexachlorobutadiene	0.5 (EPA)
Hexachloroethane	3.0 (EPA)
Methyl ethyl ketone	200 (EPA)
Nitrobenzene	2.0 (EPA)
Pentachlorophenol	100 (EPA)
Pyridine	5.0 (EPA)
Tetrachloroethylene	0.7 (EPA)
Toxaphene	0.5 (EPA)
Trichloroethylene	0.5 (EPA)
2,4,5-Trichlorophenol	400 (EPA)
2,4,6-Trichlorophenol	2.0 (EPA)
Vinyl chloride	0.2 (EPA)

Pesticides in solutions or suspension in concentrations exceeding the following:

Element	Concentration (Mg/l)
Chlordane	0.3 (EPA)
2,4-D	10.0 (EPA)
Endrin	0.02 (EPA)
Heptachlor (and its epoxide)	0.008 (EPA)
Lindane	0.4 (EPA)
Methoxychlor	10.0 (EPA)
2,4,5-TP (Silvex)	1.0 (EPA)

***Note: The** above limitations are based on RCRA TCLP threshold limits, but for <u>total</u> concentrations of the constituents in the waste solution (i.e., concentrations exceeding these threshold limits constitute characteristic hazardous wastes).*

Organic wastes that would cause the discharge to exceed a Total Toxic Organic (TTO) concentration of 2.13 mg/l.

Biological wastes exceeding the following:

> Any discharge of fats, oils, or greases of animal or vegetable origin that exceeds 200 mg/L.

Any material not found on the Safe List presented in Section 5.0 below must be approved by the EHS Office for drain disposal.

Check with the BSU EHS Office at 285-2807 if you are not certain about drain disposal for a particular material. We may also be able to provide you with instructions for laboratory detoxification for some materials.

5.0 CHEMICALS SAFE FOR DRAIN DISPOSAL

When discharging waste to the sanitary sewer, you must:

- Never dispose anything that might lead to a storm sewer rather than a sanitary sewer.
- Use a sink that does not have a history of clogging or overflowing.
- Use a sink in your laboratory, preferably in a fume hood.
- Flush with at least 10-20 fold excess of water after drain disposal to thoroughly rinse out the sink and sink trap, and to fully neutralize or inactivate the waste for discharge.
- Limit the quantities being discharged to 100 grams of solute per laboratory per day.
- Wear gloves, eye protection and a laboratory coat.
- Inactivate biological materials (e.g., autoclave or bleach-treat) before releasing to sewer.

Inorganics

Dilute solutions of inorganic salts where both cation and anion are listed below are suitable for drain disposal. Materials listed are considered to be relatively low in toxicity. Compounds of any of these ions that are strongly acidic or basic should be neutralized before drain disposal (see **Appendix A**).

Cations	Anions
Aluminum (Al^{+3})	Borates(BO_3^{-3}
Calcium (Ca^{+2})	Bromide (Br^-)
Iron ($Fe^{+2,+3}$)	Bromate (BrO_3^-)
Hydrogen (H^+)	Carbonate (CO_3^{-2})
Potassium (K^+)	Bicarbonate (HCO_3^-)
Lithium (Li^+)	Chloride (Cl^-)
Magnesium (Mg^{+2})	Chlorate (ClO_3)
Sodium (Na^+)	Bisulfite (HSO^{-3})
Ammonium (NH_4^+)	Cyanates (OCN^-)
Tin (Sn^{+2})	Hydroxide (OH^-)
Strontium ($Sr2^+$)	Iodide (I^-)
Titanium ($Ti^{+3,+4}$)	Iodate (IO_3^-)
Zirconium (Zr^{+2})	Nitrate (NO_3^-)
	Nitrite (NO_2^-)
	Phosphate (PO_4^{-3})
	Sulfate (SO_4^{-2})
	Sulfite (SO_3^{-2})
	Thiocyanate (SCN^-)

- Mineral acids and bases should be neutralized to a pH 5.5 to 9.0 range before disposal – see the recommended procedures in **Appendix A**.

Organics

Materials listed below in quantities up to about 100g or 100 ml at a time are suitable for disposal down the drain while flushing with excess water. These materials are soluble to at least 3 percent, present low toxicity hazards, and are readily biodegradable.

Alcohols

Alkanols with 4 or fewer carbon atoms:

methanol

ethanol

propanol and isomers

butanol and isomers

Alkanediols with 7 or fewer carbon atoms

ethylene glycol

propylene glycol

butylene glycol

butanediol + isomers

pentylene glycol

pentanediol + isomers hexylene glycol

hexanediol + isomers

heptamethylene glycol

heptanediol+isomers

Alkoxyalkanols with 6 or fewer carbon atoms:

methoxyethanol

ethoxyethanol

butoxyethanol

2-methoxyethoxyethanol

n-C4H9OCH2CH2OCH2CH2OH (2(2-butoxyethoxy)ethanol)

Aldehydes

Aliphatic aldehydes with 4 or fewer carbon atoms:

formaldehyde (10% or less aqueous solution)

propanal (propionaldehyde)

butanal (butyraldehyde)

isobutyraldehyde

Amides

RCONH2 and RCONHR with 4 or fewer carbon atoms and RCONR2 with 10 or fewer carbon atoms:

formamide

N-methyl formamide

N,N-diethyl formamide

N,N-dimethyl formamide

N-ethyl formamide

acetamide

N-methyl acetamide

N,N-dimethyl acetamide

N-ethyl acetamide propionamide

N-methyl propionamide

N, N-dimethyl propionamide

butyramide

isobutyramide

Amines

Aliphatic amines with 6 or fewer carbon atoms:*

methylamine

ethylamine

trimethylamine

N-ethyl methylamine

N-methyl propylamine

dimethyl propylamine

isopropylamine

1-ethyl propylamine

butylamine

methyl butylamine

N-ethyl butylamine

isobutylamine

amylamine

hexylamine

Aliphatic diamines with 6 or fewer carbon atoms:

1,2- or 1,3- propanediamine (1,2- or 1,3- diaminopropane)

* Amines with a disagreeable odor, such as dimethylamine and 1,4-butanediamine should be neutralized, and the resulting salt solutions flushed down the drain, mixed with at least 100 volumes of water in order to ensure complete neutralization and inactivation. Disposal limit is 100ml of material.

Carboxylic Acids

*Alkanoic acids with 5 or fewer carbon atom:**

formic acid

acetic acid

propionic acid

butyric acid

isobutyric acid

valeric acid

isovaleric acid

Alkanedioic acids with 5 or fewer carbon atoms:

oxalic acid (1,2-ethanedioic acid)

malonic acid (1,3-propanedioic acid)

succinic acid (1,4-butanedioic acid)

glutaric acid (1,5-pentanedioic acid)

Hydroxyalkanoic acids with 5 or fewer carbon atoms:

lactic acid (2- hydroxypropanoic acid)

3-hydroxybutyric acid

2-hydroxy isobutyric acid

Aminoalkanoic acids with 6 or fewer carbon atoms and the ammonium, sodium and potassium salts o f these acids.

Amino acids and the ammonium, sodium and potassium salts of these acids.

*Organic acids with a disagreeable odor, such as butyric acids and valeric acids should be neutralized and the resulting salt solutions flushed down the drain, mixed with at least 100 volumes of water to ensure complete neutralization and deactivation. Disposal limit is 100 ml. of material.

Esters

Esters with 4 or fewer carbon atoms:

methyl formate

ethyl formate

isopropyl formate

propyl formate

methyl acetate

ethyl acetate

methyl propionate

isopropyl acetate

Ketones

Ketones with 4 or fewer carbon atoms:

acetone

methyl ethyl ketone (butanone)

methyl isopropyl ketone (3-methyl butanone)

Sulfonic acids and the Ammonium, Sodium, and Potassium Salts of these Acids:

methane sulfonic acid, sodium or potassium salt

ethane sulfonic acid, sodium or potassium salt

1-propane sulfonic acid, sodium or potassium salt

1-butane sulfonic acid, sodium or potassium salt

1-pentane sulfonic acid, sodium or potassium salt

1-hexane sulfonic acid, sodium or potassium salt

1-heptane sulfonic acid, sodium or potassium salt

1-octane sulfonic acid, sodium or potassium salt

1-decane sulfonic acid, sodium or potassium salt

1-dodecane sulfonic acid, sodium or potassium salt

1-tetradecane sulfonic acid, sodium or potassium salt

1-hexadecane sulfonic acid, sodium or potassium salt

Note: Before discharging any of these materials into sewer make sure that all other generic disposal criteria such as pH limits and flammability) are met.

6.0 RADIOACTIVE MATERIALS

Radioactive materials **may not be drain disposed**.

APPENDIX A

NEUTRALIZATION OF SPENT ACIDS AND BASES

Spent mineral acids, straight-chain fatty acids, and bases (hydroxides) comprise a large portion of the unwanted chemicals being generated or stored in campus laboratories or utility maintenance activities. As a part of regular laboratory procedures, campus labs should neutralize spent inorganic acids, acetic acid, straight-chain fatty acids, and bases (hydroxides) that do not contain metal or organic contaminants. These chemicals will be managed in an "elementary neutralization unit" and, therefore, are not considered a part of the hazardous waste stream for the campus. An "elementary neutralization unit" is a container used for neutralizing corrosive wastes.

Neutralization is a relatively simple procedure that is best done by and in the laboratory that uses inorganic acids, acetic acid, straight-chain fatty acids, and bases (hydroxides) on a regular basis. The laboratory that generates spent corrosives usually has the facilities and expertise to neutralize them, and therefore will be responsible for doing so. The following procedures (**see A - D**) describe the proper technique for neutralization of spent inorganic acids, acetic acid, straight-chain fatty acids, and bases (hydroxides) as a part of regular laboratory procedures. At the end of this Appendix are lists of corrosives to be managed in-house by campus laboratories. Aqueous corrosive wastes shall NOT contain sulfides, cyanides, metals, or other materials that can give off hazardous fumes upon reaction with the acid or base.

Do **NOT** use these procedures for:

- *INORGANIC ACIDS THAT CONTAIN HEAVY METALS* (e.g., Atomic Absorption Standards, arsenic, cadmium, chromium, lead, mercury, nickel, selenium, silver, thallium. Solutions containing sodium, potassium, magnesium, iron can be neutralized as long as the anion is also non-hazardous.)
- *ESTERS OF INORGANIC ACIDS*
- *CHROMIC ACID*
- *PERCHLORIC ACID*
- *HYDROFLUORIC ACID*
- *ORGANIC ACIDS (EXCEPT ACETIC ACID AND STRAIGHT-CHAIN FATTY ACIDS)*
- LARGE QUANTITIES OF NITRIC ACID

A. Equipment Needed for Neutralizing Acids and Bases

1. Sodium carbonate (Soda ash), baking soda, or diluted inorganic base (hydroxide) for neutralization of an acid, or a diluted inorganic acid for neutralization of a base.

2. Polyethylene bucket - 1 or 2 gallon size, as personal preference dictates. Remember that 1 gallon weighs approximately 8 pounds or greater.

3. Protective equipment (goggles, apron, gloves).

4. 500 ml beakers.

5. pH Indicator Strips, or other pH test method.

B. Personal Protective Equipment

Read the Material Data Safety Sheet (MSDS) for detailed information. Call the BSU EHS Office if an MSDS is not available. The **MINIMUM** recommended personal protection needed when performing the neutralization procedure is:

Ventilation : Work in a fume hood

Gloves: Use neoprene, natural rubber, butyl, polyethylene, nitrile butadiene, or polyvinyl chloride depending on the MSDS information

Clothing: Apron (rubber is preferred), lab coat (or protective suit or coveralls), and closed-toe shoes.

Eye Protection: Splash-proof or dust-proof goggles **AND** a face-shield (8 inch minimum)

Hands shall always be washed after working with these chemicals. An eyewash station and quick-drench facility shall be located in the area. All employees shall locate these emergency facilities ***before starting to work***.

WARNING: *REMEMBER THAT EXTREME HEAT CAN BE PRODUCED BY THIS PROCEDURE UNLESS IT IS DONE VERY SLOWLY AND WELL-DILUTED. CLOSELY MONITOR THE AMOUNT OF HEAT PRODUCED BY USING A THERMOMETOR OR TOUCHING THE OUTSIDE OF THE NEUTRALIZATION CONTAINER. USE ICE BATH IF NECESSARY.*

C. Neutralization Procedure for Acid

1. Make a saturated solution of sodium carbonate (soda ash) in a beaker or use an inorganic base diluted in water (1:10 ratio) - set aside.

2. Put tap water into 1 or 2 gallon polyethylene bucket.

3. Dilute acid at least 1:10 (1 part acid to 9 parts of water) by slowly pouring and ***stirring the acid into the water***.

4. Slowly add soda ash or other basic solution into diluted acid with stirring, or save diluted acid to neutralize bases as described below.

5. Monitor pH with pH meter, pH indicator strips, or other pH test method.

6. When pH is between 6 and 9, dispose in a drain followed with excess water. A pH near 7 is preferred to reduce the possibility of plumbing damage.

HELPFUL HINT: *When neutralizing an acid, the pH can be tested quickly by the following method. Make a saturated solution of sodium bicarbonate in water. A small amount of sodium bicarbonate solution poured into the acid will make a "fizz", which is a release of carbon dioxide. Since carbon dioxide evolves from these procedures, insure adequate ventilation is available. This "fizz" will indicate that the solution is still acidic, and needs more base to be added. Always stir the mixture and do a final check of the pH before pouring the neutralized acid down the drain.*

D. Base Neutralization

1. Put tap water into 1 or 2 gallon polyethylene bucket.

2. Dilute alkali wastes at least 1:10 (1 part alkali to 9 parts water) by slowly pouring and ***stirring the base into the water***.

3. Neutralize the diluted alkali solution with a previously diluted inorganic acid.

4. Monitor pH with pH meter, pH indicator strips, or other pH test method.

5. When pH is between 6 and 9, dispose in a drain followed with excess water. A pH near 7 is preferred to reduce the possibility of plumbing damage.

NOTE*:* *For concentrated acids and bases, neutralization must be done slowly and with vigorous stirring. If there are any questions, or if you are hesitant about attempting this procedure with any spent acid or alkali waste, please confer with your principal investigator, laboratory manager, or department advisor. The recommended time for the neutralization procedure is when the wastewater flow is at a peak, e.g., 9:00 a.m.*

INORGANIC ACIDS

NAME/MOLECULAR WT.	FORMULA	SYNONYMS
Sulfuric Acid M.W. - 98.08	H_2SO_4	Dipping Acid Oil of Vitrol Sulphuric Acid Nordhausen Acid
Boric Acid M.W. - 61.84	BH_3O_3	Boracic Acid Orthoboric Acid
Nitric Acid M.W. - 63.02	HNO_3	Aqua Fortis Azotic Acid Hydrogen Nitrate
Hyponitrous Acid	$H_2N_2O_2$	
Hydrochloric Acid M.W. - 36.46	HCl	Chlorohydric Acid Hydrochloride Muriatic Acid
Aqua Regia	HCL/HNO_3 (3:1 mixture)	Nitrohydrochloric Acid Nitromuriatic Acid
Phosphoric Acid M.W. - 98.00	H_3PO_4	Orthophosphoric Acid

INORGANIC BASES

NAME/MOLECULAR WT.	FORMULA	SYNONYMS
Aluminum Hydroxide M.W. - 78.01	$Al(OH)_3$	Alumigel Aluminahydrate AluminaTrihydrate AluminumHydrate Aluminum(III)
Ammonium Hydroxide Hydroxide	NH_4OH	Ammonia Aqueous Aluminum Oxide-3H20 Aluminum Trihydroxide
Calcium Carbonate M.W. - 100.09	$CaCO_3$	Precipitated Chalk Chalk Dolomite Limestone/Marble
Calcium Hydroxide M.W. - 74.10	$Ca(OH)_2$	Slaked Lime Lime Water

		Hydrated Lime Calcium Hydrate
Calcium Oxide	CaO	Lime
M.W. - 56.08		Burnt Lime
		Calcia
		Calx
		Lime, Unslaked
		Quicklime
Magnesium Carbonate	$MgCO_3$	Carbonate Magnesium
M.W. - 84.32		Magnesia Alba
		Magnesium Carbonate- (Precipitated)
Magnesium Hydroxide	$Mg(OH)_2$	Magnesia Magma
M.W. - 58.33		Magnesium Hydrate
		Milk of Magnesia
Potassium Hydroxide	KOH	Caustic Potash
M.W. - 56.11		Lye
		Potassium Hydrate
Sodium Bicarbonate	$NaHCO_3$	Baking Soda
M.W - 85.01		Bicarbonate of Soda
		Sodium Acid Carbonate
Sodium Carbonate	Na_2CO_3	Soda Ash
M.W - 105.99		Crystol Carbonate
		Carbonic Acid - Disodium Salt
Sodium Hydroxide	NaOH	Lye
M.W. - 40.00		Caustic Soda
		Soda Lye
		Sodium Hydrate

38.0 GLOBALLY HARMONIZED SYSTEM (GHS) OF HAZARD CLASSIFICATION AND LABELLING (BOSTON UNIVERSITY FACT SHEET)

Changes to OSHA Hazard Communication Standard

Overview-OSHA revised its Haz Com Standard to align with the United Nations, Globally Harmonized System of Classification and Labeling of Chemicals (GHS) These changes will be phased in according to the chart to the right. The purpose of this document is to familiarize you with what to expect, when to expect it, and describe the new label elements and

Effective Completion Date	Requirements	Responsibility
December 1, 2013	*Train employees on new label elements and SDS format*	*Employer*
June 1, 2015	*Comply with all modified provisions of the final rule.*	Manufacturers, *importers, distributers, employers*
December 1, 2015	*Distributers may ship products labeled by manufacturers under the old system until this date*	
June 1, 2016	Update alternative workplace labeling and Hazard Communication Programs as necessary, and provide additional training on updated physical or health hazards	Employer

What does this mean for you? It means you must become familiar with the elements of a GHS label as well as the new content and format of a Safety Data Sheet (SDS) (formerly called an MSDS). Individual laboratories must also begin to transition their MSDS files into SDS as they are received.

GHS Label Elements-GHS labels are standardized with no variation and include the following elements;

- **Symbols** (hazard pictograms SEE BELOW): Convey health, physical and environmental hazard information, assigned to a GHS hazard class and category.
- **Signal Words:** "Danger" or "Warning" are used to emphasize hazards and indicate the relative level of severity of the hazard, assigned to a GHS hazard class and category.
- **Hazard Statements:** Standard phrases assigned to a hazard class and category that describe the nature of the hazard. Precautionary Statements: Measures to minimize or prevent adverse effects. All applicable hazard statements must appear on a label
- **Product Identifier** (ingredient disclosure): How the chemical is identified. Name or number used for a hazardous product on a label or in the SDS. The information on the label and SDS must be the same
- **Supplier identification**: The name, address and telephone number should be provided on the label. Supplemental information: non-harmonized information.
- **Precautionary Statements:** A phrase that describes recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure or improper storage
- **Symbols** (hazard pictograms): Convey health, physical and environmental hazard information, assigned to a GHS hazard class and category.

Pictograms- must be contained a red outer square, a white background, and a black hazard symbol. OSHA has designated 8 pictograms under this standard. A pictogram must be listed for each of the hazards

Carcinogen Mutagen Reproductive Toxin

Irritant Sensitizer Respiratory irritant

Burns, Skin Corrosion, Eye Damage

Acute Toxicity

Flammables Pyrophoric Self Heating Organic Peroxides

Oxidizers

Explosives Self Reactive

Gases under pressure

Changes to OSHA Hazard Communication Standard

Example GHS Label with Elements

Toxi Flam (contains XYZ)

DANGER! Toxic if swallowed, Flammable liquid and vapor

Do not eat, drink, or use tobacco when using this product. Wash hands thoroughly after handling. Keep container tightly closed and away from heat/ sparks/ open flame. NO SMOKING. Wear protective gloves and eye/face protection. Ground container and relieving equipment. Use explosion proof electrical equipment. Take measures against static discharge. Use not sparking tools. Store in well-ventilated area

IF SWALLOWED; immediately call poison control center or Dr/ Physician. Rinse mouth

Material Safety Data Sheets (MSDS) will phase into Safety Data Sheets (SDS)

Safety Data Sheet (SDS) An SDS will contain similar information as a current MSDS, however the information will always be under the same 16 categories. These categories will also always be in the same order. This should make it easier to find important information and alleviate searching. One example is that information on personal protective equipment will always be under section 8 (Exposure Controls/ Personal Protection). The information found in a SDS will always be identical to information on a GHS label.

1. **Identification**—Product identifier, manufacturer contact info, restrictions on use
2. **Hazard Identification**—Includes all hazards regarding chemical and label elements
3. **Composition/ ingredients**—Chemical ingredients, and trade name secrets
4. **First Aid measures**—Includes symptoms/ effects, acute, delayed and treatment
5. **Firefighting measures**—proper extinguishing techniques, equipment, hazards from fire
6. **Accidental release measures**—Emergency procedures, ppe, containment and cleanup
7. **Handling and Storage**—precautions for safe storage such as incompatibles
8. **Exposure Controls/ PPE**—Lists exposure limits, engineering controls, and ppe
9. **Physical and chemical properties**—Characteristics of a chemical
10. **Stability and Reactivity**—possible reactions and stability of the substance
11. **Toxicological information**—Routes of exposure, symptoms, effects, numerical toxicity measures
12. **Ecological Information***
13. **Disposal Considerations***
14. **Transport information***
15. **Regulatory Information***
16. **Other information**- preparation and revision dates

*These section must be present but OSHA doesn't regulate the information found here.

39.0 GHS SAFETY DATA SHEETS (SDSs)

OSHA® BRIEF

Hazard Communication Standard: Safety Data Sheets

The Hazard Communication Standard (HCS) (29 CFR 1910.1200(g)), revised in 2012, requires that the chemical manufacturer, distributor, or importer provide Safety Data Sheets (SDSs) (formerly MSDSs or Material Safety Data Sheets) for each hazardous chemical to downstream users to communicate information on these hazards. The information contained in the SDS is largely the same as the MSDS, except now the SDSs are required to be presented in a consistent user-friendly, 16-section format. This brief provides guidance to help workers who handle hazardous chemicals to become familiar with the format and understand the contents of the SDSs.

The SDS includes information such as the properties of each chemical; the physical, health, and environmental health hazards; protective measures; and safety precautions for handling, storing, and transporting the chemical. The information contained in the SDS must be in English (although it may be in other languages as well). In addition, OSHA requires that SDS preparers provide specific minimum information as detailed in Appendix D of 29 CFR 1910.1200. The SDS preparers may also include additional information in various section(s).

Sections 1 through 8 contain general information about the chemical, identification, hazards, composition, safe handling practices, and emergency control measures (e.g., fire fighting). This information should be helpful to those that need to get the information quickly. Sections 9 through 11 and 16 contain other technical and scientific information, such as physical and chemical properties, stability and reactivity information, toxicological information, exposure control information, and other information including the date of preparation or last revision. The SDS must also state that no applicable information was found when the preparer does not find relevant information for any required element.

The SDS must also contain Sections 12 through 15, to be consistent with the UN Globally Harmonized System of Classification and Labeling of Chemicals (GHS), but OSHA will not enforce the content of these sections because they concern matters handled by other agencies.

A description of all 16 sections of the SDS, along with their contents, is presented below:

Section 1: Identification

This section identifies the chemical on the SDS as well as the recommended uses. It also provides the essential contact information of the supplier. The required information consists of:

- Product identifier used on the label and any other common names or synonyms by which the substance is known.
- Name, address, phone number of the manufacturer, importer, or other responsible party, and emergency phone number.
- Recommended use of the chemical (e.g., a brief description of what it actually does, such as flame retardant) and any restrictions on use (including recommendations given by the supplier).

Section 2: Hazard(s) Identification

This section identifies the hazards of the chemical presented on the SDS and the appropriate warning information associated with those hazards. The required information consists of:

- The hazard classification of the chemical (e.g., flammable liquid, category[1]).
- Signal word.
- Hazard statement(s).
- Pictograms (the pictograms or hazard symbols may be presented as graphical reproductions of the symbols in black and white or be a description of the name of the symbol (e.g., skull and crossbones, flame).
- Precautionary statement(s).
- Description of any hazards not otherwise classified.
- For a mixture that contains an ingredient(s) with unknown toxicity, a statement describing how much (percentage) of the mixture consists of ingredient(s) with unknown acute toxicity. Please note that this is a total percentage of the mixture and not tied to the individual ingredient(s).

Section 3: Composition/Information on Ingredients

This section identifies the ingredient(s) contained in the product indicated on the SDS, including impurities and stabilizing additives. This section includes information on substances, mixtures, and all chemicals where a trade secret is claimed. The required information consists of:

Substances

- Chemical name.
- Common name and synonyms.
- Chemical Abstracts Service (CAS) number and other unique identifiers.
- Impurities and stabilizing additives, which are themselves classified and which contribute to the classification of the chemical.

Mixtures

- Same information required for substances.
- The chemical name and concentration (i.e., exact percentage) of all ingredients which are classified as health hazards and are:
  - Present above their cut-off/concentration limits or
  - Present a health risk below the cut-off/concentration limits.
- The concentration (exact percentages) of each ingredient must be specified except concentration ranges may be used in the following situations:
  - A trade secret claim is made,
  - There is batch-to-batch variation, or
  - The SDS is used for a group of substantially similar mixtures.

Chemicals where a trade secret is claimed

- A statement that the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret is required.

[1] Chemical, as defined in the HCS, is any substance, or mixture of substances.

Section 4: First-Aid Measures

This section describes the initial care that should be given by untrained responders to an individual who has been exposed to the chemical. The required information consists of:

- Necessary first-aid instructions by relevant routes of exposure (inhalation, skin and eye contact, and ingestion).
- Description of the most important symptoms or effects, and any symptoms that are acute or delayed.
- Recommendations for immediate medical care and special treatment needed, when necessary.

Section 5: Fire-Fighting Measures

This section provides recommendations for fighting a fire caused by the chemical. The required information consists of:

- Recommendations of suitable extinguishing equipment, and information about extinguishing equipment that is not appropriate for a particular situation.
- Advice on specific hazards that develop from the chemical during the fire, such as any hazardous combustion products created when the chemical burns.
- Recommendations on special protective equipment or precautions for firefighters.

Section 6: Accidental Release Measures

This section provides recommendations on the appropriate response to spills, leaks, or releases, including containment and cleanup practices to prevent or minimize exposure to people, properties, or the environment. It may also include recommendations distinguishing between responses for large and small spills where the spill volume has a significant impact on the hazard. The required information may consist of recommendations for:

- Use of personal precautions (such as removal of ignition sources or providing sufficient ventilation) and protective equipment to prevent the contamination of skin, eyes, and clothing.
- Emergency procedures, including instructions for evacuations, consulting experts when needed, and appropriate protective clothing.
- Methods and materials used for containment (e.g., covering the drains and capping procedures).
- Cleanup procedures (e.g., appropriate techniques for neutralization, decontamination, cleaning or vacuuming; adsorbent materials; and/or equipment required for containment/clean up).

Section 7: Handling and Storage

This section provides guidance on the safe handling practices and conditions for safe storage of chemicals. The required information consists of:

- Precautions for safe handling, including recommendations for handling incompatible chemicals, minimizing the release of the chemical into the environment, and providing advice on general hygiene practices (e.g., eating, drinking, and smoking in work areas is prohibited).
- Recommendations on the conditions for safe storage, including any incompatibilities. Provide advice on specific storage requirements (e.g., ventilation requirements).

Section 8: Exposure Controls/Personal Protection

This section indicates the exposure limits, engineering controls, and personal protective measures that can be used to minimize worker exposure. The required information consists of:

- OSHA Permissible Exposure Limits (PELs), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet, where available.
- Appropriate engineering controls (e.g., use local exhaust ventilation, or use only in an enclosed system).
- Recommendations for personal protective measures to prevent illness or injury from exposure to chemicals, such as personal protective equipment (PPE) (e.g., appropriate types of eye, face, skin or respiratory protection needed based on hazards and potential exposure).
- Any special requirements for PPE, protective clothing or respirators (e.g., type of glove material, such as PVC or nitrile rubber gloves; and breakthrough time of the glove material).

Section 9: Physical and Chemical Properties

This section identifies physical and chemical properties associated with the substance or mixture. The minimum required information consists of:

- Appearance (physical state, color, etc.);
- Odor;
- Odor threshold;
- pH;
- Melting point/freezing point;
- Initial boiling point and boiling range;
- Flash point;
- Evaporation rate;
- Flammability (solid, gas);
- Upper/lower flammability or explosive limits;
- Vapor pressure;
- Vapor density;
- Relative density;
- Solubility(ies);
- Partition coefficient: n-octanol/water;
- Auto-ignition temperature;
- Decomposition temperature; and
- Viscosity.

The SDS may not contain every item on the above list because information may not be relevant or is not available. When this occurs, a notation to that effect must be made for that chemical property. Manufacturers may also add other relevant properties, such as the dust deflagration index (Kst) for combustible dust, used to evaluate a dust's explosive potential.

Section 10: Stability and Reactivity

This section describes the reactivity hazards of the chemical and the chemical stability information. This section is broken into three parts: reactivity, chemical stability, and other. The required information consists of:

Reactivity

- Description of the specific test data for the chemical(s). This data can be for a class or family of the chemical if such data adequately represent the anticipated hazard of the chemical(s), where available.

Chemical stability

- Indication of whether the chemical is stable or unstable under normal ambient temperature and conditions while in storage and being handled.
- Description of any stabilizers that may be needed to maintain chemical stability.
- Indication of any safety issues that may arise should the product change in physical appearance.

Other

- Indication of the possibility of hazardous reactions, including a statement whether the chemical will react or polymerize, which could release excess pressure or heat, or create other hazardous conditions. Also, a description of the conditions under which hazardous reactions may occur.
- List of all conditions that should be avoided (e.g., static discharge, shock, vibrations, or environmental conditions that may lead to hazardous conditions).
- List of all classes of incompatible materials (e.g., classes of chemicals or specific substances) with which the chemical could react to produce a hazardous situation.
- List of any known or anticipated hazardous decomposition products that could be produced because of use, storage, or heating. (Hazardous combustion products should also be included in Section 5 (Fire-Fighting Measures) of the SDS.)

Section 11: Toxicological Information

This section identifies toxicological and health effects information or indicates that such data are not available. The required information consists of:

- Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact). The SDS should indicate if the information is unknown.
- Description of the delayed, immediate, or chronic effects from short- and long-term exposure.
- The numerical measures of toxicity (e.g., acute toxicity estimates such as the LD50 (median lethal dose)) - the estimated amount [of a substance] expected to kill 50% of test animals in a single dose.
- Description of the symptoms. This description includes the symptoms associated with exposure to the chemical including symptoms from the lowest to the most severe exposure.
- Indication of whether the chemical is listed in the National Toxicology Program (NTP) Report on Carcinogens (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs (latest editions) or found to be a potential carcinogen by OSHA.

Section 12: Ecological Information (non-mandatory)

This section provides information to evaluate the environmental impact of the chemical(s) if it were released to the environment. The information may include:

- Data from toxicity tests performed on aquatic and/or terrestrial organisms, where available (e.g., acute or chronic aquatic toxicity data for fish, algae, crustaceans, and other plants; toxicity data on birds, bees, plants).
- Whether there is a potential for the chemical to persist and degrade in the environment either through biodegradation or other processes, such as oxidation or hydrolysis.
- Results of tests of bioaccumulation potential, making reference to the octanol-water partition coefficient (K_{ow}) and the bioconcentration factor (BCF), where available.
- The potential for a substance to move from the soil to the groundwater (indicate results from adsorption studies or leaching studies).
- Other adverse effects (e.g., environmental fate, ozone layer depletion potential, photochemical ozone creation potential, endocrine disrupting potential, and/or global warming potential).

Section 13: Disposal Considerations (non-mandatory)

This section provides guidance on proper disposal practices, recycling or reclamation of the chemical(s) or its container, and safe handling practices. To minimize exposure, this section should also refer the reader to Section 8 (Exposure Controls/Personal Protection) of the SDS. The information may include:

- Description of appropriate disposal containers to use.
- Recommendations of appropriate disposal methods to employ.
- Description of the physical and chemical properties that may affect disposal activities.
- Language discouraging sewage disposal.
- Any special precautions for landfills or incineration activities.

Section 14: Transport Information (non-mandatory)

This section provides guidance on classification information for shipping and transporting of hazardous chemical(s) by road, air, rail, or sea. The information may include:

- UN number (i.e., four-figure identification number of the substance)[2].
- UN proper shipping name[2].
- Transport hazard class(es)[2].
- Packing group number, if applicable, based on the degree of hazard[2].
- Environmental hazards (e.g., identify if it is a marine pollutant according to the International Maritime Dangerous Goods Code (IMDG Code)).
- Guidance on transport in bulk (according to Annex II of MARPOL 73/78[3] and the International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk (International Bulk Chemical Code (IBC Code)).
- Any special precautions which an employee should be aware of or needs to comply with, in connection with transport or conveyance either within or outside their premises (indicate when information is not available).

[2] Found in the most recent edition of the United Nations Recommendations on the Transport of Dangerous Goods.

[3] MARPOL 73/78 means the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto, as amended.

Section 15: Regulatory Information (non-mandatory)

This section identifies the safety, health, and environmental regulations specific for the product that is not indicated anywhere else on the SDS. The information may include:

- Any national and/or regional regulatory information of the chemical or mixtures (including any OSHA, Department of Transportation, Environmental Protection Agency, or Consumer Product Safety Commission regulations).

Section 16: Other Information

This section indicates when the SDS was prepared or when the last known revision was made. The SDS may also state where the changes have been made to the previous version. You may wish to contact the supplier for an explanation of the changes. Other useful information also may be included here.

Employer Responsibilities

Employers must ensure that the SDSs are readily accessible to employees for all hazardous chemicals in their workplace. This may be done in many ways. For example, employers may keep the SDSs in a binder or on computers as long as the employees have immediate access to the information without leaving their work area when needed and a back-up is available for rapid access to the SDS in the case of a power outage or other emergency. Furthermore, employers may want to designate a person(s) responsible for obtaining and maintaining the SDSs. If the employer does not have an SDS, the employer or designated person(s) should contact the manufacturer to obtain one.

References

OSHA, 29 CFR 1910.1200(g) and Appendix D.

United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS), third revised edition, United Nations, 2009.

These references and other information related to the revised Hazard Communication Standard can be found on OSHA's Hazard Communication Safety and Health Topics page, located at: http://www.osha.gov/dsg/hazcom/index.html.

Disclaimer: This brief provides a general overview of the safety data sheet requirements in the Hazard Communication Standard (see 29 CFR 1910.1200(g) and Appendix D of 29 CFR 1910.1200). It does not alter or determine compliance responsibilities in the standard or the Occupational Safety and Health Act of 1970. Since interpretations and enforcement policy may change over time, the reader should consult current OSHA interpretations and decisions by the Occupational Safety and Health Review Commission and the courts for additional guidance on OSHA compliance requirements. Please note that states with OSHA-approved state plans may have additional requirements for chemical safety data sheets, outside of those outlined above. For more information on those standards, please visit: http://www.osha.gov/dcsp/osp/statestandards.html.

This is one in a series of informational briefs highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory-impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

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DSG BR-3514 2/2012

40.0 GHS Pictograms and OSHA Hazard Classifications

The first three (3) pages of this Chapter show the nine (9) pictograms and the health, physical, and environmental hazards that they denote. These also show the categories within each hazard classification.

The remainder of the Appendix is a summary on the definitions or technical basis for the classifications and categories within each of those classifications.

For more detailed information on the the basis for these hazards you are referred to the "Purple Book", *Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*, 4th revised edition (United Nations). A link to that document is provided below:

http://www.unece.org/fileadmin/DAM/trans/danger/publi/ghs/ghs_rev04/English/ST-SG-AC10-30-Rev4e.pdf

The Nine (9) Pictograms and the Hazards they represent are shown in the table immediately below. The next tables show the "sub" categories within each of these hazard classifications.

HCS Pictograms and Hazards:

Health Hazard	**Flame**	**Exclamation Mark**
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non Mandatory)
Gas Cylinder	**Corrosion**	**Exploding Bomb**
• Gases under Pressure	• Skin Corrosion/ burns • Eye Damage • Corrosive to Metals	• Explosives • Self-Reactives • Organic Peroxides
Flame over Circle	**Environment (Non Mandatory)**	**Skull and Crossbones**
• Oxidizers	• Aquatic Toxicity	• Acute Toxicity (fatal or toxic)

GHS Hazard Categories: Physical

Hazard Classification	Hazard Category						
Explosives	Unstable explosive	1.1	1.2	1.3	1.4	1.5	1.6
Flammable Gases	1	2					
Flammable Aerosols	1	2					
Oxidizing Gases	1						
Gases Under Pressure	Compressed Gas	Liquefied Gas	Refrigerated Liquefied Gas	Dissolved Gas			
Flammable Liquids	1	2	3	4			
Flammable Solids	1	2					
Self-reactive Substances & Mixtures	Type A	Type B	Type C & D	Type E & F	Type G		
Pyrophoric Liquids	1						
Pyrophoric Solids	1						
Self-heating Substances & Mixtures	1	2					
Substances & Mixtures, which in contact with water, emit flammable gases	1	2	3				
Oxidizing Liquids	1	2	3				
Oxidizing Solids	1	2	3				
Organic Peroxides	Type A	Type B	Type C & D	Type E & F	Type G		
Corrosive to Metals	1						

Source: Globally Harmonized System of Classification and Labeling of Chemicals (GHS) 3rd revision, Annex 2: Classification and labeling summary tables

Remember that the GHS hazard rating for the categories within each hazard classification go from 1 to 5, with "1" representing the greatest degree of hazard.

GHS Hazard Categories: Health

Hazard Classification	Hazard Category				
Acute Toxicity	1	2	3	4	5
Skin Corrosion/Irritation	1	2	3		
Serious Eye Damage/Eye Irritation	1	2A	2B		
Respiratory Sensitizer	1	1A	1B		
Skin Sensitizer	1	1A	1B		
Germ Cell Mutagenicity	1A	1B	2		
Carcinogenicity	1A	1B	2		
Toxic to Reproduction	1A	1B	2		
Effects on or via Lactation	Additional category for effects on or via lactation				
Specific target organ toxicity following single exposure	1	2	3		
Specific target organ toxicity following repeated exposure	1	2			
Aspiration Hazard	1	2			

GHS Hazard Categories: Environment

Hazard Classification	Hazard Category				
Acute Hazard to the Aquatic Environment	1	2	3		
Long-term Hazard to the Aquatic Environment	1	2	3	4	5
Hazard to the Ozone Layer	1				

Pictogram Technical Content

1. **Health Hazard pictogram.**

Health hazards in the context of the Globally Harmonized System for Classification and Labeling of Chemicals are chemicals that can harm the body. There are many types of such health hazards; these are described below.

Definitions

- **Carcinogen**: a substance or a mixture of substances which induce cancer or increase its incidence. Substances and mixtures which have induced benign and malignant tumors in well-performed experimental studies on animals are considered also to be presumed or suspected human carcinogens unless there is strong evidence that the mechanism of tumor formation is not relevant for humans.
- **Germ Cell Mutagenicity**: a permanent change in the amount or structure of the genetic material in a cell.
- **Reproductive Toxicity**: includes adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on development of the offspring.
- **Respiratory Sensitizer**: a substance that will lead to hypersensitivity of the airways following inhalation of the substance.
- **Target Organ Toxicity**: specific target organ toxicity, non-lethal.
- **Aspiration Toxicity:** the entry of a liquid or solid chemical directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system resulting in severe acute effects such as chemical pneumonia, varying degrees of pulmonary injury or death following aspiration.

Specific notes:

Carcinogen: Classification of a substance or mixture as posing a carcinogenic hazard is based on its inherent properties and does not provide information on the level of the human cancer risk which the use of the substance or mixture may represent.

There are two categories of carcinogen. Category assignment is based on strength of evidence and addition considerations (weight of evidence). In certain instances, route specific classification may be warranted.

Category 1 comprises known or presumed human carcinogens. The placing of a substance in Category 1 is done on the basis of epidemiological and/or animal studies. Category 1 is further split into sub-categories 1A and 1B. Sub-category 1A comprises substances known to have carcinogenic potential for humans. The placing of a substance in sub-category 1A is

largely based on human evidence. Sub-category 1B comprises substances presumed to have carcinogenic potential for humans. The placing of a substance in sub-category 1B is largely based on animal evidence.

Category 2 comprises suspected human carcinogens. The placing of a substance in Category 2 is done on the basis of evidence obtained from human and/or animal studies, but which is not sufficiently convincing to place the substance in Category 1.

A mixture is classified as a carcinogen when at least one ingredient has been classified as a Category 1 or Category 2 carcinogen and is present at or above 0.1 percent. See Table A.6.1 (*Cut-off values/concentration limits of ingredients of a mixture classified as carcinogen that would trigger classification of the mixture*) of the OSHA GHS Proposal for further information.

See OSHA GHS Proposal Appendix A.6 for additional information.

Germ Cell Mutagenicity: This hazard class is primarily concerned with chemicals that may cause mutations in the germ cells of humans that can be transmitted to the progeny. However, mutagenicity/genotoxicity tests invitro and in mammalian somatic cells in vivo are also considered in classifying substances and mixtures within this hazard class.

The term mutation applies both to heritable genetic changes that may be manifested at the phenotypic level and to the underlying DNA modifications when known (including, for example, specific base pair changes and chromosomal translocations). The term mutagenic and mutagen is used for agents giving rise to an increased occurrence of mutations in populations of cells and/or organisms.

The more general terms genotoxic and genotoxicity apply to agents or processes which alter the structure, information content, or segregation of DNA, including those which cause DNA damage by interfering with normal replication processes, or which in a non-physiological manner (temporarily) alter its replication. Genotoxicity test results are usually taken as indicators for mutagenic effects.

There are two categories of germ cell mutagens. Category 1 comprises substances known to induce heritable mutations or to be regarded as if they induce heritable mutations in germ cells. Category 1 is further split into sub-categories 1A and 1B. Sub-category 1A comprises substances known to induce mutations in germ cells of humans. The placing of a substance in sub-category 1A is largely based on positive evidence from human epidemiological studies. Sub-category 1B comprises substances which should be regarded as if they induce heritable mutations in the germ cells of humans. The placing of a substance in sub-category 1B is largely based on:

- Positive result(s) from in vivo heritable germ cell mutagenicity test in mammals; or
- Positive result(s) from in vivo somatic cell mutagenicity test in mammals, in combination with some evidence that the substance has potential to cause mutations to germ cells; or
- Positive results from tests showing mutagenic effects in the germ cells of humans, without demonstration of transmission to progeny.

Category 2 comprises substances which cause concern for humans owing to the possibility that they may induce heritable mutation in the germ cells of humans. Positive evidence obtained from experiments in mammals and/or in some cases from in vitro experiments, obtained from:

- Somatic cell mutagenicity test in vivo, in mammals; or
- Other in vivo somatic cell genotoxicity tests which are supported by positive results from in vitro mutagenicity assays.

See OSHA GHS Proposal Appendix A.5 for additional information.

Reproductive Toxicity: There are two categories of reproductive toxicity. Effects on sexual function and fertility, and on development, are considered for category assignment.

Category 1 comprises known or presumed human reproductive toxicants. Category 1 is further split into sub-categories 1A and 1B. Sub-category 1A comprises substances that are known reproductive toxicants. The placing of a substance in sub-category 1A is largely based on human evidence. Sub-category 1B comprises substances that are presumed human reproductive toxicants. The placing of a substance in sub-category 1B is largely based on evidence from experimental animals.

Category 2 comprises suspected human reproductive toxicants. This category includes substances for which there is some evidence from humans or experimental animals of an adverse effect on sexual function and fertility, or on development, in the absence of other toxic effect, or if occurring together with other toxic effects the adverse effect on reproduction is considered not to be a secondary non-specific consequence of the other toxic effect, and where the evidence is not sufficiently convincing to place the substance in Category 1.

Effects on or via lactation are allocated to a separate single category. Substances which are absorbed by women and have been shown to interfere with lactation, or which may be present (including metabolites) in breast milk in amounts sufficient to cause concern for the health of a breastfed child, should be classified to indicate this property hazardous to breastfed babies.

A mixture is classified as reproductive toxicants when at least one ingredient has been classified as a Category 1 or Category 2 reproductive toxin and is present at or above 0.1 percent, or has effects on or via lactation. See Table A.7.1 (*Cut-off values/concentration limits of ingredients of a mixture classified as reproductive toxicants or for effects on or via lactation that would trigger classification of the mixture*) of the OSHA GHS Proposal for further information.

See OSHA GHS Proposal Appendix A.7 for additional information.

Respiratory Sensitizer: Respiratory sensitizers are classified in Category 1 where sub-categorization is not required by a competent authority or where data are not sufficient for sub-categorization. Category 1 respiratory sensitizers are those substances for which there is evidence in humans that the substance can led to specific respiratory hypersensitivity and/or there are positive results from an appropriate animal test.

Category 1 can be further split into sub-categories 1A and 1B. Sub-category 1A comprises substances showing a high frequency of occurrence in humans; or a probability of occurrence of a high sensitization rate in humans based on animal or other tests. Sub-category 1B comprises substances showing a low to moderate frequency of occurrence in humans; or a probability of occurrence of a low to moderate sensitization rate in humans based on animal or other tests. Severity of reaction may also be considered for either sub-categories 1A or 1B.

See Table A.4.5 (*Cut-off values/concentration limits of ingredients of a mixture classified as either respiratory sensitizers or skin sensitizers that would trigger classification of the mixture*) of the OSHA GHS Proposal for information on when a mixture is classified as a respiratory sensitizer.

See OSHA GHS Proposal Appendix A.4 for additional information.

Specific Organ Toxicity

Specific organ toxins are designated as either single or repeated exposure. For non-lethal target organ toxicity arising from a single exposure, classification depends upon the availability of reliable evidence that a single exposure to the substance or mixture has produced a consistent and identifiable toxic effect in humans, or, in experimental animals, toxicologically significant changes which have affected the function or morphology of a tissue/organ, or has produced serious changes to the biochemistry or hematology of the organism and these changes are relevant for human health. It is recognized that human data will be the primary source of evidence for this hazard class. Substances are classified for immediate or delayed effects separately, by the use of expert judgment on the basis of

the weight of all evidence available, including the use of recommended guidance values. Then substances are placed in Category 1 or 2, depending upon the nature and severity of the effect(s) observed, or in Category 3. Specific Organ Toxicity Category 1 and 2 substances require labeling with the Chronic Health Hazard pictogram. Specific Organ Toxicity Category 3 (for single exposure) substances require labeling with the Exclamation Mark pictogram.

Category 1 comprises substances that have produced significant toxicity in humans, or that, on the basis of evidence from studies in experimental animals can be presumed to have the potential to produce significant toxicity in humans following a single exposure. Category 2 comprises substances that, on the basis of evidence from studies in experimental animals can be presumed to have the potential to be harmful to human health following a single exposure. Category 3 comprises substances which adversely alter human function for a short duration after exposure and from which humans may recover in a reasonable period without leaving significant alteration of structure or function (transient effects).

See Table A.8.2 (*Cut-off values/concentration limits of ingredients of a mixture classified as a specific target organ toxicant that would trigger classification of the mixture as Category 1 or 2*) of the OSHA GHS Proposal for information on when a mixture is classified as a single exposure target organ toxicant.

For non-lethal target organ toxicity arising from repeated exposure, classification depends upon the availability of reliable evidence that a repeated exposure to the substance or mixture has produced a consistent and identifiable toxic effect in humans, or, in experimental animals, toxicologically significant changes which have affected the function or morphology of a tissue/organ, or has produced serious changes to the biochemistry or hematology of the organism and these changes are relevant for human health. It is recognized that human data will be the primary source of evidence for this hazard class. Substances are classified as specific target organ toxicant by expert judgment on the basis of the weight of all evidence available, including the use of recommended guidance values which take into account the duration of exposure and the dose/concentration which produced the effect(s), and are placed in one of two categories, depending upon the nature and severity of the effect(s) observed. For both categories the specific target organ/system that has been primarily affected by the classified substance may be identified, or the substance may be identified as a general toxicant.

Category 1 comprises substances that have produced significant toxicity in humans, or the, on the basis of evidence from studies in experimental animals can be presumed to have the potential to produce significant toxicity in humans following repeated exposure. Category 2 comprises substances that, on the basis of evidence from studies in experimental animals

can be presumed to have the potential to be harmful to human health following repeated exposure.

See Table A.9.3 (*Cut-off values/ concentration limits of ingredients of a mixture classified as a specific target organ toxicant that would trigger classification of the mixture*) of the OSHA GHS Proposal for information on when a mixture is classified as a repeated exposure target organ toxicant.

See OSHA GHS Proposal Appendix A.8 and A.9 for additional information.

Aspiration Toxicity: There are two categories for aspiration toxicity. Category 1 comprises substances known to cause human aspiration toxicity hazards or to be regarded as if they cause human aspiration toxicity hazard. A substance is classified in Category 1:

- Based on reliable and good quality human evidence; or
- If it is a hydrocarbon and has a kinematic viscosity ≤ 20.5 mm^2/s at 40°C.

Category 2 comprises substances which cause concern owing to the presumption that they cause human aspiration toxicity hazard. A substance is classified in Category 2 on the basis of existing animal studies and expert judgment that takes into account surface tension, water solubility, boiling point, and volatility of substances, other than those classified in Category 1, which have a kinematic viscosity ≤ 14 mm^2/s at 40°C.

See OSHA GHS Proposal Appendix A.10 for additional information.

2. **Flame pictogram**.

The flame indicates a substance that is flammable, self-reactive, pyrophoric, self-heating, water reactive, or is organic peroxide.

Definitions

- **Flammables:**
  - A **flammable gas** is a gas having a flammable range with air at 20°C (68°F) and a standard pressure of 101.3 kPa (14.7 psi). A chemically unstable gas that is able to react explosively even in the absence of air or oxygen is also considered a flammable gas.
  - An aerosol is any non-refillable receptacle containing a gas compressed, liquefied or dissolved under pressure, and fitted with a release device

allowing the contents to be ejected as solid or liquid particles in suspension in a gas, as a foam, paste or powder or in a liquid state or in a gaseous state. **A flammable aerosol** contains any component classified as a flammable liquid, gas, or solid.
    - A **flammable liquid** has a flash point of not more than 93°C (199.4°F). Flash point means the minimum temperature at which a liquid gives off vapor in sufficient concentration to form an ignitable mixture with air near the surface of the liquid.
    - **A flammable solid** is a solid which is readily combustible, or which may cause or contribute to fire through friction. Readily combustible solids are powdered, granular, or pasty chemicals which are dangerous if they can be easily ignited by brief contact with an ignition source, such as a burning match, and if the flame spreads rapidly.
- **Pyrophoric:**
    - **A pyrophoric liquid** is a liquid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.
    - **A pyrophoric solid** is a solid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air.
- **Self-Heating**: a solid or liquid substance, other than a pyrophoric liquid or solid, which, by reaction with air and without energy supply, is liable to self-heat. These substances or mixtures differ from a pyrophoric liquid or solid in that they will ignite only when in large amounts (kg) and after long periods of time (hours or days).
- **Emits Flammable Gas**: solid or liquid substances or mixtures which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities.
- **Self-Reactive**: thermally unstable liquid or solid substances liable to undergo a strongly exothermic decomposition even without participation of oxygen (air). This definition excludes chemicals classified under GHS as explosives, organic peroxides, or as oxidizing. A self-reactive chemical is regarded as possessing explosive properties when in laboratory testing the formulation is liable to detonate, to deflagrate rapidly or to show a violent effect when heated under confinement.
- **Organic Peroxides**: a liquid or solid organic substance which contains the bivalent -O-O- structure and as such is considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.

Specific Notes

Flammable Gases: There are two categories of flammable gases. Category 1 (extremely flammable gases) comprises gases, which at 20°C (68°F) and 101.3 kPa, are ignitable when in a mixture of ≤ 13% by volume in air or have a flammable range with air of ≥ 12 % (regardless of the lower flammable limit). Category 2 (flammable gases) comprises gases, other than those of Category 1, having a flammable range while mixed in air. Category 2 flammable gases don't require labeling with the Flame pictogram.

A flammable gas that is also chemically unstable is additionally classified in one of the following two categories (using the methods described in Part III of the Manual of Tests and Criteria) according to the following criteria:

- Category A: Flammable gases which are chemically unstable at 20°C (68°F) and a standard pressure of 101.3 kPa
- Category B: Flammable gases which are chemically unstable at a temperature greater than 20°C (68°F) and/or a pressure greater than 101.3 kPa

See OSHA GHS Proposal Appendix B.2 for additional information.

Flammable aerosols: There are two categories of flammable aerosols. Category 1 comprises extremely flammable aerosol and Category 2 comprises flammable aerosols. To classify an aerosol as a flammable aerosol, data on its flammable components, on its chemical heat of combustion and, if applicable, the results of the foam test (for foam aerosols) and of the ignition distance test and enclose space test (for spray aerosols) are required.

An aerosol will be classified Category 1 if any of the following conditions are met:

- contains ≥ 85% flammable components and the chemical heat of combustion is ≥ 30 kJ/g
- ignition distance is ≥ 75 cm/29.5 in (spray aerosols)
- flame height in the aerosol foam flammability test is ≥ 4 cm (1.57 in) and the flame duration ≥ 7 s or the flame height is ≥ 20 cm (7.87 in) and the flame duration ≥ 2 s

An aerosol will be classified Category 2 if any of the following conditions are met:

- contains > 1% flammable components, or the heat of combustion is ≥ 20 kJ/g
- for spray aerosols, in the ignition distance test, ignition occurs at a distance ≥ 15 cm (5.9 in) or in the enclosed space ignition test, the (i) time equivalent is ≤ 300 s/m^3; or (ii) the deflagration density is ≤ 300 g/m^3
- for foam aerosols, in the aerosol foam flammability test, the flame height is ≥ 4 cm and the flame duration is ≥ 2 s

Aerosols containing more than 1% flammable components or with a heat of combustion of at least 20 kJ/g, which are not submitted to the flammability classification procedures in OSHA GHS Proposal Appendix B.3 should be classified as aerosols, Category 1.

See OSHA GHS Proposal Appendix B.3 for additional information.

Flammable liquid: There are four categories of flammable liquids: flash point < 23°C (73.4°F) and initial boiling point ≤ 35°C (95°F), flash point < 23°C (73.4°F) and initial boiling point >

35°C (95°F), flash point ≥ 23°C (73.4°F) and ≤ 60°C (140°F), and flash point > 60°C (140°F) and ≤ 93°C (199.4°F). Category 4 flammable liquids don't require labeling with the Flame pictogram.

See OSHA GHS Proposal Appendix B.6 for additional information.

Flammable solid: There are two categories of flammable solids. Category 1 comprises substances (excluding metal powders) for which the burning rate test demonstrates that the wetted zone does not stop fire, and the burning time is < 45 s or burning rate is > 2.2 mm/s. For metal powders, the burning time is ≤ 5 min. Category 2 comprises substances (excluding metal powders) for which the burning rate test demonstrates that the wetted zone stops the fire for at least 4 min, and the burning time is < 45 s or burning rate is > 2.2 mm/s. For metal powders, the burning time is > 5 min and ≤ 10 min.

See OSHA GHS Proposal Appendix B.7 for additional information.

Pyrophoric liquid: Category 1 is only category for pyrophoric liquids. The liquid ignites within 5 min when added to an inert carrier and exposed to air, or it ignites or chars a filter paper on contact with air within 5 min.

See OSHA GHS Proposal Appendix B.9 for additional information.

Pyrophoric solid: Category 1 is only category for pyrophoric solids.

See OSHA GHS Proposal Appendix B.10 for additional information.

Self Heating chemical: There are two categories of self-heating chemicals. Category 1 comprises substances which undergo oxidative self-heating by exposure to air using a 25 mm sample cube at 140°C (284°F). A substance is classified Category 2 if:

- a positive result is obtained in a test using a 100 mm sample cube at 140°C (284°F) and a negative result is obtained in a test using a 25mm cube sample at 140°C (284°F) and the substance or mixture is to be packed in packages with a volume of more than $3m^3$; or
- a positive result is obtained in a test using a 100mm sample cube at 140°C (284°F) and a negative result is obtained in a test using a 25mm cube sample at 140°C (284°F), a positive result is obtained in a test using a 100mm cube sample at 120°C (248°F) and the substance or mixture is to be packed in packages with a volume of more than 450 liters; or
- A positive result is obtained in a test using a 100mm sample cube at 140°C (284°F) and a negative result is obtained in a test using a 25mm cube sample at 140°C

(284°F) and a positive result is obtained in a test using a 100 mm cube sample at 100°C (212°F).

See OSHA GHS Proposal Appendix B.11 for additional information.

Emits Flammable Gases: There are three categories of emits flammable gases. Category 1 comprises any substance or mixture which reacts vigorously with water at ambient temperatures and demonstrates generally a tendency for the gas produced to ignite spontaneously, or which reacts readily with water at ambient temperatures such that the rate of evolution of flammable gas is equal to or greater than 10 liters per kilogram of substance over any one minute. Category 2 comprises any substance or mixture which reacts readily with water at ambient temperatures such that the maximum rate of evolution of flammable gas is equal to or greater than 20 liters per kilogram of substance per hour, and which does not meet the criteria for Category 1. Category 3 comprises any substance or mixture which reacts slowly with water at ambient temperatures such that the maximum rate of evolution of flammable gas is equal to or greater than 1 liter per kilogram of substance per hour, and which does not meet the criteria for Categories1 and 2.

See OSHA GHS Proposal Appendix B.12 for additional information.

Self-Reactive: Any self-react

There are seven categories for self-reactive. Classification is made according to the results of Test Series A to H described in Part II of the UN Manual of Tests and Criteria. Self-Reactive Category B, C, D, E and F substances require labeling with the Flame pictogram.

See OSHA GHS Proposal Appendix B.8 for additional information.

Organic Peroxides: Organic peroxides are thermally unstable substances, which may undergo exothermic self-accelerating decomposition. In addition, they may have one or more of the following properties: liable to explosive decomposition; burn rapidly; sensitive to impact or friction; react dangerously with other substances. An organic peroxide is regarded as possessing explosive properties when in laboratory testing the formulation is liable to detonate, to deflagrate rapidly or to show a violent effect when heated under confinement.

There are seven categories of organic peroxides. Classification is made according to the results of Test Series A to H described in Part II of the UN Manual of Tests and Criteria. Organic Peroxide Category B, C, D, E and F substances require labeling with the Flame pictogram.

See OSHA GHS Proposal Appendix B.15 for additional information.

3. **Exclamation Mark pictogram**.

The exclamation mark depicts chemicals that are health hazards that can harm the body in specific ways, such as: skin and eye irritant, skin sensitizer, acute toxicity, narcotic effects, respiratory tract irritant.

Definitions

- **Skin Irritant:** A skin irritant is a substance that produces reversible damage to the skin following the application of a test substance for up to 4 hours.
- **Eye Irritant:** An eye irritant is a substance that produces changes in the eye which are reversible within 21 days of application.
- **Skin Sensitizer**: a substance that will lead to an allergic response following skin contact.
- **Acute Toxicity:** those adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.
- **Narcotic Effects**: Central nervous system depression including narcotic effects in humans such as drowsiness, narcosis, reduced alertness, loss of reflexes, lack of coordination, and vertigo are included. These effects can also be manifested as severe headache or nausea, and can lead to reduced judgment, dizziness, irritability, fatigue, impaired memory function, deficits in perception and coordination, reaction time, or sleepiness. Narcotic effects observed in animal studies may include lethargy, lack of coordination righting reflex, narcosis, and ataxia.
- **Respiratory Tract Irritant:** characterized by localized redness, edema, pruritus and/or pain that impair function with symptoms such as cough, pain, choking, and breathing difficulties. Based primarily on human data.
- **Hazardous to Ozone Layer (Non-Mandatory):** not included

Specific Notes

Skin Irritant: There are three categories of skin corrosion/irritation. Category 1 comprises substances that are skin corrosive, while Categories 2 and 3 comprise skin irritants. Skin Corrosion/Irritation Category 2 substances require labeling with the Exclamation Mark pictogram. Skin Corrosion/Irritation Category 3 (mildly irritating) substances don't require labeling with the Exclamation Mark pictogram

See OSHA GHS Proposal Appendix A.2 for additional information.

Eye Irritant: There are two categories for substances that cause eye damage/eye irritation. Category 1 comprises substances which cause irreversible eye effects. Category 2 comprises substances that cause reversible eye effects. Category 2 is further split into sub-categories 2A and 2B. Sub-category 2A comprises substances that are eye irritants and sub-category 2B comprises mild eye irritants. Serious Eye Damage/Eye Irritation Category 2A substances require labeling with the Exclamation Mark pictogram, while Serious Eye Damage/Eye Irritation Category 2B substances don't require labeling with the Exclamation Mark pictogram.

See Table A.3.3 (Concentration of ingredients of a mixture classified as skin Category 1 and/or eye Category 1 or 2 that would triggers classification of the mixtures as hazardous to the eye) and Table A.3.4 (*Concentration of ingredients of a mixture for which the additivity approach does not apply, that would trigger classification of the mixture as hazardous to the eye)* of the OSHA GHS Proposal for information on when a mixture is classified as a hazardous to the eye.

See OSHA GHS Proposal Appendix A.3 for additional information.

Skin Sensitizer:

Category 1 skin sensitizers are those substances for which there is evidence in humans that the substance can led to sensitization by skin contact in a substantial number of persons, or if there are positive results from an appropriate animal test.

Category 1 is further split into sub-categories 1A and 1B. Sub-category 1A comprises substances showing a high frequency of occurrence in humans and/or a high potency in animals can be presumed to have the potential to produce significant sensitization in humans. Sub-category 1B comprises substances showing a low to moderate frequency of occurrence in humans and/or a low to moderate potency in animals can be presumed to have the potential to produce sensitization in humans. Severity of reaction may also be considered for either sub-categories 1A or 1B.

Skin Sensitization Category 1 and sub-categories 1A and 1B substances require labeling with the Exclamation Mark pictogram.

See OSHA GHS Proposal Appendix A.4 for additional information.

Acute Toxicity: There are five categories of toxicity based on acute toxicity by the oral, dermal or inhalation route according to numeric cut-off criteria. Acute Toxicity Category 4 substances require labeling with the Exclamation Mark pictogram. See Table A.1.1 (*Acute toxicity hazard categories and acute toxicity estimate (ATE) values defining the respective*

categories) of the OSHA GHS Proposal for further information. Acute toxicity values are expressed as (approximate) LD50 (oral, dermal) or LC50 (inhalation) values or as acute toxicity estimates (ATE). The categories range from most acutely toxic for each exposure route (oral, dermal, inhalation-gases, inhalation-vapors, and inhalation-dusts and mists) to least acutely toxic.

For mixtures, the approach to classification for acute toxicity is tiered, and is dependent upon the amount of information available for the mixture itself and for its ingredients. See Figure A.1.1 (*Tiered approach to classification of mixtures for acute toxicity*) of the OSHA GHS Proposal for further information.

See OSHA GHS Proposal Appendix A.1 for additional information.

Narcotic Effects: A substance displaying narcotic effects is considered a Category 3 specific target organ toxicity single exposure substance. Category 3 specific target organ toxicity after single exposure substances require labeling with the Exclamation Mark pictogram.

See Section A.8.2.2.2 of the OSHA GHS Proposal for additional information.

Respiratory Tract Irritant: special classification occurs only when more severe organ effects in the respiratory system are not observed. A respiratory tract irritant is considered a Category 3 specific target organ toxicity single exposure substance. Category 3 specific target organ toxicity after single exposure substances require labeling with the Exclamation Mark pictogram.

See Section A.8.2.2.1 of the OSHA GHS Proposal for additional information.

Hazardous to Ozone Layer (Non-Mandatory): not included

See Chapter 4.2 of GHS Rev.4 for additional information.

4. Gas Cylinder pictogram.

A gas cylinder or tank: is a pressure vessel designed to store compressed gas at an absolute pressure greater than 1 atmosphere (101.3 kPa) at 20°C (68°F). A compressed gas is a gas, having neither independent shape nor volume and able to expand indefinitely, and when packaged under pressure is entirely gaseous at -50ºC (-122ºF).

Definitions

- **Gases under pressure:** gases that are contained in a receptacle at a pressure of 200 kPa or more at 20 °C (68°F), or which are liquefied or liquefied and refrigerated. They comprise compressed gases, liquefied gases, dissolved gases and refrigerated gases.

Specific Notes

A compressed gas is a gas which when packaged under pressure is entirely gaseous at -50 °C. A liquefied gas is a gas which when packaged under pressure, is partially liquid at temperatures above -50 °C. A refrigerated liquefied gas is a gas which when packaged is made partially liquid because of its low temperature. A dissolved gas is a gas which when packaged under pressure is dissolved in a liquid phase solvent.

A Gas Cylinder is a pressure vessel designed to hold compressed gas at an absolute pressure greater than 1 atmosphere (101.3 kPa) at 20°C (68°F). Gas cylinders include the following types of containers:

- Standard Department of Transportation (DOT) compressed gas cylinders (such as DOT-3A, DOT-3AA, DOT-3B, DOT-3E);
- Lecture bottles and sample cylinders;
- Acetylene cylinders (such as DOT-8, DOT-8AL);
- Portable liquefied petroleum gas (LPG) cylinders.

See OSHA GHS Proposal Appendix B.5 for additional information.

5. **Corrosion pictogram**.

Corrosion of the body is the production of irreversible tissue damage or decay to any part of the body when exposed to corrosive materials; resulting in visible necrosis through the epidermis and into the dermis (i.e., layers of skin). Corrosion is also defined as a process in which a solid such as metal, is slowly deteriorate by being worn away or changed by a chemical action (i.e. oxidation of iron in the presence of water by an electrolytic process) and is included because corrosion of a solid could indirectly result in harm to a body.

Definitions:

- **Skin Corrosion:** is the production of irreversible damage to the skin; namely, visible necrosis through the epidermis and into the dermis, following the application of a test substance for up to 4 hours. Corrosive reactions are typified by ulcers, bleeding, bloody scabs, and, by the end of observation at 14 days, by discoloration due to blanching of the skin, complete areas of alopecia, and scars.
- **Serious Eye Damage:** the production of tissue damage in the eye, or serious physical decay of vision, following application of a test substance to the anterior surface of the eye, which is not fully reversible within 21 days of application.
- **Corrosive to Metal:** Substance or a mixture which by chemical action will materially damage, or even destroy, metals.

Specific notes:

Generally speaking, corrosive materials have a very low pH (acids) or a very high pH (bases). Strong bases are usually more corrosive than acids. Examples of corrosive materials are sodium hydroxide (lye) and sulfuric acid.

Skin Corrosion/Burns: There are three categories of skin corrosion/irritation. Category 1 comprises substances that are skin corrosive, while Categories 2 and 3 comprise skin irritants. Category 1 is further split into three sub-categories 1A, 1B, and 1C. Sub-category 1A comprises substances that are corrosive in ≥ 1 of 3 animals with an exposure of time of ≤ 3 minutes. Sub-category 1B comprises substances that are corrosive in ≥ 1 of 3 animals with an exposure of time of > 3 minutes and ≤ 1 hour. Sub-category 1C comprises substances that are corrosive in ≥ 1 of 3 animals with an exposure of time of > 1 hour and ≤ 4 hours. Skin Corrosive Category 1 substances require labeling with the Corrosion pictogram.

Chemical hazards can sometimes occur in which immediate necrosis, ulceration, and sloughing of the skin occurs. This injury may be permanent and can leave deep wounds that scar or require transplanted skin to repair the damaged area.

Some chemicals can cause irritation by defatting of the skin; for example, commonly used ketones or chlorinated compounds (such as the solvents trichloroethylene, methylene chloride, and gasoline).

Cutaneous hazards may cause skin to react giving neither irritation nor allergic reactions. Oils and halogenated aromatic hydrocarbons can cause acne, mercury and lead can cause increased pigmentation of the skin, hydroquinone can cause decreased pigmentation, and skin cancer can be induced by workplace exposure to arsenic.

See OSHA GHS Proposal Appendix A.2 for additional information.

Serious Eye Damage: There are two categories for substances that cause eye damage/eye irritation. Category 1 comprises substances which cause irreversible eye effects. Category 2 comprises substances that cause reversible eye effects. Category 2 is further split into sub-categories 2A and 2B. Sub-category 2A comprises substances that are eye irritants and sub-category 2B comprises mild eye irritants. Serious Eye Damage/Eye Irritation Category 1 substances require labeling with the Corrosion pictogram.

See Table A.3.3 (Concentration of ingredients of a mixture classified as skin Category 1 and/or eye Category 1 or 2 that would triggers classification of the mixtures as hazardous to the eye) and Table A.3.4 (*Concentration of ingredients of a mixture for which the additivity approach does not apply, that would trigger classification of the mixture as hazardous to the eye)* of the OSHA GHS Proposal for information on when a mixture is classified as a hazardous to the eye.

Chemicals exposure can cause damage to the eye and the eye's visual capacity. The primary toxic effects from direct exposure of chemicals to the eye are conjunctivitis or corneal damage. Conjunctivitis is inflammation of the conjunctiva, the delicate membrane that lines the eyelids and covers the eyeballs.

Chemicals that accidentally splash onto the face can directly contact the eye structures. Acids and strong alkalis (such as lye) may cause severe corneal corrosion and may result in permanent blindness. Organic solvents (such as acetone) and detergents can cause temporary clouding of vision, primarily due to dissolving of fats from the cornea.

Some chemicals can cause toxic effects to the eye without the direct contact to the eye. Chemicals that are inhaled or ingested may move to the eye through the blood circulation and produce eye damage. 2-4-Dinitrophenol (a wood preservative) can cause cataracts after ingestion. The ingestion of thallium salts (found in some pesticides) and methanol (wood alcohol) has been associated with blindness due to damage to the optic nerve. Retina damage has been associated with exposures to arsenicals and carbon disulfide.

See OSHA GHS Proposal Appendix A.3 for additional information.

Corrosive to Metals: A substance or a mixture which is corrosive to metals is classified in a single category for this class, using the test in Part III, sub-section of the UN Recommendations on the Transport of Dangerous Goods, Manual of Test and Criteria. For example, if the corrosion rate of a solution on steel or aluminum surfaces exceeds 6.25 mm per year at a test temperature of 55 °C (131°F), then the solution is considered corrosive to metals.

See OSHA GHS Proposal Appendix B.16 for additional information.

6. **Exploding Bomb pictogram**.

The exploding bomb depicts explosive substances which consist of liquids or solids or a mixture of substances which are capable by chemical reactions of producing mass explosion hazards; causing extreme physical damage to a specified area. Explosives are divided into six categories ranging from extremely sensitive to extremely insensitive items. The extremely insensitive items pose negligible probability of accidental initiation or propagation of an explosion.

Themselves

Definitions

- **Explosive substances:** are solids or liquids substances (or mixture of substances) which are in themselves capable by chemical reactions of producing gases at such a temperature and pressure and at such a speed as to cause damage to the surroundings. Pyrotechnic substances/mixtures are considered explosives. Pyrotechnic substances are substances designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative self-sustaining exothermic chemical reactions.
- **Self-reactive substances**: are thermally unstable liquid or solid substances liable to undergo strongly exothermic reactions even without participation of oxygen (air). This definition excludes substances or mixtures classified under the GHS as explosive, organic peroxides or as oxidizing.
- **Organic Peroxides**: are liquid or solid organic substances which contain the bivalent -O-O- structure and maybe considered derivatives of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The term also includes organic peroxide formulation (mixtures).

Specific Notes:

Explosive substances: Unstable explosives are explosives which are thermally unstable and/or too sensitive for normal handling, transport, or use. Unstable explosives are considered *forbidden* by U.S. Department of Transportation (DOT) regulations and therefore are not assigned Division classifications as discussed below. Examples of unstable explosives include: liquid nitroglycerin not desensitized, pure dry RDX or HMX, ammonium permanganate.

Explosives and articles are classified and allocated to a division according to the results of Test Series 2 to 7 of Part I of the UN Manual of Tests and Criteria (ST/SG/AC.10/11/Rev.5).

- Division 1.1 – Chemicals and items which have a mass explosion hazard (a mass explosion is one which affects almost the entire quantity present virtually instantaneously). Examples: ammonium picrate (dry), RDX, HMX, or PETN compositions (e.g., C4), picric acid, TNT (dry), black powder
- Division 1.2 – Chemicals and items which have a projection hazard but not a mass explosion hazard. Examples: incendiary or white phosphorus ammunition, some types of small arms cartridges
- Division 1.3 – Chemicals and items which have a fire hazard and either a minor blast hazard or a minor projection hazard or both, but not a mass explosion hazard. Examples: anhydrous 1-hydroxybenzotriazole, nitrocellulose (wetted), sodium picramate, zirconium picramate (dry), some types of small arms cartridges
- Division 1.4 – Chemicals and items which present no significant hazard in the event of ignition or initiation. The effects are largely confined to the package and no projection of fragments of appreciable size or range is to be expected. An external fire shall not cause virtually instantaneous explosion of almost the entire contents of the package. Examples: model rocket motors, detonating cord, air bag inflators, some types of flares/signaling devices, safety fuse, some types of small arms cartridges
- Division 1.5 – Very insensitive chemicals which have a mass explosion hazard, but are so insensitive that there is very little probability of initiation or of transition from burning to detonation under normal conditions. Examples: ammonium nitrate-fuel oil mixture (ANFO), certain types of blasting agents
- Division 1.6 – Extremely insensitive items which do not have a mass explosion hazard. This includes items which contain only extremely insensitive detonating chemicals and which demonstrate a negligible probability of accidental initiation or propagation. Examples: (no specific examples available – see 49 CFR 173.58 c; division 1.6 explosive).

Division 1.1, 1.2, 1.3, and 1.4 explosives, as well as unstable explosive substances, require labeling with the Exploding Bomb pictogram.

See OSHA GHS Proposal Appendix B.1 for additional information.

Self-reactive substances: These unstable (reactive) materials can vigorously decompose, polymerize, condense, or become self-reactive under conditions of shocks, pressure or temperature.

Decomposition reactions can occur with many chemicals and mixtures. In this process, complex molecules dissociate to form simpler substances. This process may require input

of heat or there may be a release of heat during the chemical reaction. The most hazardous reactions are those in which heat is released. Decomposition of materials can cause physical and health damage by the release of gases that will burn, explode, or produce high pressure that can inflict injury to a person nearby. In some cases, the reactive materials may release substances that are considerably more toxic than themselves.

Polymerization is a reaction in which small molecules (usually monomers) react with each other to form larger molecules (polymers). In the chemical process, a large amount of heat may be released. This raises the temperature of the monomer mixture that further accelerates the polymerization process until the reaction runs away or explodes.

While there are classes of chemicals that in themselves may be reactive, there are also stable chemicals which are not reactive but when combined may interact, resulting in an explosive reaction. Mixing incompatible materials may result in the formation of unstable/reactive species. Therefore, the literature search should document incompatible materials.

The main difference between an unstable material and an explosive is the rate of the reaction. While the rate of reaction for unstable materials is less than that in the case of explosives, the unstable materials can still present a serious hazard due to the generation of high temperatures and pressures. In some cases, the reaction may be rapid enough to approach explosive potential.

There are seven categories of self-reactive substances and mixtures. Classification is made according to the results of Test Series A to H described in part II of the UN Manual of Tests and Criteria. Self-Reactive Category A and B substances require labeling with the Exploding Bomb pictogram.

See OSHA GHS Proposal Appendix B.8 for additional information.

Organic Peroxides: The peroxide functional group (-O-O-) is relatively unstable and most organic peroxides will spontaneously decompose at a slow rate. Some organic peroxides, however, are capable of very violent reactions with detonation at environmental temperatures, causing fires and explosions.

Several organic peroxides are used in the plastics industry to initiate polymerization and serve as cross-linking agents. The characterization of the severity of the hazard is usually based upon fairly extensive laboratory testing. Examples of organic peroxides are benzoyl peroxide and alkyl hydroperoxide.

There are seven categories of organic peroxides. Classification is made according to the results of Test Series A to H described in Part II of the UN Manual of Tests and Criteria. Organic Peroxide Category A and B substances require labeling with the Exploding Bomb pictogram.

In addition to simple peroxide groups, other heteroatomic bonds may also be reactive, in particular -N-O- and -N-N- bonds, such as hydroxylamine, hydrazine, and their derivatives.

See OSHA GHS Proposal Appendix B.15 for additional information.

7. **Flame Over Circle pictogram**

Flame over Circle (Oxidizers): An oxidizer contributes or yields oxygen resulting in the combustion of other material.

Definitions

- **Oxidizing gas:** any gas which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does (i.e. pure gases or gas mixtures with an oxidizing power greater than 23.5% as determined by a test method specified in ISO 10156:2010.
- **Oxidizing liquid:** a liquid which, while in itself not necessarily combustible, may generally by yielding oxygen, cause, or contribute to, the combustion of other material.
- **Oxidizing solids:** a solid which, while in itself not necessarily combustible, may generally by yielding oxygen, cause, or contribute to, the combustion of other material.

Specific Notes

Note the similarity and differences between the oxidizer and flammable pictograms-users sometimes confuse these two pictograms

Oxidizing gas: There is one single category for this class.

See OSHA GHS Proposal Appendix B.4 for additional information.

Oxidizing liquid: There are three categories for oxidizing liquids. The three categories are defined in terms of the propensity to spontaneously ignite and/or the comparison between

the mean pressure rise time of a test mixture containing the subject chemical and cellulose, and a reference mixture.

Category 1 comprises any substance or mixture which, in the 1:1 mixture, by mass, of substance (or mixture) and cellulose tested, spontaneously ignites; or the mean pressure rise time of a 1:1 mixture, by mass, of substance and cellulose is less than that of a 1:1 mixture, by mass, of 50% perchloric acid and cellulose.

Category 2 comprises any substance or mixture which, in the 1:1 mixture, by mass, of substance (or mixture) and cellulose tested, exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture, by mass, of 40% aqueous sodium chlorate solution and cellulose; and the criteria for Category 1 are not met.

Category 3 comprises any substance or mixture which, in the 1:1 mixture, by mass, of substance (or mixture) and cellulose tested, exhibits a mean pressure rise time less than or equal to the mean pressure rise time of a 1:1 mixture, by mass, of 65% aqueous nitric acid and cellulose; and the criteria for Categories 1 and 2 are not met.

The following exclusions apply to oxidizing liquids:

- This classification does not apply to an organic substance that does not contain oxygen, fluorine, or chlorine; or the substance does oxygen, fluorine or chlorine but these elements are bonded only to carbon or hydrogen.
- This classification also does not apply to inorganic chemicals if the chemical does not contain oxygen or halogen atoms.

See OSHA GHS Proposal Appendix B.13 for additional information.

Oxidizing Solids: There are three categories of oxidizing solids. The hazard categories are distinguished based on a comparison of mean burn times of the subject chemical to various reference mixtures of potassium bromate and cellulose. Similar to oxidizing liquids above, some exclusions apply, if for example, the chemical does not contain oxygen, fluorine, or chlorine.

Category 1 comprises any substance or mixture which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time less than the mean burning time of a 3:2 mixture, by mass, of potassium bromate and cellulose.

Category 2 comprises any substance or mixture which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 2:3 mixture (by mass) of potassium bromate and cellulose and the criteria for Category 1 are not met.

Category 3 comprises any substance or mixture which, in the 4:1 or 1:1 sample-to-cellulose ratio (by mass) tested, exhibits a mean burning time equal to or less than the mean burning time of a 3:7 mixture (by mass) of potassium bromate and cellulose and the criteria for Categories 1 and 2 are not met.

The following exclusions apply to oxidizing solids:

- This classification does not apply to an organic substance that does not contain oxygen, fluorine, or chlorine; or the substance does oxygen, fluorine or chlorine but these elements are bonded only to carbon or hydrogen.
- This classification also does not apply to inorganic chemicals if the chemical does not contain oxygen or halogen atoms.

An important caveat; In the event known experience in the handling or use of a chemical shows it to be oxidizing, judgments based on known experience shall take precedence over test results.

See OSHA GHS Proposal Appendix B.14 for additional information.

8. Environment pictogram-Hazardous to the Aquatic Environment.

Environmental hazard: Those substances that pose an acute or chronic toxicity hazard in the aquatic environment.

While the GHS includes criteria on classifying chemicals for aquatic toxicity, these provisions were not adopted in the GHS Final Rule because OSHA does not have the regulatory authority to address environmental concerns. However, the "building block approach" is utilized here to provide classification and labeling guidance to support the goals of harmonization that are useful to other regulatory authorities (e.g. EPA).

See the Globally Harmonized System of Classification and Labeling of Chemicals (Rev.1 2005) at http://www.unece.org/trans/danger/publi/ghs/ghs_rev01/01files_e.html including Annexes 9 and 10 for detailed information.

Definitions

- **Acute Aquatic Toxicity**: The intrinsic property of a material to cause injury to an aquatic organism in a short-term exposure.

- **Chronic Aquatic Toxicity:** The potential or actual properties of a material to cause adverse effects to aquatic organisms during exposures that are determined in relation to the lifecycle of the organism.
- **Degradation:** The decomposition of organic molecules to smaller molecules and eventually to carbon dioxide, water and salts.
- **Bioaccumulation:** net result of uptake, transformation and elimination of a substance in an organism due to all routes of exposure (i.e. air, water, sediment/soil and food).

Specific Notes:

The harmonized system for classifying chemical substances for the hazards they present to the aquatic environment is based on a consideration of those organisms that live in the water, and the aquatic ecosystem of which they are part. To that extent, it does not address aquatic pollutants for which there may be a need to consider effects beyond the aquatic environment such as the impacts on human health etc. The basis, therefore, of the identification of hazard is the aquatic toxicity of the substance, although this may be modified by further information on the degradation and bioaccumulation behavior of the chemical.

The core part of the harmonized classification system for substances consists of three acute classification categories and three chronic classification categories. See Table 4.1.1 (a) and (b) (*Categories for substances hazardous to the aquatic environment*) of GHS Rev.4. The acute and the chronic classification categories are applied independently. The criteria for classification of a substance in categories Acute 1 to 3 are defined on the basis of the acute toxicity data only (EC50 or LC50). The criteria for classification of a substance into categories Chronic 1 to 4 follow a tiered approach where the first step is to see if available information on chronic toxicity merits long-term hazard classification. In absence of adequate chronic toxicity data, the subsequent step is to combine two types of information, i.e. acute toxicity data and environmental fate data (degradability and bioaccumulation data) (see Figure 4.1.1 (*Categories for substances hazardous to the aquatic environment*) of GHS Rev.4).

Acute Aquatic Toxicity Category 1 substances, as well as Chronic Aquatic Toxicity Category 1 and 2 substances, require labeling with the Environment pictogram.

See Chapter 4.1 of GHS Rev.4 for additional information.

9. Skull and Crossbones pictogram.

The skull and Crossbones depict substances that are allocated to one of four acute toxicity hazard categories based on the oral, dermal, or inhalation route of entry into the body. The degree of toxicity is expressed in LD_{50} (lethal dose to half of the test animals by oral or dermal exposure), or LC_{50} (lethal dose to half of the test animals by inhalation exposure). For example, category 1 substances reflect relatively higher acute toxicity hazard (and correspondingly lower LD_{50} or LC_{50} values).

Definitions

- Acute Toxicity: adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours. Acute toxicity values are expressed as (approximate) lethal dose LD_{50} (oral, dermal) or lethal concentration LC_{50} (inhalation) values or as acute toxicity estimates (ATE).
- LD_{50}: the amount of a material, given all at once, which causes the death of 50% (one half) of a group of test animals (often rats, rabbits, or mice, but can include other kinds of animals). The LD_{50} is usually expressed as the amount of chemical administered (e.g., milligrams) per 100 grams (for smaller animals) or per kilogram (for bigger test subjects) of the body weight of the test animal. The LD_{50} typically reflects oral or dermal exposure.
- LC_{50}: the concentration of a material in air that results in the death of 50% (one half) of a group of test animals following an inhalation exposure of 4 hours.
- Acute toxicity estimate (ATE): used in GHS classification to characterize the acute toxicity of a substance or ingredient in a mixture.
- Bridging principles: An important concept in the GHS used for classifying untested mixtures

a. Specific Notes

- Under the OSHA-adopted GHS, substances are allocated to one of four acute toxicity hazard categories (1-4) based on the oral, dermal, or inhalation route as shown in **Table A.1.1** of the Standard. Values in the Table are expressed in LD_{50} (oral, dermal), or LC_{50} (inhalation) or as acute toxicity estimates (ATE). Detailed notes in applying these values are included with the Table. Category 1 substances reflect relatively higher acute toxicity hazard (and corresponding lower LD_{50} or LC_{50} values).
- The Skull and Crossbones pictogram is used to depict acutely toxic hazard categories 1-3 (signal word "Danger"), while the exclamation point pictogram denotes category 4 (signal word "Warning").
- OSHA elected not to include a fifth acutely hazard category identified under GHS in the Final Rule as it felt that Categories 1-4 were sufficiently protective of safety and still consistent with harmonization objectives. Notably, OSHA does not preclude the

inclusion of information on GHS Category 5 on the chemical label or the Safety Data Sheet (SDS), allowing manufacturers or importers to utilize one label for both the workplace and consumer sector while still being compliance with the Hazard Communication Standard.

- Where possible, the preferred test species for evaluation of acute toxicity by the oral and inhalation routes is the rat, while the rat or rabbit is recommended for evaluation of acute dermal toxicity.
- OSHA takes a tiered-approach to classifying mixtures for acute toxicity dependent on the amount of information available for the mixture itself and for its ingredients; **Figure A.1.1** identifies the process that must be followed, and ATEs are calculated using the prescribed methods based on this information. The calculated ATEs are then compared and classified according to the acute toxicity hazard category values in **Table A.1.1**.
- Bridging principles: When a mixture has not been tested, but there are sufficient data on the components and/or similar tested mixtures, these data can be used in accordance with the following bridging principles:
    - Dilution: If a mixture is diluted with a diluent that has an equivalent or lower toxicity, then the hazards of the new mixture are assumed to be equivalent to the original.
    - Batching: If a batch of a complex substance is produced under a controlled process, then the hazards of the new batch are assumed to be equivalent to the previous batches.
    - Concentration of Highly Toxic Mixtures: If a mixture is severely hazardous, then a concentrated mixture is also assumed to be severely hazardous
    - Interpolation within One Toxic Category: Mixtures having component concentrations within a range where the hazards are known are assumed to have those known hazards.
    - Substantially Similar Mixtures: Slight changes in the concentrations of components are not expected to change the hazards of a mixture and substitutions involving toxicologically similar components are not expected to change the hazards of a mixture
    - Aerosols: An aerosol form of a mixture is assumed to have the same hazards as the tested, non-aerosolized form of the mixture unless the propellant affects the hazards upon spraying.

All bridging principles do not apply to every health and environmental endpoint. Therefore, each endpoint must be evaluated to determine which bridging principles and appropriate methodology apply. When the bridging principles do not apply or cannot be used, the health and environmental hazards of mixtures

41.0 LABORATORY DOOR SIGNAGE

Ball State University Laboratory Signage Policy

The Ball State University laboratory door sign program has been developed to allow personnel, students, visitors, and emergency responders to quickly identify the potential hazards present in research laboratories, laboratory classrooms, preparation areas, and chemical/biological storage rooms prior to entrance. Each laboratory and related area is to use this system to create a laboratory-specific door sign and post it on, or immediately adjacent to, the entry door(s) of the laboratory and associated rooms.

The entrance to each laboratory or space in which chemicals, biologicals, or animals are used, housed, or stored shall also be posted with emergency contact information and the names and phone numbers of the principal investigator, lab supervisor, or any other designated personnel who should be contacted in the event of an emergency. In addition, these laboratory postings must indicate the presence of certain specific hazards as identified in the template that follows, as well as any other hazards that may be present to persons in the space. Further, the signs should include the baseline protective apparel or measures to be employed when working in, or visiting, the laboratory or related space.

The EHS and ORI Offices have developed a tool and instructions for the development of signs that fulfill these standards and can be easily printed on a color printer by the individual laboratory instructors, laboratory managers, or principal investigators. Tamper-proof holders for the required signs will be provided and installed on the subject doors or entrances. The sign must be revised or replaced whenever there is a change in the hazards present in the space, the degree of hazard, or whenever any of the emergency contacts or precautions change.

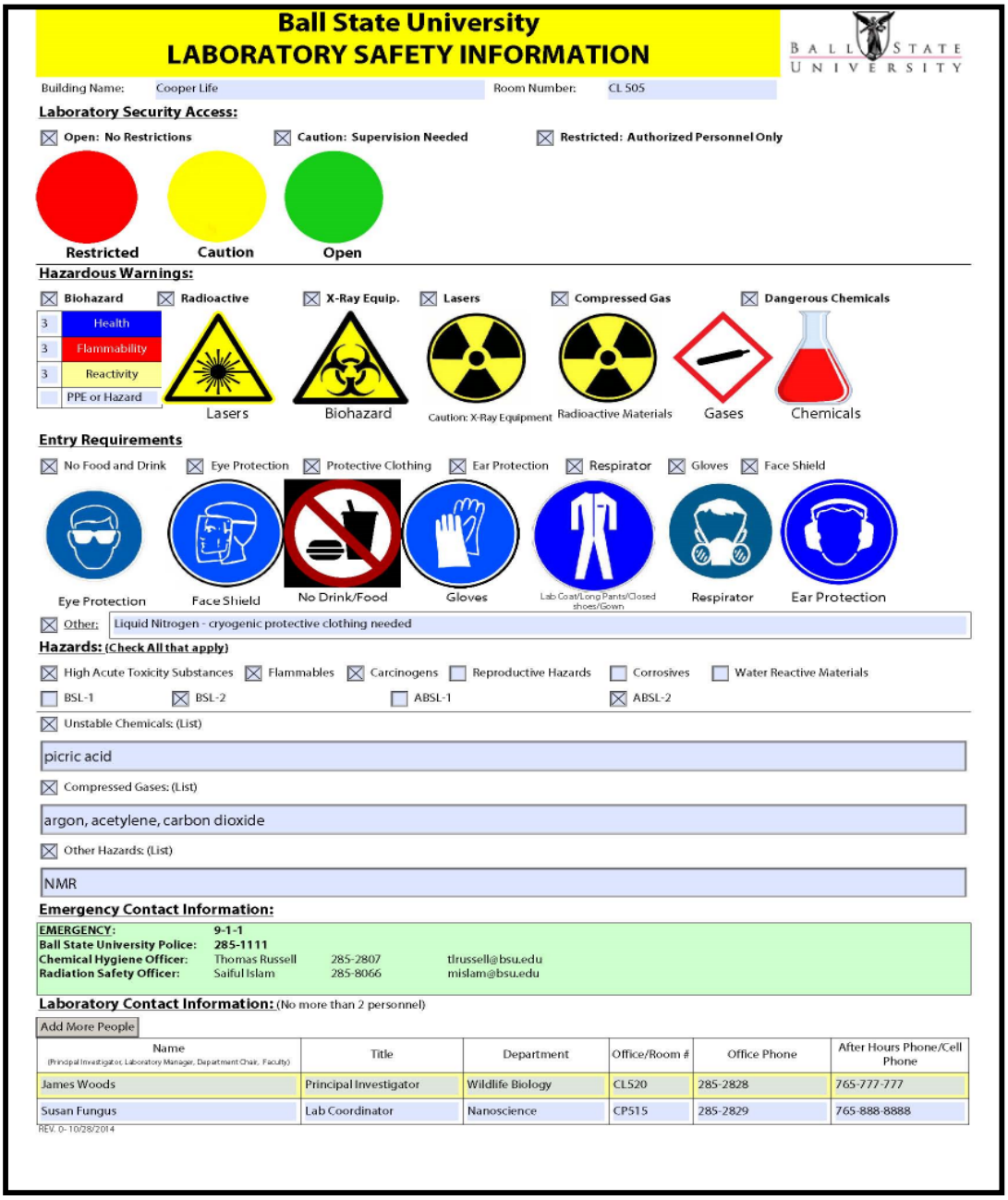
Departments that are active in the Ball State *ChemTracker* web-based chemical inventory program can easily identify the hazards presented by the materials in a particular room by generating a *Life Safety Box* report for the particular room. Contact the Environmental Health and Safety Office at 285-2807 or tlrussell@bsu.edu for any assistance with this laboratory signage standard. A detailed instruction form for completion of the laboratory signage has been made available.

INSTRUCTIONS FOR COMPLETING THE BSU LAB SIGN TEMPLATE

BSU Lab Door Signs.pdf

To <u>Begin</u>: Click on the icon to the above right and save the pdf file to your computer!

Reference Sign (All field options/symbols illustrated below)



Ball State University
LABORATORY SAFETY INFORMATION

Building Name: Cooper Life Room Number: CL 505

Laboratory Security Access:

☒ Open: No Restrictions ☒ Caution: Supervision Needed ☒ Restricted: Authorized Personnel Only

Restricted Caution Open

Hazardous Warnings:

☒ Biohazard ☒ Radioactive ☒ X-Ray Equip. ☒ Lasers ☒ Compressed Gas ☒ Dangerous Chemicals

3	Health
3	Flammability
3	Reactivity
	PPE or Hazard

Lasers Biohazard Caution: X-Ray Equipment Radioactive Materials Gases Chemicals

Entry Requirements

☒ No Food and Drink ☒ Eye Protection ☒ Protective Clothing ☒ Ear Protection ☒ Respirator ☒ Gloves ☒ Face Shield

Eye Protection Face Shield No Drink/Food Gloves Lab Coat/Long Pants/Closed shoes/Gown Respirator Ear Protection

☒ Other: Liquid Nitrogen - cryogenic protective clothing needed

Hazards: (Check All that apply)

☒ High Acute Toxicity Substances ☒ Flammables ☒ Carcinogens ☐ Reproductive Hazards ☐ Corrosives ☐ Water Reactive Materials

☐ BSL-1 ☒ BSL-2 ☐ ABSL-1 ☒ ABSL-2

☒ Unstable Chemicals: (List)

picric acid

☒ Compressed Gases: (List)

argon, acetylene, carbon dioxide

☒ Other Hazards: (List)

NMR

Emergency Contact Information:

EMERGENCY:	**9-1-1**		
Ball State University Police:	**285-1111**		
Chemical Hygiene Officer:	Thomas Russell	285-2807	tlrussell@bsu.edu
Radiation Safety Officer:	Saiful Islam	285-8066	mislam@bsu.edu

Laboratory Contact Information: (No more than 2 personnel)

Add More People

Name (Principal Investigator, Laboratory Manager, Department Chair, Faculty)	Title	Department	Office/Room #	Office Phone	After Hours Phone/Cell Phone
James Woods	Principal Investigator	Wildlife Biology	CL520	285-2828	765-777-777
Susan Fungus	Lab Coordinator	Nanoscience	CP515	285-2829	765-888-8888

REV. 0- 10/28/2014

Next Steps:

1. At the top, fill in the ***Building Name*** and ***Room Number*** fields for your laboratory;

2. Under **Laboratory Security Access** click on the phrase that applies to your lab and the appropriate colored circle will appear – only one access restriction should be chosen. If custodians or visitors are allowed without escort choose the first selection – ***Open: No Restrictions***. If custodians or others need an escort, choose the second selection – ***Caution: Supervision Needed***. If custodians, visitors, and anyone without prior authorization are not allowed choose the third section – ***Restricted: Authorized Personnel Only***. Please note that if you have lasers, powerful magnets, or chemicals that are dangerous when wet, then you MUST use the second or third phrase;

3. Under **Hazardous Warnings**, first, there are six (6) optional warning symbols each of which will appear when the corresponding box is checked. Check each of the hazard boxes for the chemicals, biologicals, radioactive materials, lasers, or other hazards that are maintained in your lab;

4. Next is the **Hazardous Material Information System (HMIS) symbol**. Directions for completing that symbol are on the last page of this Chapter. Often, you can obtain this information directly from the (Material) Safety Data Sheet (MSDS or SDS) for a particular chemical - or use your knowledge of the solution hazard(s). Use the highest (most severe) hazard number for any chemical or hazard within the lab for each of the categories. Use the PPE letter that best illustrates the PPE to be worn if entering or working in the laboratory;

5. Under **Entry Requirements**, there are seven (7) choices for restrictions or PPE to be worn in the laboratory. In all cases where hazardous chemicals or biologicals are present, the ***No Food or Drink*** symbol should be checked. The other boxes relate to hazards that may be present in the laboratory and should be checked accordingly so that the appropriate hazard warning symbols will appear;

6. Next is the **Other** line. Here, you should indicate any other entry restrictions not signified by one or more of the preceding symbols. Examples could include *fire resistant lab coats* where highly flammable liquids are in use, or *No Pacemakers* where Nuclear Magnetic Resonance (NMR) equipment is installed, required vaccinations or medical surveillance;

7. Following that optional line item, are the **Hazards: (Check All that apply)** options. You may need to refer to the *BSU Chemical Hygiene Plan* to determine whether you have any *High Acute Toxicity Substances*, *Carcinogens*, or *Reproductive Hazard* chemicals in the laboratory. Each of these are defined as *Particularly Hazardous Substances (PHSs)* by OSHA and necessitate additional precautions in use. Reference to container labels or Safety Data Sheets will also provide this information. Finally, these particular chemical hazards (PHSs) or characteristics (flammable, water-reactive) may be determined by an inventory search using ChemTracker. The second row allows you to indicate if your lab is a *Biosafety* or *Animal Biosafety* operation along with the appropriate hazard level.

8. Next are entries for any **Unstable Chemicals (list)** where peroxide formers or other highly reactive chemicals should be listed, as well as any **Compressed Gases (list)** that are present in your laboratory.

9. **Other Hazards: (List)** offers the ability to list any other health or physical hazards present in the laboratory that were not noted previously, or deserve repeated attention. An example could be equipment such as an NMR, a physical hazard such as no secondary means of escape, or chemicals requiring particular response capabilities such as hydrofluoric acid or aldehydes;

10. **Emergency Contact Information:** This section is already completed and contains the BSU emergency contact information in the event of a fire, injury, exposure, spill, or other incident in the laboratory;

11. **Laboratory Contact Information:** Here you must list a primary and secondary contact person for the laboratory. These should be persons familiar with the laboratory contents and activities and who may be contacted by emergency responders in the event of an emergency. The persons should include the laboratory manager, instructor, faculty, or Principal Investigator, and another person who may be the Department Chair or anyone knowledgeable about the chemical, biological, or physical hazards that may be present in the laboratory, prep room, or storage area. All of the columns must be completed;

12. **Print the sign** using a **Color Printer** in the portrait orientation. The edited sign may be saved for future revisions using Adobe Acrobat Reader;

13. **Place the sign** in a sign holder to be affixed on the exterior of the laboratory (or prep room or stockroom) door(s) or the wall space immediately adjacent to the entry door(s). Questions should be directed to Tom Russell in the EHS Office or John Mulcahy in the Office of Research Integrity (5-5106 or jmulcahy@bsu.edu) for assistance.

Hazardous Material Information System (HMIS)

This sign or symbol is intended to allow quick identification of the relative risks to laboratory entrants or emergency responders that are presented by the flammability, health, or reactivity characteristics of the chemicals (or biologicals or physical threats) contained in the particular laboratory. As it indicates the risks presented by the entire laboratory--rather than a single chemical--the respective boxes should reflect the most severe hazard rating(s) for any one substance stored or used in the laboratory, preparation, or store room. The bottom PPE index box may be used to supplement other symbols to follow in the BSU sign that denote the required PPE for laboratory entry.

HMIS Health Rating Chart

* Chronic Hazard	Chronic (long- term) health effects may result from repeated exposure.
0- Minimal Hazard	No signifigant risk to health.
1- Slight Hazard	Irritation or minor reversable injury possible.
2- Moderate Hazard	Temporary or minor injury may occur.
3- Serious Hazard	Major injury likely unless prompt action is taken and medical treatment is given.
4- Severe Hazard	Life-threatening, major or permanent damage may result from single or repeated exposures.

HMIS Flammability Rating Chart

0- Minimal Hazard	Materials that will not burn.
1- Slight Hazard	Materials that must be preheated before ignition will occur. Includes liquids, solids, and semi-solids having a flash point above 200° F. (Class IIIB)
2- Moderate Hazard	Materials which must be moderately heated or exposed to high ambient temperatures before ignition will occur. Includes liquids having a flash point at or above 100°F but below 200°F. (Class II & IIIA)
3- Serious Hazard	Materials capable of ignition under almost all normal temperature conditions. Includes flammable liquids with flash points between 73°F and 100°F. (Class IB & IC)
4- Severe Hazard	Flammable gases, or very volatile flammable liquids with flash points below 73°F and boiling points below 100°F. Materials may ignite spontaniously with air. (Class IA)

HMIS Reactivity Rating Chart

0- Minimal Hazard	Materials that are normally stable, under fire conditions and will not react to water, polymerize, decompse, condense or self react.
1- Slight Hazard	Materials that are normally stable, but can become unstable at high temperatures and pressures. Materials may react non-violently with water or undergo hazardous polymerization in the absence of inhibitors.
2- Moderate Hazard	Materials that are unstable and may undergo violent chemical change at normal temperature and pressure with low risk for explosion. Materials may react violently with water or form peroxides upon exposure to air.
3- Serious Hazard	Materials that may form explosive mixtures with water and are capable of detonation or explosive reaction in the presence of a strong igniting source or undergo chemical change at normal temperature and pressure with moderate risk of explosion.
4- Severe Hazard	Materials that are readily capable of water reaction, detonation or explosive decomposition at normal temperatures and pressures.

PERSONAL PROTECTION INDEX

A		G	+ +
B	+	H	+ + +
C	+ +	I	+ +
D	+ +	J	+ + +
E	+ +	K	+ + +
F	+ + +	X	Consult your supervisor or S.O.P. for "SPECIAL" handling directions

A Safety Glasses	n Splash Goggles	o Face Shield & Eye Protection	p Gloves	q Boots	r Synthetic Apron	s Full Suit
t Dust Respirator	u Vapor Respirator	w Dust & Vapor Respirator	y Full Face Respirator	z Airline Hood or Mask	Additional Information	

BALL STATE UNIVERSITY

Environmental Health and Safety Office

Tom Russell, CHMM, CCHO, REHS
Environmental Specialist
765-285-2807 tlrussell@bsu.edu

42.0 SAFETY IN BSU LABORATORIES BROCHURE AND LABORATORY SAFETY AGREEMENT AND CERTIFICATION FORM

Safety In BSU Laboratories Brochure And Laboratory Safety Agreement And Certification Forms

This chapter provides two (2) forms for general distribution and use by the BSU departments with laboratories for educational or research purposes, and are equally applicable to both employees and students. The first is a tri-fold brochure that is printed double-sided on the short edge and folded as a handout, and the second is an agreement and certification form to be signed by all employees and students, countersigned by the laboratory manager or principal investigator, certifying that the laboratory student or worker has been advised of the basic precautions, prohibitions, procedures, available resources, and safety equipment in the laboratory area.

Laboratory Safety Agreement and Certification Form

For Department Students

Department: _____

Faculty/Instructor/Principal Investigator (PI): _____

Laboratory / Course: _____ **Room:** _____

I recognize that an uninformed, unprepared, or merely careless and inconsiderate person in the laboratory hinders the learning or research process and is a real danger not only to themselves--but to others as well. I therefore acknowledge that I understand the following and agree to abide by all university rules to minimize the hazards inherent in laboratory work and that:

1. I have read the brochure, ***Safety in University Laboratories*** and understand those rules and prohibitions;
2. I understand what Personal Protection Equipment (PPE) I am required to use in this lab, its limitations, how to put on, take off, care for, and maintain this PPE. Failure to bring the required PPE or have it available may result in exclusion from the laboratory class or activity;
3. I am aware of the location and proper use of the safety equipment in the laboratory including emergency eye washes and/or showers, utility shutoffs, fire extinguishers, spill kits, etc.;
4. I am aware of emergency signals, exit locations, and emergency evacuation procedures;
5. I know the location of the chemical inventory and Safety Data Sheets (SDSs) for any hazardous chemicals I may use and how to read and understand them;
6. I will follow the research protocols or lesson plans for the laboratory and not deviate from those procedures. No unauthorized experiments or modifications of stipulated procedures will be undertaken without the consent of the instructor—this includes straying from the specified quantities or reagents in various operations;
7. I understand the necessary and proper use of engineering controls provided in the laboratory such as chemical fume hoods, biosafety hoods, general and local exhaust ventilation, chemical safety cabinets, sharps containers, biohazard or infectious waste containers, and broken glass boxes.
8. I am not to bring, consume, and/or store any food or beverage in the laboratory, research, storage, or preparation areas unless authorized to do so;
9. Chemical wastes must be disposed in proper, compatible containers that are kept closed and bear a completed LAB WASTE label. Other waste materials will be disposed as directed by the instructor using proper procedures, containers, labels, and precautions;
10. I will notify the instructor or PI of any allergies, immunological, or other concerns that may need to be addressed. If pregnant, or trying to become pregnant, I may so advise in order to minimize exposure to any reproductive hazards in the laboratory; and
11. The **penalties for violation of this Safety Agreement** in a given laboratory period are as follows:

    a. ***First Violation during a lab period: Warning***
    b. ***Second Violation during a lab period: Dismissal from that lab period with a grade of zero for that lab's experiment or procedure***
    c. ***Repeated Safety Violations: Formal disciplinary actions (Departmental and University)***

By signing below, I certify that I have read, understood, and accept the foregoing as requirements of the course, realizing that failure to adhere strictly to these precautions is sufficient reason for expulsion from the laboratory.

Full Signature: _____ Date: _____

Printed Name: _____

Faculty/Instructor/P.I. Signature: _____ Date: _____

[**NOTE:** This is a template to be revised and adopted to the needs of particular departments or laboratories]

hazards to the extent possible. Minimize hand to face contact – use local exhaust systems.
- Use lubricants, protective gloves, thick cloth and proper procedures when inserting tubing or working with glassware.
- Do not use any distracting electronic equipment in the laboratory – turn it off and put it away.
- Do not wear your PPE outside of the laboratory – it must be considered to be contaminated.
- Wash your hands whenever leaving the laboratory, changing gloves, and at least hourly.
- Safely store or locate your personal items to prevent their contamination or obstructions.
- Smell substances only as directed and only by fanning smell toward you.
- Never pipet by mouth!
- Never look into test tubes or containers from the top – only through the sides.
- To the extent possible, administrative tasks should not be performed in the laboratory work area.
- Report all injuries or exposures to the instructor immediately! *Instructor is to call the EHS Office.*

HOUSEKEEPING

- You are responsible for ensuring that a clean workspace is maintained both in your own work area and the common working areas. The lab environment should be at least as clean and orderly when you finish your work as when you began.
- Immediately clean laboratory benches or tables free of spilled chemicals or biologicals. Clean up, disinfect, or decontaminate, spills as directed by your instructor.
- Avoid physical hazards by keeping drawers and cabinets closed and benches/tables clear.
- Clean glassware, tools, and equipment before returning them to storage or for re-use.
- Prevent tripping and contamination hazards—never place materials on the floor – particularly chemicals or biologicals.
- Dispose of chemical lab wastes in compatible, closed containers bearing a LAB WASTE label.
- Broken glass should be placed in *Broken Glass* boxes – not in trash cans.
- All sharps must be placed in *Sharps* containers.
- Potentially infectious wastes must be placed in *Infectious* or *Biohazard* containers, red bags, or boxes.
- Maintain all aisles and corridors clear and exits open at all times.

The preceding are only basic laboratory safety rules and precautions and are far from complete in scope or detail. They must be supplemented by general laboratory safety training and laboratory-specific training. Please contact the Ball State EHS Office for more information on laboratory safety at 765-285-2807 or on the EHS website at: http://cms.bsu.edu/about/administrativeoffices/riskmanagement/ehs/envhealth.

The American Chemical society publication, *Safety in Academic Chemistry Laboratories* available at this link: *http://chemistry.org/committees/ccs* is a basic reference for chemical laboratory safety, as is the National Research Council, *Prudent Practices in the Laboratory:* (http://www.ncbi.nlm.nih.gov/books/NBK55878/)

Note: Any concerns by students, staff, faculty, or researchers regarding laboratory safety or integrity should be immediately brought to the attention of the laboratory instructor, manager, or principal investigator, followed by the Department Chair, if necessary. If not resolved, the BSU Chemical Hygiene Officer should be contacted at 765-285-2807, by email at tlrussell@bsu.edu, or by radio at 285-5081.
Emergency: Call 285-1111 (BSU PD) or 911.

Safety in the University Laboratories

BALL STATE UNIVERSITY

UNIVERSITY LABORATORY ACTIVITIES PRESENT HAZARDS AND RISKS!

Scientists and practitioners understand the risks involved in the laboratory and have established a set of laboratory safety practices. This guide summarizes the basic safety rules that are applied in all Ball State University laboratories.

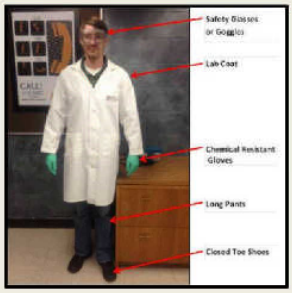
ADMINISTRATIVE PROTECTIONS

- All science laboratories and art studio or workshop entry ways are to be posted with signs that clearly identify the major safety hazards therein, access restrictions, required personal protective equipment, prohibitions, and emergency contacts. Instructors, faculty, and researchers are expected to set the example by following these guidelines.
- General laboratory safety training is to be provided by the department, school, or the EHS Office to all students, staff, faculty, and researchers prior to work in any laboratory.
- Lab-specific safety training is to be provided for the particular physical, chemical, or biological hazards present in each laboratory (location of safety equipment, chemical information, PPE use,

emergency procedures, etc.) by the lab manager, instructor, faculty, or researcher.
- An inventory of all hazardous chemicals, and access to the Safety Data Sheets (SDS) for those chemicals, must be readily available at all times.
- Access to the BSU Chemical Hygiene Plan (CHP), Standard Operating Procedures (SOPs), and specific written protocols must be available and those policies and procedures must be followed.
- All chemical and biological containers must be labeled with the identity of, and hazards presented by, the material.

PERSONAL PROTECTION

- Follow the prescribed personal protection equipment (PPE) procedures for the particular laboratory and activity. This applies to guests and any person in the lab handling or exposed to hazardous chemicals, physical, or biological hazards.



- Clothing must protect you from accidental spills or exposure. Clothes should cover the body to the extent practicable, but must include long pants and closed-toe shoes. Sandals and flip-flops, high heels or shoes made of woven materials are not allowed. Oil-resistant slip-proof soles are preferred.
- Lab coats or chemical-resistant aprons or clothing are normally required and are always advisable.
- Minimize skin and respiratory exposure.
- Eye protection is required ranging from safety glasses to chemical splash goggles, to face shields.
- Long hair must be tied back or otherwise restrained and jewelry must be removed before entering the laboratory.
- Gloves are often required in the laboratory--ensure proper fit and chemical resistance.
- Additional PPE requirements may be required including thermal protection, fire-resistant coats, puncture-resistant gloves, etc.
- If students or staffs do not have the required PPE for the laboratory or a given activity, they will be excluded from the class or participation in that educational or research activity.

LABORATORY PROTOCOL

- Your responsibility to prevent accidents in the laboratory extends to others in addition to yourself. The laboratory experience should be enjoyable but is serious--it is not a time for play. Be aware of what is happening around you and report any questionable behavior.
- Always plan laboratory work before executing it. Providing for safety and avoiding potential accidents are important elements of the plan. You must understand the hazards associated with the chemicals, biologicals, or physical apparatus before you start or continue the experiment or procedure.
- If you are unsure about the hazards, the procedures, or the protection you need, the Safety Data Sheets, the BSU CHP, the SOP, your instructor, faculty, or the researcher should be consulted. **YOU MUST ASK IF IN DOUBT!**
- Do not work alone in a laboratory without faculty or supervisor approval and other precautions.
- Always alert others before lighting a flame
- Flames are never allowed when flammable gases or liquids are in use in the space.
- Use a safety shield when working with highly reactive chemicals and mixtures.
- Label solutions / experiments, with name & date.
- Know where to find and how to use all emergency equipment (eye washes, showers, fire extinguishers, spill kits) in the laboratory.
- Never perform unauthorized experiments—especially do not scale up the procedure! Avoid deviation from the lesson plan or research protocol unless authorized by instructor.
- Be certain that you understand the proper use and operation of all laboratory equipment.
- Always assemble laboratory apparatus away from the edge of the laboratory bench.
- Always check your glassware and discard any with chips, breaks, or obvious flaws.
- Never leave experiments, flames, or running water unattended without notifying your faculty, instructor, or supervisor. Post signs to warn others. Have an approved contingency plan in the event of service interruptions.
- Use chemical fume hoods for all operations in which toxic, corrosive, irritating, or flammable chemicals are involved. *Confirm the hood is operating properly before starting your work!*
- Keep the hood sash within the safe operating height and between your face and the work and keep the work at least 6 inches inside the hood front.
- Never use flammable or toxic materials in a biosafety hood – these recirculate air to the room.
- Use proper disinfectants and exposure time for disinfecting surfaces and equipment that may be contaminated with biological agents.
- Lab doors and windows must remain closed to maintain negative pressure and proper fume hood operation.
- Ensure that you are trained and confident in the procedures, chemicals, and equipment – *if not consult your instructor first!*

PERSONAL BEHAVIOR

- Eating or drinking in a laboratory is not allowed.
- Conscious efforts must be maintained to minimize exposure to all chemicals, biologicals, and physical

43.0 RECENT POLICIES, GUIDANCE, OR ANNOUNCEMENTS

44.0 ACKNOWLEDGEMENTS AND BIBLIOGRAPHY

1. The format and much of the general content of this Chemical Hygiene Plan is derived from a template of the *Ohio State University Chemical Hygiene Plan*.

2. The pdf-fillable Chemical Inventory Form contained in Section 25.0 (Form 6) is derived from an interactive form developed by Georgetown University Medical Center.

3. *International Fire Code®*, 2006, International Code Council

4. *Prudent Practices in the Laboratory,* 1995, National Academy of Sciences

5. *NIOSH Pocket Guide to Chemical Hazards, 2007,* Centers for Disease Control and Prevention

6. Particularly Hazardous Substances Table, 2011, from Duke University EHS