University of Alabama in Huntsville

Campus Chemical Hygiene Plan

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1.0 Introduction

1.1 Purpose

The UAHuntsville is committed to protecting employees from health hazards associated with chemicals in university laboratories. Every effort is made to ensure that risks, including those from hazardous chemicals, are mitigated to an acceptable level through appropriate engineering controls, specific procedures, and policies instituted by the university. While the UAHuntsville administration has provided significant resources to ensure that the vital research performed is done in full compliance with applicable federal, state, and local regulations, the responsibility for ensuring a safe workplace must truly be a shared responsibility between faculty, staff, students, and campus environment, health and safety professionals.

The Campus Chemical Hygiene Plan (Campus CHP) was developed to maintain compliance with the OSHA Laboratory Standard. In addition to OSHA regulations, this document also presents key information on the practices and procedures that must be implemented to maintain compliance with other state, federal, and local regulations required for the use and storage of hazardous chemicals.

1.2 Background on Regulatory Compliance

The Occupational Safety and Health Act of 1970 established the Occupational Safety and Health Administration (OSHA). The mission of OSHA is to save lives, prevent injuries and protect the health of America's workers. Beginning in the early 1970s, a variety of groups and individuals representing laboratories contended that the existing OSHA standards were designed to protect workers from exposure conditions in industry and were inappropriate for the different exposure conditions in research laboratories. To correct this situation, OSHA developed a special regulatory section specific for laboratories. This standard, *Occupational Exposure to Hazardous Chemicals in Laboratories,* is often referred to as the OSHA Laboratory Standard (29 CFR 1910.1450).

The requirements imposed by the OSHA Laboratory Standard include:

- Protecting employees from physical and health hazards associated with hazardous chemicals in laboratories;
- Keeping chemical exposures below specified limits;
- Training and informing workers of the hazards posed by the chemicals used in the laboratory;
- Providing for medical consultations and exams, as necessary;
- Preparing and maintaining a written safety plan (the Chemical Hygiene Plan)
- Designating personnel to manage chemical safety.

Other agencies, including the U.S. Environmental Protection Agency, the U.S. Department of Transportation, the Alabama Department of Environmental Management, the State of Alabama Fire Marshalls Office, and the Huntsville Fire Department, also impose obligations on users of hazardous chemicals, including:

- Specific storage requirements for hazardous chemicals;
- Limitations on the quantities of hazardous chemicals;
- Handling, storage, and disposal requirements for hazardous waste, and,
- Restrictions on the shipping and transporting of hazardous chemicals.

1.3 Chemical Hygiene Plan Overview

This document, in and of itself, is not sufficient to maintain compliance with OSHA regulations. A complete Chemical Hygiene Plan for each laboratory consists of three elements:

1. **The UAHuntsville Campus Chemical Hygiene Plan (Campus CHP)**
   This document outlines roles and responsibilities for key personnel, contains policies and practices applicable to the entire campus, and provides an understanding of the applicability of various regulations to operations in a campus laboratory.
2. **The UAHuntsville *Laboratory Safety Manual* (and other guidance documents)**
   The Laboratory Safety Manual is prepared by the Office of Environmental Health & Safety (OEHS) in the Facilities & Operations Department. This contains a wealth of information including specific practices and procedures for the safe use and disposal of chemicals. The OEHS also provides guidance documents on specific topics. The *Laboratory Safety Manual*, along with the guidance documents, can be found at the OEHS website: www.uah.edu/OEHS
3. **Laboratory Specific Chemical Hygiene Plan (Laboratory CHP)**
   Each Principal Investigator must prepare a laboratory-specific Chemical Hygiene Plan that contains standard operating procedures (SOPs), personal protective equipment (PPE) requirements, engineering and administrative controls, and training prerequisites specific to their laboratory's operations.

   A template for laboratory specific CHP can be found on the OEHS website (www.uah.edu/OEHS). The template includes directions on how to complete each section. This template provides an organizational framework for ensuring that Principal Investigators are compliant with OSHA laboratory safety regulations. The Laboratory CHP template contains the following sections:

   Section 1: Personnel
   - Safety Personnel
   - Laboratory Staff and Students

   Section 2: Locations
   Section 3: Laboratory-specific Policies

1.4 Scope and Applicability

The Chemical Hygiene Plan describes the necessary protection from risks posed by the laboratory use of hazardous chemicals and is limited to laboratory settings (where small amounts of hazardous chemicals are used on a laboratory-scale on a non-production basis). All campus laboratories must comply with the elements of this plan. While certain organizations within or associated with the university have the option of adopting their own Chemical Hygiene Plans, those plans must, at a minimum, meet the elements outlined within this document and the Laboratory CHP template.

This plan does not specifically address protection needed against radiological, biological or other hazards (electrical, laser, mechanical, etc.), though elements of these may be covered in lab-specific SOPs. Questions on the applicability of this plan can be addressed to the OEHS by calling 824-2171 or via email at greenm@uah.edu. Information can also be found on the OEHS website: www.uah.edu/OEHS/ .

1.5 Implementation of the Plan

The OSHA Laboratory Standard requires the designation of personnel responsible for implementation of the Chemical Hygiene Plan. Specifically, it calls for the assignment of a Chemical Hygiene Officer (CHO). The UAHuntsville has assigned the position of Chemical Hygiene Officer to the OEHS, organizationally residing within Facilities & Operations. This individual has the responsibility for development and implementation of the UAHuntsville CHP and for ensuring overall compliance with all chemical safety regulations.

The CHO works with the UAHuntsville Laboratory Safety Committee (LSC) on the development of a campus-wide chemical safety and compliance program. The LSC approves this plan and aids in its implementation.

For laboratories on campus, the university designates the Principal Investigators as the individuals responsible for developing and implementing the Laboratory CHP for laboratories under their control. For some academic units that have developed departmental or organizational CHPs, the responsibility for developing and implementing a CHP has been designated as a departmental function and assigned to an individual or committee. Ultimate responsibility for compliance still resides with the Principal Investigator (or to an individual who has been assigned responsibility for a given laboratory). Academic units that have laboratories containing hazardous materials are encouraged to have their own safety officers to help implement their chemical hygiene plans.

1.6 Availability of the Plan

The Chemical Hygiene Plan (including the Campus CHP, Laboratory CHP and Laboratory Safety Manual) must be made readily available to employees or employee representatives.

1.7 Annual Review and Evaluation of Plan

The UAHuntsville Chemical Hygiene Officer shall review and evaluate the effectiveness of the Campus CHP at least annually and update it as necessary. The university's Laboratory Safety Committee will review and approve all changes to the plan. Updates to the CHP will be posted on the OEHS website.

For a Laboratory CHP to be useful it must reflect the work that is currently performed within the laboratory. The Principal Investigator must formally review the Laboratory CHP at minimum annually to ensure that its contents are appropriate and adequate for current operations. If changes are necessary before the review date, the Laboratory CHP must be amended and the changes approved by the respective Principal Investigator.

2.0 Roles and Responsibilities

In order to maintain an effective chemical safety program, it is important for all parties to clearly understand the responsibilities inherent in their roles. Below are assigned roles and responsibilities which are necessary to remain compliant with chemical safety regulations.

For the sake of this document, a Principal Investigator is any individual who has primary responsibility for the operations of assigned laboratory space. In most instances this will be a UAHuntsville faculty member. In some instances a facility director or department chair may assign the responsibilities outlined in this plan to a member of the academic staff (e.g., a supervisor of an instrumentation laboratory can be considered a Principal Investigator for the purposes of this plan).

2.1 Director, Environment, Health & Safety Department

The Director of OEHS will provide the necessary staffing and resources for maintaining an effective Chemical Safety Program.

2.2 University Chemical Hygiene Officer

The university Chemical Hygiene Officer (CHO) has the primary responsibility for ensuring implementation of the campus CHP and overall compliance with chemical safety regulations. The CHO will:

- Review and update the Campus CHP;
- Maintain and update the UAHuntsville *Laboratory Safety Manual* and other guidance documents;
- Facilitate the campus community's understanding of, and compliance with, required chemical health and safety regulations;
- Provide technical guidance to Principal Investigators on the development and implementation of Laboratory CHPs;
- Provide guidance for the safe handling, storage, and disposal of chemicals used on campus;
- Facilitate waste minimization by redistributing surplus chemicals; and,
- Facilitate efforts to implement processes that are environmentally friendly.

2.3 Office of Environmental Health & Safety Department (OEHS) Staff

The OEHS staff will have extensive expertise covering all areas of safety and compliance. OEHS personnel will:

- Develop, implement, and manage a comprehensive safety program for the university;
- Develop campus safety policies in conjunction with the appropriate campus faculty committees;
- Develop and prepare safety training specific to laboratory operations;
- Inspect laboratories and identify hazards and issues of non-compliance;
- Inspect campus safety showers, eyewash stations, and fire extinguishers annually to ensure their proper operation;
- Coordinate campus chemical emergency response with the Huntsville Fire Department's Hazardous Incident Response Team; and
- Maintain website containing easily accessible information, guidance, forms, etc.

2.4 Principal Investigator

The Principal Investigator has the primary responsibility for providing a safe work environment and for ensuring compliance with all elements of the Campus and Laboratory CHPs within their own assigned laboratory space. While the Principal Investigator can delegate health and safety responsibilities to a trained and knowledgeable individual (referred to as the Laboratory Chemical Hygiene Officer), the Principal Investigator must ultimately assure that the duties are performed. The Principal Investigator must:

- Develop and implement the Laboratory CHP;

- Approve SOPs, ensuring that PPE, engineering controls, and administrative controls described within the SOPs provide adequate protection to staff;
- Maintain compliance with federal, state, and local regulations related to the use of hazardous chemicals in their laboratory (as outlined in this document);
- Provide access to MSDSs, CHP, and other safety-related information for laboratory staff;
- Ensure that workers understand and follow the chemical safety policies, practices, and regulations related to their laboratory's operation;
- Assess individual roles of their staff and hazards associated with those roles;
- Ensure that PPE and required safety equipment are available and in working order and that laboratory staff is trained in their use;
- Determine training needed for laboratory workers based on their duties and tasks and ensure appropriate training has been provided. While OEHS provides some general instruction, training on laboratory-specific operations must be provided;
- Ensure that staff is knowledgeable on emergency plans, including fires, equipment failure, and chemical spills;
- Complete and keep the Laboratory Emergency Door Card up to date;
- Conduct regular chemical hygiene inspections and housekeeping inspections, including inspection of emergency equipment;
- Correct any unsafe conditions identified within the laboratory through either self-inspections or inspections by OEHS or other authorized safety professionals;
- Maintain documentation on training, exposure monitoring, approvals, and other safety related issues, as outlined in this document;
- Ensure proper disposal of hazardous materials according to university procedures;
- Contact OEHS on any lab-related injury or significant exposure; and
- Submit accident reports to Office of Counsel, Risk Management as soon as possible and within two calendar days of the incident.

2.5 Laboratory Personnel

The individuals working under the supervision of the Principal Investigator must:

- Follow campus and laboratory practices, policies, and SOPs and as outlined in the Campus and Laboratory CHPs;
- Attend all safety training as required by the Principal Investigator;
- Perform only procedures and operate only equipment that they have been authorized to use and trained to use safely;
- Check relevant information on the chemical reactivity and physical and toxicological properties of hazardous materials (such as the Material Safety Data Sheet or the *Laboratory Safety Manual*) prior to use of the material;
- Have knowledge of emergency procedures prior to working with hazardous chemicals;
- Incorporate safety in the planning of all experiments and procedures;

- Use the personal protective equipment and hazard control devices provided for his/her job;
- Routinely check that engineering controls are functioning;
- Ensure that equipment is safe and functional by inspection and preventative maintenance, including glassware, electrical wiring, mechanical systems, tubing and fittings, and high energy sources;
- Keep work areas clean and orderly;
- Avoid behavior which could lead to injury;
- Dispose chemical/hazardous waste according to university procedures;
- Report incidents involving chemical spills, exposures, work-related injuries, and illnesses or unsafe conditions to Principal Investigator; and,
- Consult with the Principal Investigator or with OEHS staff on any safety concerns or questions.

2.6. UAHuntsville Laboratory Safety Committee

The UAHuntsville Laboratory Safety Committee is comprised of university faculty and staff drawn from many organizations and departments. The Lab Safety Committee will:

- Develop, review, and approve campus policies on issues related to the purchase, use, storage, and disposal of chemicals;
- Review compliance with campus policies and recommend methods to promote compliance;
- Periodically review laboratory safety issues in OEHS publications and on its web site, including reviews of the Campus Chemical Hygiene Plan;
- Collaborate with other institutional committees to assure that laboratory safety concerns are properly addressed;
- Evaluate the broad needs for an effective campus-wide chemical safety program;
- Provide a forum for the campus community to raise concerns regarding the safe use, handling, and disposal of chemicals and assist in the resolution of disputes regarding chemical safety issues; and
- Review and approve the Campus CHP.

3.0 General Laboratory Rules and Policies

The UAHuntsville Laboratory Safety Committee has the ability to develop, review, and approve campus policies on issues related to the purchase, use, storage, and disposal of chemicals. All university personnel are subject to these policies in addition to federal state, and local regulations and codes.

Each Principal Investigator has the right to set polices for laboratories under their control as long as these are, at a minimum, compliant with regulations and campus-wide policies. Laboratory specific policies should be included in the Laboratory CHP.

The following general policies apply for all laboratory operations involving hazardous chemicals:

> *It is university policy* that appropriate PPE must be worn at all times. At a minimum, close-toed shoes and safety glasses must be worn whenever hazardous chemicals are present in the laboratory.
>
> *It is university policy* that no eating and drinking is allowed in laboratories where hazardous chemicals are present.
>
> *It is university policy* that unnecessary exposure to hazardous chemicals via any route will be avoided through proper use of engineering controls, personal protective equipment, and administrative controls.
>
> *It is university policy* that good housekeeping practices be upheld in all laboratories and that all passageways, exits, utility controls, and emergency equipment remain accessible at all times.
>
> *It is university policy* that any procedure or operation identified by laboratory or OEHS staff as imminently dangerous (i.e., the operation puts individuals at immediate serious risk of death or serious physical harm) must be immediately stopped until corrective action is taken.

The *Laboratory Safety Manual* also provides general laboratory safety rules as well as recommendations for safe work practices. Additional university policies are outlined in subsequent sections of this document.

4.0 Hazardous Chemical Identification and Control

4.1 Risk Assessments

Many chemicals can cause immediate health problems as well as long-term health effects. Examples include carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. Hazardous chemicals can also pose inherent physical dangers (such as flammable and combustible liquids, compressed gases, and unstable and water-reactive materials). The UAHuntsville is committed to minimizing worker exposure to the hazards imparted by use of hazardous chemicals and takes a risk-based approach in determining means of mitigating risk taking into account the characteristics of the chemical, the amounts used, the method in which a chemical is used, and the location.

The university requires that each Principal Investigator review all operations involving laboratory use of hazardous chemicals and implement control measures commensurate with the risk. Control measures include personal protective equipment (gloves, eye protection, respirators, etc.), engineering controls (such as fume hoods, glove boxes, intrinsically safe hot plates, etc.), and administrative controls (such as policies against working alone or other laboratory policies). OEHS provides tools to perform this risk assessment, including the *Laboratory Safety Manual* and other guidance documents. Additionally, OEHS staff can provide consultation services if there are any questions on this process.

4.2 Exposure Limits

It is the responsibility of the Principal Investigator to insure that laboratory staff members have knowledge of the exposure limits applicable to the chemicals that are used within the lab. OSHA has the regulatory authority to set specific air exposure limits for chemicals. These Permissible Exposure Limits (PELs) are listed in 29 CFR 1910.1000
For substances that do not have an exposure limit specified in the OSHA standards, UAHuntsville will accept the recommendations of the American Conference of Governmental Industrial Hygienists (ACGIH) for threshold limit values (TLVs).

While the published PELs and TLVs are enforceable, they were not created with a university laboratory setting in mind. The published ACGIH exposure limits, like the PELs, are levels to which it is believed nearly all workers may be exposed during a 40-hour work week over a working lifetime without harmful effects. Most laboratory workers perform non-routine operations over a short time span. In these instances short- term exposure limits are often more appropriate. Many chemicals do not have any published exposure limits. It is the university's policy, therefore, that all prudent steps will be taken to reduce exposures beyond what is legally required or, when there is no legal requirement, to minimize exposure by reasonable actions. See **Appendix A** on finding and interpreting OSHA PELs and ACGIH TLVs.

4.3 Personal Protective Equipment (PPE)

Exposure to hazardous chemicals can normally be minimized, if not eliminated, through proper selection of PPE. Typical examples of PPE include safety goggles, safety glasses, lab coat, gloves, and respirators. The Principal Investigator has the primary responsibility to determine the appropriate PPE and ensure that the PPE is made available. Details are important. If respirators are required, specific types of respirators must be indicated. The same is true for gloves – chemical compatibility plays a major role in determining the type of glove (e.g., latex, nitrile, vinyl). The *Laboratory Safety Manual* provides guidance on PPE choices. Additional information can be found on Material Safety Data Sheets, which often provide information on the proper choice. The OEHS can provide assistance on proper choice for PPE.

While close-toed shoes and safety glasses are the minimum PPE requirements for all laboratories containing hazardous chemicals, the PPE required for specific procedures and tasks should be reflected in the Laboratory CHP which is one of the primary tools for informing laboratory workers of the necessary protective clothing. The Standard Operating Procedure (SOP) templates available on the OEHS website provide a means to document the requirements.

It is recommended that prescription safety glasses be required to perform your work. The safety glasses provide frontal protection only from such hazards as flying particles encountered in woodworking, machine metal work, general warehouse, stock clerk, dock work, brush cleaning, etc. Side shields, which are necessary for side protection from flying particles, are available with the glasses. These do not provide adequate eye and face protection from chemical splash or fumes. Contact OEHS at 824-2171 if additional information is needed.

4.4 Engineering Controls

As stated above, a primary goal of chemical safety efforts is to minimize the potential for exposures. The PPE requirements discussed above are common ways to minimize risk. Often a more direct way of reducing exposure can be accomplished by isolating the source or removing contaminants through various ventilation methods. Engineering controls should be implemented within the laboratory whenever practical to minimize exposure to hazardous chemicals.

By far the most commonly used engineering control used in laboratories is the chemical fume hood. Fume hoods are especially effective when handling gases, vapors, or powders. Laboratory workers rely heavily on these, often while performing the most hazardous tasks. Section 4.4 of the *Laboratory Safety Manual* provides information on the proper us of fume hoods.

Due to the importance placed on fume hoods some key requirements are emphasized below:

- Laboratory workers must understand how to properly use chemical fume hoods. Principal Investigators need to ensure that workers have received the proper training, and document that training for laboratory safety records.
- Details of chemical fume hood use, maintenance, and annual testing can be found in the UAHuntsville *Laboratory Safety Manual* under the "Fume hoods and other Engineering Controls" heading.
- Fume hood inspection, testing, and maintenance are performed annually by the UAHuntsville Facilities & Operations Maintenance Division. After inspection, a certification sticker is affixed to each fume hood, which lists the most recent certification date. Fume hoods with a certification date greater than one year must be put out of service until recertification is complete (if fume hood inspection date is more than one year old, contact wodesk@uah.edu for recertification or 824-6480).
- Fume hoods must be tested prior to any hazardous operations. In many instances, fume hoods are alarmed and provide an audible warning when the air flow is outside normal parameters. If the fume hoods are not working properly in the laboratory, chemicals in the hood should be secured and the work stopped. Contact the Facilities & Operations Work Order Desk at

wodesk@uah.edu or 824-6480 if any issues with the fume hoods have been detected.

- Fume hood alarms should never be disarmed without first consulting with the OEHS and contacting wodesk@uah.edu.

Other ventilation methods, including general room ventilation, point-source, and gas cabinets also provide protection to workers. Glove boxes, glove bags, pressure relief valves, automatic shut-offs, and air monitors are also routinely used on campus.

Due to the reliance placed on these engineering controls, laboratory personnel need to incorporate regular inspections and/or testing of the controls into their standard operating procedures to ensure proper operation. This may be as simple as testing that air is flowing or gauges are working. Some controls are more complicated and may require routine maintenance or calibration by outside vendors.

4.5 Particularly Hazardous Substances (PHSs)

OSHA regulations require that provisions for additional employee protection be made for work with particularly hazardous substances (PHSs). These include carcinogens, reproductive toxins, and substances that have a high degree of acute toxicity. As part of the required risk assessment for any work involving hazardous materials, all PHSs must be identified by the Principal Investigator or laboratory worker designing the experiment or procedure. (Note: see **Appendix B** for more information on PHSs). Use of any PHS requires:

- Establishment of a designated area;
- Use of appropriate containment devices such as fume hoods or glove boxes;
- Procedures for safe removal of contaminated waste; and
- Decontamination procedures.

The room or area where work with PHS is performed must be posted with a ***Designated Area*** sign; sign samples in MS Word and PDF formats can be found on the OEHS website. The posting of an established "designated area" identifies areas of higher health risk. In many laboratories it is appropriate to establish the entire room as a "designated area" whereas in other laboratories a workbench or fume hood is more appropriate.

The controls used to minimize exposures to PHSs must be documented in the Laboratory CHP. The Standard Operating Procedure (SOP) templates found in the Laboratory CHP template provide a means to document the controls.

4.6 Prior Approvals

The nature of the work performed in laboratories on campus varies widely. Principal Investigators are relied upon to perform (or at minimum review) a risk assessment of all activities involving hazardous substances. Certain procedures may be considered hazardous enough that these should only be performed with prior approval of the Principal

Investigator. While typically these may involve work with PHS, other procedures, such as those involving pyrophoric, highly reactive or flammable compounds, may appropriately fall within this category.

The UAHuntsville allows the Principal Investigator to make the determination if a procedure needs prior approval. The Standard Operating Procedure (SOP) templates available on the OEHS website provide a means to document whether a specific procedure requires prior approval. Additionally, within the Laboratory CHP a section has been devoted to documentation of approvals.

5.0 Hazard Communication

One of the key requirements in OSHA chemical safety regulations is the communication of the potential hazards to which a worker may be exposed. This section describes UAHuntsville policies for meeting these requirements.

5.1 Chemical Hygiene Plans

OSHA regulations require the development of a Chemical Hygiene Plan, which 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 that particular workplace. The Campus CHP and *Laboratory Safety Manual* meet many of the requirements. However, work practices are laboratory specific and the university requires that Principal Investigators prepare the Laboratory CHP in order to be in full compliance. Additionally, the entire CHP (including the Campus CHP, the Laboratory CHP, and the *Laboratory Safety Manual*) must be readily available to laboratory workers and worker representatives. These documents should be placed in a location that are readily accessible to all workers or made available electronically (such as on the internet or hard drive).

5.2 Material Safety Data Sheets and Other Safety Information

A Material Safety Data Sheet (MSDS) is prepared by manufacturers and summarizes the physical and chemical characteristics, health and safety information, handling, and emergency response recommendations related to their products. An MSDS should be reviewed before beginning work with a chemical in order to determine proper use and safety precautions. OSHA regulations require that once a chemical is present in the laboratory the MSDS must be made available, either electronically or as a hardcopy. Personnel must have ready access for reference in the case of emergencies. The International Fire Code (IFC) which has been adopted by the Huntsville/Madison County Fire Department (HFD) also states that MSDSs shall be readily available on the premises.

MSDSs alone may not provide sufficient information on the hazards of a chemical. Laboratory personnel should review other sources of information on the chemical, such as the chemical literature or references on safe handling of chemicals such as National Research Council's *Prudent Practices in the Laboratory*. These resources should be made available to laboratory staff.

5.3 Exposure Monitoring Results

In certain instances UAHuntsville OEHS may measure laboratory worker exposure to a chemical regulated by a standard. The Principal Investigator must, within 15 working days after the receipt of any monitoring results, notify the laboratory staff of these results in writing either individually or by posting results in an appropriate location that is accessible to employees. A section of the Laboratory CHP has also been delegated to the documentation of these results. Additional information on exposure monitoring is provided in Section 12.0.

5.4 Labeling Chemical Containers

All containers must be labeled as to their contents. Manufacturer labels on chemical containers shall not be removed or defaced. Chemicals received from outside vendors or from departmental stockrooms will have labels indicating the chemical identity and common name, if applicable, with other physical and chemical data. Toxicity warning signs or symbols should be prominently visible on the labels. Waste containers must be labeled as to all relevant contents, the hazardous ingredients and the solvents or absorbent materials. Labeling as “solid waste” or “liquid waste” is not sufficient.

Frequently, small quantities of chemicals are dispensed from the original shipping container to a smaller container. Any container that may be used by more than one person or that will contain the chemical for more than one day, regardless of who uses the container, must be labeled. Label information must include:

- The chemical name;
- The primary hazard(s);
- The responsible person; and
- The date.

If such chemicals are dispensed into a secondary container for the sole, immediate use of the person dispensing the chemical, and will be consumed over the period of a single day, the container must still be labeled with the chemical name and user. Chemical mixtures or special chemicals are often prepared in the laboratory. Containers of these chemicals must be marked with the chemical name(s), primary hazard(s), and person responsible for the preparation, and date.

It is acceptable to use one label for a rack containing individual vials of similar chemicals.

5.5 Laboratory Emergency Management Door Signs

Hazard communication is not only necessary for providing laboratory workers necessary information on the hazardous chemicals present, but also be provided to first responders in the event of an emergency. The HMCFD relies on the Laboratory Emergency Management Door Signs to provide valuable information and these cards are required by fire code. Emergency responders need to know the hazards before entering a laboratory. OEHS requires that the cards be, at a minimum, reviewed annually and updated in the event of any change in the information. Door cards can be obtained by contacting OEHS at 824-2171.

6.0 Chemical Storage and Inventory

Use and storage of hazardous chemicals is regulated by federal, state, and local regulations. These regulations include OSHA worker protection standards, emergency response and planning regulations and local building and fire codes. Each of these place limitations on how much materials can be used, where they can be used or stored, or require information on inventory to be available for emergency planning and response.

6.1 Chemical Storage and Use Limits

The university is subject to the International Fire Code (IFC), by virtue of its adoption by the State Fire Marshall, as well as the International Building Code (IBC) as the State of Alabama has adopted the 2006 version. HMCFD also enforces sections of the National Fire Protection Association (NFPA) standards since these have been adopted by IFC reference. Finally, OSHA 29 CFR 1910.106 "*Flammable and Combustible Liquid*s" is also enforceable. Together, these place limitations on use and storage of compressed gases, cryogenic fluids, highly toxic and toxic materials, flammable and combustible liquids, and water reactive solids, to name a few. The HMCFD performs routine inspections of buildings and has the authority to cite any situation that they deem in violation of the relevant codes.

The allowable quantities (both in use and in storage) per 2009 IFC are presented in tables found in **Appendix C**. Allowable quantities are based on control areas, defined as "spaces within a building which are enclosed and bounded by exterior walls, fire walls, fire separation assemblies and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the exempt amounts are stored, dispensed, used or handled." Although the code limits appear straightforward, application of the code can be more complicated due to the following:

- While quantities are based on control areas, these may consist of more than one laboratory and the boundary of a control area is not obvious;
- Building features, such as the presence of sprinklers, can affect the allowable quantities;
- The quantities allowed are also dependent on the specific floor the laboratory is located. Generally, the higher the floor level the lower the allowable quantity per control area. Also the number of control areas tends to decrease; and,
- Changes to the fire codes are not always retroactively applied to existing structures.

Due to the complexities of the standards and the university's need to remain compliant with these regulations it is the university's policy that every effort be made to minimize the quantity of hazardous chemicals within the campus laboratories.

In addition to the IFC limits, other limitations to storage and use apply. Below are some of the key policies and code requirements for storage of chemicals at UAHuntsville. This list is not comprehensive and does not include many of the prudent safety practices included in Laboratory Safety Manual or the guidance documents found on the OEHS website (www.uah.edu/OEHS/).

Flammable Liquids:
In addition to the IFC code requirements, the following university limits have been set (in instances in which the building limits are more stringent, those limits will apply):

- No more than ten (10) gallons of flammable liquids per typical laboratory may be stored outside a flammable storage cabinet (with the exception of materials stored in approved safety cans). Exception can be made by the Chemical Safety Office for larger laboratory suites, though this cannot exceed fire code limits;
- Further limitations are placed on the quantities that can be placed in an individual container based on the type of container (glass, metal, etc.). See Table C2 in **Appendix C**; and
- Flammable liquids, if they need to be refrigerated, must be stored in laboratory-safe refrigerators. All the electrical components in this type of refrigerator are outside the refrigerator. UL-approved laboratory–safe refrigerators can be purchased. Refrigerators that are not laboratory-safe can be altered if modifications and signage in NFPA 45 *Standard on Fire Protection for Laboratories Using Chemicals* are used but modifications must be performed by a trained electrician. Contact the OEHS for more information.

Gas Cylinders:
In order to ensure safe use and storage, gas cylinders must be:

- Stored within a well-ventilated area, away from damp areas, salts or corrosive atmospheres, and away from exit routes;
- Stored in an upright position with full cylinders separated from empty cylinders;
- Secured with a chain or appropriate belt above the midpoint but below the shoulder. Laboratory cylinders less than 18" tall may be secured by approved stands or wall brackets;
- Capped when not in use or attached to a system (if the cylinder will accept a cap);
- Kept at least 20 ft. away from all flammable, combustible or incompatible substances. Storage areas that have a noncombustible wall at least 5 ft. in height and with a fire resistance rating of at least 30 minutes may be used to segregate gases of different hazard classes in close proximity to each other; and,

Cryogenic Liquids:

- Storage areas for stationary or portable containers of cryogenic fluids in any quantity must be stored in areas with adequate mechanical ventilation or natural ventilation. If it can be demonstrated that there is no risk of oxygen depletion or harmful vapors then ventilation is not required upon OEHS approval.
- Indoor areas where cryogenic fluids in any quantity are dispensed must be ventilated in a manner that captures any vapor at the point of generation. If it can be demonstrated that there is no risk of oxygen depletion or harmful vapors then ventilation is not required upon OEHS approval.

More comprehensive guidance can be found in the *Laboratory Safety Manual* and other documents on the OEHS website or by contacting OEHS at 824-2171.

6.2 Chemical Compatibility and Safe Storage

In addition to chemical storage limitations imposed by regulations and codes, the Principal Investigator is responsible for following prudent storage practices of chemicals. This includes separating incompatible chemicals and disposing of unstable compounds (such as peroxide formers) after their indicated expiration date. Chemicals must be grouped according to their hazard category (i.e. acids, bases, flammables, corrosives, etc.). Chapter 4 and Appendix F of the *Laboratory Safety Manual* outline the principles that need to be followed.

6.3 Chemical Inventories

As stated throughout this document, the university is subject to numerous regulations above and beyond the OSHA Laboratory Standard. Below are some of the codes and regulations requiring that laboratory staff have knowledge of their chemical inventories

Emergency Planning and Community Right-to Know Act (EPCRA) EPCRA is a federal statute that requires all entities that store, use or process hazardous chemicals to report this information to the State Emergency Management Agency and Local Emergency Planning Committees and in some cases the local fire department. EPCRA has four major provisions which are largely independent of each other and involve different chemical lists with different threshold reporting quantities.

Department of Homeland Security (DHS) Chemicals of Interest
The DHS has issued regulations related to security of high risk chemical facilities. These regulations were released in 2007 required facilities to determine if they have specific chemicals above screening threshold quantities. 300 chemicals (and respective thresholds) were identified. While most of the thresholds were set at thousands of pounds, some of the threshold amounts were significantly lower.

The university completed the initial security screening but must report any change to DHS.

Huntsville / Madison County Fire Codes
The HMCFD requires entities that use hazardous materials to maintain inventories and to provide them upon request.

While maintaining a complete inventory of chemicals is highly recommended (it prevents unnecessary purchases and reduces inventory), ***at a minimum****, Principal Investigators must maintain an up-to-date chemical inventory for the following:*

- All quantities of Class IA flammable liquids;
- Class IB and IC flammable liquids greater than 100 milliliters;
- Water reactive chemicals in quantities greater than 50 grams;
- All organic peroxides, unstable compounds, and pyrophoric compounds;
- All gas cylinders;
- Highly toxic materials greater than 50 grams;
- Corrosive liquids greater than 2 liters;
- All EPCRA extremely hazardous substances listed in Appendix D.
- All DHS Chemicals of Interest listed in Appendix D.

Appendices B and C have information that would be useful in determining whether a chemical would fall under the inventory requirement. NFPA fire diamond information commonly available can also help. Liquids with a flammability rating of 3 are considered Class IB and IC liquids while those with a flammability rating of 4 are Class IA. If in doubt whether a chemical would fall under one of the above categories, then maintain it on your inventory. Inventories must be made available to the OEHS upon request.

7.0 Chemicals and Drugs Used to Illicit a Biological Response

Use of FDA-approved drugs or experimental drugs in a clinical setting is outside the purview of this document. However, the safe handling and use of drugs in a laboratory setting must be described in the lab-specific CHP if the drug has the characteristics of a hazardous chemical or is a carcinogen and is in a form that has the potential to lead to an exposure. More broadly, *usage of any hazardous chemical for the purpose of eliciting a biological response must be covered by the Laboratory CHP.*

For animal experiments involving hazardous chemicals, it is the responsibility of the Principal Investigator to provide hazard communication information to Institutional Animal Use and Care Committee. This information will include, at a minimum:

- Identity of the chemical;
- Hazards associated with the chemical;
- Means that one should take to minimize exposure, including PPE and engineering controls;
- Location of MSDSs;
- First aid response in the event of an exposure.

8.0 Drug Enforcement Agency (DEA) Scheduled Drugs

The Congress of the United States enacted into law the Controlled Substances Act (CSA) as Title II of the Comprehensive Drug Abuse Prevention and Control Act of 1970. Use of controlled substances in animal research is common in animal research where pain medication is required.

Use of controlled substances for research requires obtaining both federal (DEA) and state registration. Penalties for using such drugs without proper registration can be severe. The regulations strictly limit who can handle or administer the drugs and imposes both physical security requirements as well as inventory requirements. Some key points concerning the regulations:

- The permitting process is between an individual researcher and the DEA and State;
- Registrants cannot share controlled substances with non-registered users who are not under their supervision (e.g., another research laboratory in their department);
- Possession of expired drugs also poses a risk to researchers from the USDA since administration of expired controlled substances is not allowed; and,
- Disposal is also strictly regulated. Only the DEA Special Agent in Charge can authorize the disposal of controlled substances.

OEHS has no role in the permitting process, though it can provide limited guidance upon request. In certain instances the DEA may request that the registrant provide a letter stating that sewer disposal of a substance is acceptable by the Huntsville Water Pollution Control Engineer. If the OEHS determines that the drug can be sewered it can provide this letter to the researcher.

The IAUCC should be consulted on the use of controlled substances with animals.

9.0 Surplus Chemicals and Hazardous Waste

The Resource Conservation and Recovery Act (RCRA), enacted in 1976, is the principal Federal law in the United States governing the disposal of hazardous waste. RCRA is administered by the U.S. Environmental Protection Agency (EPA). In Alabama the hazardous waste regulations are found in Chapter 335.14 "*Hazardous Waste Generator Standards.*"

The university strives to maintain compliance with all regulations regarding hazardous wastes while at the same time minimizing waste by a number of programs. Our waste minimization efforts include chemical recycling and inventory reduction programs.

9.1 On-Site Hazardous Materials Management (OSHMM)

The OEHS operates the university's Hazardous Materials Management program. Through the program, UAHuntsville OEHS staff will come directly to laboratories to remove those items that can be redistributed, require a more complex disposal procedure or require disposal at a commercial hazardous waste treatment, storage and disposal facility. Most materials picked up are considered to be surplus chemicals and are not designated as waste until OEHS staff has made this determination. The main exceptions are the materials placed in the waste solvent carboys as well as used silica gel (commonly used for chromatography). These materials are considered hazardous waste at the time of generation.

The OEHS website provides detailed information on how to request a chemical pick-up, the documentation that needs to be completed prior to the pick-up, and how materials should be packaged for pick-up.

9.2 In-Lab Chemical Management

As part of the chemical disposal process, Principal Investigators and laboratory staff are allowed to perform In-Lab Chemical Management of their inventories. In-Lab Chemical Management includes simple disposal and treatment methods that can be done in a lab, such as solvent commingling, flushing down the sanitary sewer (for non-hazardous chemicals), and neutralization. Approved disposal procedures are described in detail in *the Laboratory Safety Manual*. The OEHS gives advice regarding the disposal of specific chemicals and wastes and, in some cases, can demonstrate treatment and neutralization procedures. Follow the chemical disposal procedures in Chapter 7 and **Appendix A** of the *Laboratory Safety Manual*, including the In-Lab Chemical Management Procedures.

Sanitary Sewer Disposal

The EPA does not allow the university to sewer hazardous waste. Hazardous waste is usually classified as belonging to one of two groups: (1) characteristic hazardous waste (ignitable, corrosive, reactive or toxic) or (2) listed hazardous waste (K, F, P, U are the four lists published by EPA). However, the university is able to perform elementary neutralizations and dispose of the product in the sanitary sewer and sewer disposal of non-hazardous chemicals by complying with the Huntsville Water Pollution Control Board and the university's agreed criteria for the environmentally sound disposal of laboratory chemicals.

It is essential that materials being sewered are water soluble and completely dissolved before going into the sink drain. Huntsville Water Pollution Control Board ordinances emphasize that materials that damage the pipes (corrosive), create an unsafe atmosphere (ignitable or toxic) in the line access points, block flow or interfere with the treatment process are prohibited. The OEHS must be contacted to gain approval for sewering any laboratory wastes.

Satellite Accumulation Areas

Federal regulations allow a waste generator to accumulate as much as 55 gallons of non-acute hazardous waste or one quart of acutely hazardous waste in containers at or near any point of generation and under the control of the operator. These storage locations are referred to as "Satellite Accumulation Areas" or SAAs. Each laboratory is allowed one SAA. Requirements for laboratories maintaining SAAs include the following:

- There is no limit on the amount of time to accumulate the waste. However, once the 55 gallon limit is met, the laboratory staff has 72 hours to have the container transferred to the university's hazardous waste storage area.
- Containers must be marked with the words "Chemical Waste" and with other words that identify the contents and the quantity of each in the containers. The labeling must comply with labeling requirements of hazardous chemicals in the lab.
- Containers must be kept closed, except when adding/removing waste and must be handled in a manner that avoids ruptures and leaks. There must be no spill material on or around the containers.
- Personnel who generate waste or work in satellite accumulation areas need to be trained in waste handling and management, emergency procedures and other topics specific to that area. Typically this level of training is laboratory-
- specific and should be held in conjunction with other required training (see the
- Laboratory CHP template).

Non-halogenated solvent waste must be collected separately from halogenated waste. While 55 gallons are allowed per SAA other regulations, such as the fire codes may impose further limits on the number of carboys that can be stored in the laboratory.

9.3 Laboratory Clean Outs

The OEHS will perform laboratory clean outs on a set schedule and upon request. These provide opportunities for old and expired chemicals that may pose unnecessary risk to be removed. Contact the CHO for more information.

9.4 Surplus Chemical Redistribution

The UAHuntsville chemical redistribution program tries to reduce the volume of unused chemicals being disposed as waste. OEHS will deliver these surplus chemicals to your laboratory for free. After surplus chemicals are collected a chemist examines them to determine that they are not degraded and are still useful for research. If so, OEHS will redistribute such chemicals to another campus laboratory. All redistributed chemicals are in their original manufacturer's container. In many cases, these surplus chemicals still have the manufacturer's seals.

There are several ways to obtain surplus chemicals. OEHS provides an updated list of redistributable chemicals on the OEHS website. Call OEHS to arrange for delivery to your laboratory.

Redistribution works with chemicals that have not degraded with age. Principal

Investigators should review their inventory regularly and have their surplus chemicals picked up by OEHS so that these can be made available for use by other laboratories.

10.0 Employee Information and Training

The OSHA Laboratory Standard is clear on the requirement that all laboratory personnel receive the necessary information and training so that they understand the hazards of the chemicals present in their work area. The primary responsibility for ensuring this rests with the Principal Investigator, though OEHS provides various courses and classes to meet these needs. OEHS staff can also help by providing guidance on common techniques and the use of common chemicals. However, the lab-specific training must come from the Principal Investigator (or designated staff member). The Principal Investigator must ensure that the information and training is presented before laboratory workers are allowed to use or handle chemicals in their laboratory.

10.1 Information

Laboratory personnel must be informed of:

- The contents of the Laboratory Standard and its appendices. Below is a link to the OSHA Laboratory Standard. This is also found in **Appendix B** of the *Laboratory Safety Manual*: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=10106;
- The location and availability of the Campus Chemical Hygiene Plan, The Lab-Specific Chemical Hygiene Plan and the Laboratory Safety Manual;
- The permissible exposure limits for OSHA-regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard (see **Appendix B** of this document for more information);
- Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and
- 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.

10.2 Training

The Chemical Safety Staff offers regularly scheduled training on general laboratory safety. This covers details of the OSHA Laboratory Standard as well as campus safety policies (including the Campus CHP), resources, and services. Contact the OEHS for additional information.

Laboratory staff must also receive training on the laboratory-specific operations. This must include:

- The specific classes of physical and health hazards (e.g., corrosive, carcinogenic, flammable, water-reactive chemicals) associated with the hazardous chemicals staff may come in contact within the laboratory where they work;
- The methods that are to be used to control these hazards, including engineering and administrative controls, and personal protective equipment;
- Any laboratory-specific emergency procedures and the location and proper use of safety equipment (e.g., fume hood, fire extinguisher, emergency eyewash, and shower);
- 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.).

Typically this training is provided by the Principal Investigator or other experienced laboratory staff member. Training must be communicated in a manner readily understood to those being trained. This may require written as well as oral transmission of information. The frequency of refresher training and information can be determined by the Principal Investigator. Refer to Laboratory CHP template for information on documentation requirements.

11.0 Emergency Response

Each Principal Investigator must ensure that all laboratory staff is knowledgeable and trained on emergency procedures. Many of the procedures are covered in other campus plans, including a Building's Emergency Action Plan (BEAP). The BEAP is an all-hazard plan designed around a building's unique layout and function. The primary purpose of the BEAP is to provide guidance to building occupants in the event of an emergency, such as a tornado, active shooter, gas leak or bomb threat. Contact your building manager or department chair for location of this document.

Assess the hazards present in your workspace and tailor your emergency equipment and response plans accordingly. Emergency response plans should be developed covering lab-specific procedures, including:

- Procedures for handling small and large chemical spills;
- Procedures for handling instrument failures;
- Procedures for handling ventilation failures; and
- Procedures for responding to local alarms, such as oxygen or toxic gas sensors.

In case of an emergency, be prepared to follow the planned emergency procedures for your workplace and building. Before an emergency strikes, there are several things that can be done to improve preparedness.

- Review your building's emergency plans, taking note of proper exit and reentry procedures and emergency contacts. Make sure these procedures and contacts are visibly posted and that all employees are familiar with them.

- Check your Laboratory Emergency Information Card (located near the laboratory entrance) and make sure the information is up to date. Keep your MSDS files up to date and easily accessible.
- Locate and become knowledgeable with important emergency equipment in the laboratory such as fire extinguishers, eyewash stations, and spill kits. Have several of the laboratory employees trained on proper use of first aid and fire extinguishers.
- Periodically check the emergency equipment to make sure it is properly maintained, appropriate for the hazard and ready for use. For example, eyewash stations need to be flushed weekly to make sure the water is clean and adequately dispensed. Also, if you have acids in the lab, a spill kit for flammable liquids will be insufficient.
- Have emergency contacts posted:

  Police: 911

  Dialing 6911 on a landline phone will go directly to UAHuntsville Police dispatch. Calling 911 from a cell phone will connect you to the Huntsville Madison County dispatch. When calling from a cell phone make clear that you are calling from a campus facility.

For additional information contact OEHS.

12.0 Exposure Monitoring

Regulations require exposure monitoring where exposure may occur at or above a published exposure value of OSHA or ACGIH (American Conference of Governmental Industrial Hygienists). Examples of such values could include the action level, permissible exposure level, threshold limit value, short-term exposure limit or ceiling limit. If you believe that you are being exposed to levels above the permissible limits, contact OEHS. OEHS personnel will provide consultation and, if deemed appropriate, will perform the necessary exposure monitoring. The affected university staff will be notified of the results within 15 days of OEHS receipt of the results (see Section 5.3).

13.0 Respiratory Protection

As stated in Section 4.1, it is the policy of the university to take all prudent steps to minimize exposures to hazardous chemicals. This is primarily achieved by prudent experimental design and engineering controls. Examples include eliminating the hazard by substituting for a less hazardous alternative or containing the hazard through ventilation or other controls.

If no alternatives can be found, then respiratory protection may be required. Before using a respirator, a Respiratory Protection Plan must be developed. To aid in doing so, you can access an easy to fill in program template on the OEHS website.

The written program identifies who will be responsible for administering the respirator program in your laboratory or department. In addition, the website will detail how other obligations will be met such as medical surveillance, fit testing equipment selection and maintenance. Click on the following link to fill out and download a written respiratory protection program template.

14.0 Medical Consultations and Evaluations

The university offers access to medical evaluation and associated services under the following circumstances:

- Signs or symptoms of exposure to chemical used in the laboratory are experienced;
- Exposure to an agent repeatedly occurs above a permissible level;
- A spill or release occurs resulting in agent exposure; and,
- Respirator use is required when working with the agent.

In addition to the circumstances listed above, there may be other occasions when consultation with either your personal physician or a university-affiliated Occupational Health physician may be warranted. Examples of such conditions may include pregnancy, desire to conceive or existence of a health condition which may put you at greater risk. To arrange for or discuss medical consultations and evaluations, contact the Office of Counsel, On-the-Job Injury Coordinator at 824-6633.

In the event of a possible exposure, the affected individual (or other laboratory staff present) must be prepared to supply the following information:

- The identity of the hazardous chemical(s) to which the worker may have been exposed;
- A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and
- A description of the signs and symptoms of exposure that the worker is experiencing, if any.

15.0 Laboratory Visitation Program

The Laboratory Visitation Program is an ongoing program that provides assistance and consultation to help create a safe work environment. As part of the visit, OEHS Chemical Safety staff will help insure all university and governmental regulations are being complied with in the laboratories. The OEHS Laboratory Visitation Team performs a review of all safety documentation and physical hazards which include fire safety, chemical safety, engineering controls, and safety training. Upon completion of the laboratory visit, a report is issued to each laboratory manager. This report outlines areas that need improvement as well as any necessary guidance documents.

The OEHS visits laboratories by departments on a rotating basis. However, the OEHS staff is available to visit any laboratory upon request. To schedule a laboratory visitation contact the OEHS at 824-2171.

For additional information on the Laboratory Visitation Program, visit the OEHS website.

16.0 Incident/Accident Notification Investigation

Principal Investigators and supervisors must report any incident involving personal injury, exposure or illnesses, property damage or incidents involving an environmental release of hazardous materials, and near misses directly to the UAH Police Department at 824-6596.

A primary tool to identify and recognize the areas responsible for accidents is a thorough and properly completed accident investigation. Accident investigations shall be conducted by the OEHS staff with the primary focus of understanding why the accident or near miss occurred and what actions can be taken to preclude recurrence.

Procedures for investigating workplace accidents and hazardous materials exposures include:

- Visiting the accident scene as soon as possible;
- Interviewing injured workers and witnesses;
- Examining the workplace for factors associated with the accident/exposure;
- Determining the cause of the accident/exposure;
- Taking corrective action to prevent the accident/exposure from reoccurring;
- Recording the findings and corrective actions taken.

The investigation will be recorded in writing and will adequately identify the cause(s) of the accident or near-miss occurrence. Documentation of the investigation and all follow-ups will be prepared and maintained by a member of the OEHS staff performing the investigation.

17.0 Transportation and Shipping of Hazardous Materials

17.1 Shipping of Hazardous Materials

In order to protect the public at large, the US Department of Transportation (DOT) regulates the shipping and transportation of hazardous materials *in commerce* on roadways and airways. A hazardous material is defined as any substance or material that could adversely affect the safety of the public, handlers or carriers during transportation. All DOT hazardous materials are listed in the DOT's Hazardous Material Table:

http://49CFR/172_101tb.pdf

The regulations for shipping hazardous materials apply to all individuals involved in the shipping process, including individuals who:

- Arrange for transport;
- Package materials;
- Mark and label packages;
- Prepare shipping papers;
- Handle, load, secure and segregate packages within a transport vehicle.

Non-compliance with these standards is subject to civil penalties up to $50,000 per violation and up to $100,000 if death, serious illness, severe injury to any person or substantial destruction of property. Criminal penalties may result in penalties up to 10 years imprisonment. The requirements can be found in 49 CFR Parts 171-178 and cover the documentation, packing, marking, and labeling of hazardous materials as well as the training of shippers, carriers, and handlers. International Air Transport Association (IATA) regulations also apply when shipping hazardous chemicals by common air carriers such as FedEx since these carriers require that IATA rules are met.

In addition to proper packaging and labeling, the regulations require that the individual receive training that must be refreshed at minimum of every three years or when there is a significant change in the regulations. Contact OEHS at 824-2171 for information on training or other shipping concerns.

17.2 On-Campus Transportation of Hazardous Materials

Under the current regulations, UAHuntsville is considered a government agency; therefore university employees transporting hazardous materials are not technically placing the materials "in commerce." As a result, university employees transporting hazardous materials between campus buildings on public roadways are exempt from the DOT Hazardous Material Regulations (i.e. the normal packaging, labeling, placarding, and documentation do not apply). However, individuals who move hazardous chemicals on campus are still subject to the following university requirements:

- The employees involved in moving the hazardous materials should be trained and familiar with its hazards and basic handling properties.
- Before moving the material, an emergency plan and spill kit must be available in case of an accident or environmental discharge.
- Secondary containment of hazardous materials must be used for all materials where there is a potential for a spill.
- Only university vehicles (i.e., not personal vehicles) can be used for the transportation of hazardous materials.

Arrangements can be made with the OEHS for transportation of large quantities of chemicals between buildings.

Hazardous waste is regulated by the US Environmental Protection Agency (EPA) in 40 CFR 260-265. The transportation of waste requires special marking, training, and documentation. Hazardous waste can only be transported by OEHS employees and approved contractors.

18.0 Records

Principal Investigators are required to maintain all worker records associated with their laboratories. These records include:

- Copies of Laboratory CHPs;
- Training records for laboratory personnel;
- Records of any internal audits or inspections; and
- Results of any exposure monitoring.

Records of visitations performed by OEHS staff will be maintained by OEHS. While training records for all lab-specific training must be maintained by the Principal Investigator, training performed by other organizations on campus is often maintained by those organizations. Consult with the training organization to ensure that they maintain these records.

19.0 Acronyms

ACGIH: American Conference of Governmental Industrial Hygienists
CHO: Chemical Hygiene Officer
CHP: Chemical Hygiene Plan **CSA:**
Controlled Substance Act **DEA:**
Drug Enforcement Agency
DHS: Department of Homeland Security
DOT: Department of Transportation
OEHS: Environment, Health & Safety
EPCRA: Emergency Planning and Community Right-to Know Act
HMCFD: Huntsville Madison County Fire Department
IATA: International Air Transport Association
IBC: International Building Code
IFC: International Fire Code
LSC: Laboratory Safety Committee
MSDS: Material Safety Data Sheet
NFPA: National Fire Protection Association
OSHA: Occupational Safety and Health Administration
PEL: Permissible Exposure Limit
PHS: Particularly Hazardous Substance
PI: Principal Investigator
PPE: Personnel Protective Equipment
SOP: Standard Operating Procedure
STEL: Short Term Exposure Limit
TLV: Threshold Limit Values
TWA: Time weighted average

Appendix A: Exposure Limits

Laboratories as workplaces pose unique hazards. There is the potential for exposure to a large number of chemicals but exposures, if they do occur, tend to be of short duration. All prudent steps should be taken to minimize exposure, but the steps should be risk based. Various occupational exposure limits have been set by organizations. Some of the limits are enforceable by law while others are recommendations only, with no legal bases. These limits still perform a needed function in aiding an informed risk assessment process. Below is some information on the major occupational exposure limits.

Permissible Exposure Limits (PELs):

OSHA sets enforceable permissible exposure limits (PELs) to protect workers against the health effects of exposure to hazardous substances. PELs are regulatory limits on the amount or concentration of a substance in the air. They may also contain a skin designation that serves as a warning of potential cutaneous absorption that should be prevented in order to avoid exceeding the absorbed dose received by inhalation at the permissible exposure level (PEL). Most OSHA PELs are based on an 8-hour work shift of a 40-hour workweek time weighted average (TWA) exposure that an employee may be exposed to for a working lifetime without adverse effects. Some of the PELs are listed as ceiling values – concentrations above which a worker should never be exposed. To locate PELs on specific chemicals go to: http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992,

Threshold Limit Value (TLV®):

Threshold Limit Value (TLV) are occupational exposure limit set by the American Conference of Governmental Industrial Hygienists (ACGIH). The time-weighted average TLV (TWA-TLV) is an airborne concentration of a gas or particle to which most workers can be exposed on a daily basis for a working lifetime without adverse effect (assuming an average exposure on the basis of a 8h/day, 40h/week work schedule). In addition ACGIH define:

- Short-term exposure limits (TLV-STEL) which are concentrations above which a worker should not be exposed (averaged over 15 minutes). Exposures cannot be repeated more than 4 times per day;

- Ceiling limits (TLV-C) which are concentrations above which a worker should never be exposed.

TLVs are regulatory limits if OSHA does not designate a PEL for that specific gas or particulate. In many laboratories the TLV-STEL or TLV-C of a chemical are more appropriate values unless the individual routinely works with the chemical.
Unfortunately values for TLVs are not available on the ACGIH website. Contact OEHS for

assistance with TLVs.

Recommended Exposure Limits (RELs)

Recommended Exposure Limits (RELs) were developed the National Institute for Occupational Safety and Health (NIOSH). NIOSH is the principal federal agency engaged in research, education, and training related to occupational safety and health. The REL is a level that NIOSH believes would be protective of worker safety and health over a working lifetime if used in combination with engineering and work practice controls, exposure and medical monitoring, posting and labeling of hazards, worker training and personal protective equipment. RELs are not legally enforceable.

NIOSH is well known for its *NIOSH Pocket Guide to Chemical Hazards.* In addition to containing RELs, it also has information on incompatibilities and reactivities, exposure routes, symptoms of exposure, target organs, potential cancer site, PPE, and first aid. A searchable version of the guide can be found at http://www.cdc.gov/niosh/npg/ . The pocket guide can also be downloaded from this site.

Immediately Dangerous to Life or Health (IDLH)

NIOSH also provides concentrations for chemicals that it considers immediately dangerous to life or health (IDLH). NIOSH defines an IDLH condition as a situation "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." IDLH values can be found in the *NIOSH Pocket Guide to Chemical Hazards* (see link above).

Workplace Environmental Exposure Levels (WEELs)

The American Industrial Hygiene Association (AIHA) develops worker exposure levels for health-based chemicals. Since most of the other worker protection limits are for commonly used industrial chemicals AIHA began developing Workplace Environmental Exposure Levels to meet a specific need. The latest WEELs can be found at:

http://www.aiha.org/insideaiha/GuidelineDevelopment/weel/Documents/WEEL_Values2010.pdf

Appendix B: Particularly Hazardous Substances

When working with hazardous materials, laboratory personnel need to understand the risks associated with the chemicals. Once the hazards are known then steps can be taken to minimize the risk associated with the hazard. Such steps include appropriate PPE and engineering controls, such as fume hoods. OSHA requires that special provisions be taken when working with Particularly Hazardous Substances (PHSs) since these substances potentially pose a higher health risk. PHSs are, according to OSHA, “select carcinogens”, reproductive toxins, or substances that have a high degree of acute toxicity.

The OSHA requirements for working with PHSs are more a matter of degree than a clear-cut differentiation from other substances. Risk assessments must always be done. The Laboratory Standard simply requires that higher risk materials be identified and mandates that extra precautions be used, if appropriate.

Laboratory personnel must do their due diligence when planning an experiment or procedure to determine hazards. This appendix provides some information and links to resources that help you identify PHSs. It is impossible to provide a master list of all PHSs so the information below should not be considered as comprehensive. This is especially true at a research institution where exotic materials are used for which there is no toxicological information. Also, toxicity is often related to the chemical’s form and how it is used. For example, compounds which are not considered highly dangerous may pose a much greater risk in the form of a nanoparticle. It is for this reason that prudent practices should always be taken to minimize exposures.

Carcinogens

“Select carcinogens” are any substances that meet one of the following criteria:

- It is regulated by OSHA as a carcinogen; or
- 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
- It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC; latest edition); or
- It is listed in either Group 2A or 2B by IARC or under the category "reasonably anticipated to be carcinogens" by NTP.

The National Toxicology Program has a website that provides the most recent list of materials known or reasonably anticipated to be carcinogenic. The website also provides a profile for each of the chemicals summarizing the carcinogenicity, properties, uses, and exposure routes for the substance. The website can be accessed at: http://ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932

A list of all the materials for which the IARC has issued reports can be found at the following website:
http://monographs.iarc.fr/ENG/Classification/ClassificationsAlphaOrder.pdf
This site also indicates the category the material falls under, with Group 1, 2A, and 2B being the chemicals of greatest concern.

Reproductive Toxins

Reproductive toxins, according to OSHA, are chemicals that affect the reproductive capabilities including chromosomal damage (mutations) and effects on fetuses (teratogenesis). The Environmental Health and Safety Office at the University of Hawaii at Manoa have compiled a list of select carcinogens on their website. This can be found at: http://www.hawaii.edu/ehso/lab/list.htm

Highly Toxic Compounds

OSHA defines substances that have a high degree of acute toxicity as substances that are "fatal or cause damage to target organs as a result of a single exposure or exposures of short duration". UAHuntsville, like many institutions, applies the OSHA Hazard Communication Standard for highly toxic substances. According to OSHA, a chemical falling within any of the following categories is considered to be highly toxic:

- A chemical that has a median lethal dose LD_{50} of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each;
- A chemical that has a median lethal dose LD_{50} of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each;
- A chemical that has a median lethal concentration LC_{50} in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

A complete list of all highly toxic compounds is impossible to compile. The compounds listed below were obtained from Penn State University. This list is provided as an aid. Laboratory personnel must still do their due diligence when performing a risk assessment. Consult other sources whenever possible. The MSDS should also be consulted as it often has NFPA or HMIS health ratings for the compounds.

Table B1. List of Highly Toxic Compounds

COMPOUND	CAS #
ACETONE CYANOHYDRIN (DOT)	75-86-5
ACETONYLBENZYL)-4-HYDROXYCOUMARIN, 3-(ALPHA-	81-81-2
ACROLEIN, INHIBITED (DOT)	107-02-8
ACTIDIONE	66-81-9
ACTINOMYCIN D	50-76-0
AFLATOXINS	1402-68-2
ALDRIN (DOT)	309-00-2
ALLYL BROMIDE (DOT)	106-95-6
ALLYL ISOTHIOCYANATE	57-06-7
ALLYLIDENE DIACETATE	869-29-4
ALUMINUM PHOSPHIDE (DOT)	20859-73-8
AMINO PYRIDINE, 2-	504-29-0
AMINOPTERIN	54-62-6
AMINOPYRIDINE, 4-	504-24-5
ANTU (NAPHTHYLTHIOUREA, ALPHA-)	86-88-4
ARSENIC ACID, SODIUM SALT (SODIUM ARSENATE)	7631-89-2
ARSENIC ACID, SOLUTION	7778-39-4
ARSENIC IODIDE	7784-45-4
ARSENIC PENTASULFIDE	1303-34-0
ARSENIC PENTOXIDE (DOT)	1303-28-2
ARSENIC TRICHLORIDE	7784-34-1
ARSENIC TRIOXIDE	1327-53-3
ARSENIC TRISULFIDE	1303-33-9
ARSENIOUS ACID (ARSENIC TRIOXIDE, SOLID)	1327-53-3
ARSENIOUS OXIDE (ARSENIC TRIOXIDE, SOLID)	1327-53-3
ARSINE	7784-42-1
AZINPHOS-METHYL	86-50-0
AZIRIDINE	151-56-4
BAY 25141	115-90-2
BENZEDRINE	300-62-9
BENZENETHIOL(PHENYL MERCAPTAN) (DOT)	108-98-5
BIDRIN	141-66-2
BORON TRIFLUORIDE	7637-07-2
BUSULFAN	55-98-1
BUTANEDIOL DIMETHYLSULFONATE, 1,4-	55-98-1
BUTYL-4,6-DINITROPHENOL, 2-SEC-	88-85-7

CALCIUM ARSENATE, SOLID	7778-44-1
CALCIUM CYANIDE	592-01-8
CARBON OXYFLUORIDE	353-50-4
CARBONYL CHLORIDE	75-44-5
CARBONYL FLUORIDE	353-50-4
CARBONYL SULFIDE	463-58-1
CHLORINATED DIPHENYL OXIDE	31242-93-0
CHLORINE (DOT)	7782-50-5
CHLORINE PENTAFLUORIDE	13637-63-3
CHLORINE TRIFLUORIDE	7790-91-2
CISPLATIN	15663-27-1
CYANOGEN	460-19-5
CYANOGEN CHLORIDE	506-77-4
CYCLOHEXIMIDE	66-81-9
CYCLOPHOSPHAMIDE	50-18-0
DASANIT	115-90-2
DAUNOMYCIN	20830-81-3
DDVP (DICHLORVOS)	62-73-7
DEMETON, MIXED ISOMERS	8065-48-3
DICHLORO-N-METHYLDIETHYLAMINE, 2,2'-	51-75-2
DICHLORVOS	62-73-7
DICROTOPHOS	141-66-2
DIELDRIN (DOT)	60-57-1
DIETHYL S-[2- (ETHYLTHIO)ETHYL] PHOSPHORODITHIOATE, O	298-04-4
DIETHYLHYDRAZINE, 1,2-	1615-80-1
DIISOPROPLY FLUOROPHOSPHATE	55-91-4
DIMETHYL MERCURY	593-74-8
DINITRO-O-CRESOL, 4,6-	534-52-1
DINITROPHENOL, 2, 4-	51-28-5
DINOSEB	88-85-7
DIOXATHION	78-34-2
DISULFOTON	298-04-4
DNBP	88-85-7
ENDOSULFAN	115-29-7
ENDRIN	72-20-8
EPN	2104-64-5
ETHION	563-12-2
ETHYLENEIMINE (DOT)	151-56-4
FENAMIPHOS	22224-92-6
FENSULFOTHION	115-90-2
FLUOROACETIC ACID, SODIUM SALT	62-74-8
FONOFOS	944-22-9
GLYCOLONITRILE	107-16-4
GUTHION	86-50-0
HEPTACHLOR	76-44-8
HEPTACHLOR EPOXIDE	1024-57-3
HYDROCYANIC ACID, LIQUIFIED	74-90-8
HYDROGEN CHLORIDE GAS	7647-01-0
HYDROGEN CYANIDE	74-90-8
HYDROGEN FLUORIDE GAS	7664-39-3
HYDROXY-3(3-OXO-1-PHENYLBUTYL)	

-2H-1- BENZOPYRAN-2-ONE	81-81-2
IRON PENTACARBONYL	13463-40-6
LANNATE	16752-77-5
MELPHALAN	148-82-3
MERCURIC CHLORIDE	7439-97-6
METHYL CYCLOPENTADIENYL MANGANESE TRICARBONYL, 2-	12108-13-3
METHYL HYDRAZINE	60-34-4
METHYL IODIDE	74-88-4
METHYL MERCURY	593-74-8
METHYL PARATHION, LIQUID	298-00-0
METHYL VINYL KETONE, INHIBITED (DOT)	78-94-4
METHYL-BIS(2-CHLOROETHYL) AMINE (NITROGEN MUSTARD), N-	51-75-2
METHYL-N-NITROSO-METHANAMINE,N-	62-75-9
METHYLAZIRIDINE, 2- (PROPYLENEIMINE, INHIBITED)	75-55-8
METHYLHYDRAZINE (DOT)	60-34-4
METHYLPROPYL)-4,6-DINITRO-PHENOL,2-(1-	88-85-7
MEVINPHOS	7786-34-7
MITOMYCIN C	50-07-7
MONOCROTOPHOS	6923-22-4
MYLERAN	55-98-1
NAPHTHYLTHIOUREA, ALPHA-	86-88-4
NITROGEN MUSTARD	51-75-2
NITROSODIMETHYLAMINE, N-	62-75-9
PARAQUAT, RESPIRABLE FRACTION	2074-50-2
PERFLUOROISOBUTYLENE	382-21-8
PHENYL MERCAPTAN (DOT)	108-98-5
PHENYLPHOSPHINE	638-21-1
PHORATE	298-02-2
PHOSDRIN (MEVINPHOS)	7786-34-7
PHOSGENE	75-44-5
PHOSHONOTHIOIC ACID, O-ETHYL O-(P- NITROPHENYL)ESTER,	2104-64-5
PHOSPHINE	7803-51-2
PHOSPHORUS PENTAFLUORIDE	7641-19-0
POTASSIUM CYANIDE, SOLID (DOT)	151-50-8
PREMERGE	88-85-7
PROPANENITRILE	107-12-0
PROPIONITRILE	107-12-0
PROPYLENEIMINE, INHIBITED (DOT)	75-55-8
SODIUM AZIDE	26628-22-8
SODIUM CYANIDE, SOLID (DOT)	143-33-9
STRYCHNINE, SOLID (DOT)	57-24-9
SULFOTEP	3689-24-5
SYSTOX	8065-48-3
TETRACHLORODIBENZO-P-DIOXIN, 2,3,7,8- (TCDD)	1746-01-6
TETRAETHYL DITHIOPYROPHOSPHATE(TEDP)	3689-24-5
TETRAETHYL LEAD, LIQUID	78-00-2
TETRAETHYLPYROPHOSPHATE, LIQUID	107-49-3
THIODAN (ENDOSULFAN)	115-29-7

THIOPHENOL (PHENYL MERCAPTAN) (DOT)	108-98-5
TRIETHYLENETHIOPHORAMIDE, N,N',N"-	52-24-4
TRIMETHYLENETRINITRAMINE	121-82-4
URACIL MUSTARD	66-75-1
VANADIUM PENTOXIDE	1314-62-1
VAPATONE (TETRAETHYLPYROPHOSPHATE, LIQUID)	107-49-3
WARFARIN	81-81-2

Appendix C: Chemical Storage Limits

The university is subject to the International Fire Code (IFC), by virtue of it being adopted by the HMCFD, as well as the International Building Code since the State of Alabama has adopted the 2006 version. HMCFD also enforces sections of the National Fire Protection Association (NFPA) standards since these have been adopted by IFC reference.

The tables in this section attempt to portray the limits that are imposed by the codes mentioned above. The maximum allowable quantities (MAQs) listed below are per control area. As discussed in Section 6.1 of this document a laboratory is not necessarily a control area – it may consist of more than one laboratory. Also, fire codes are not necessarily applied retroactively unless significant remodeling of the facility has occurred. These limits are therefore guidelines since it is beyond the scope of this document to provide information on each campus building. The vast majority of laboratories are unlikely to exceed the MAQs. In instances where the MAQs are approached, it is often possible to reduce the inventory on-hand by making minimal changes to procedures. Contact the OEHS if you have any questions concerning the limits. Note: Only a few facilities have been specifically constructed to allow quantities in excess of the MAQs.

Table C1. This table provides a list of MAQs based on the class of material. The table includes storage limits and limits for usage in an open or closed system. IFC defines "open" and "closed" systems as the following:

> *OPEN SYSTEM.* The use of a solid or liquid hazardous material involving a vessel or system that is continuously open to the atmosphere during normal operations and where vapors are liberated, or the product is exposed to the atmosphere during normal operations. Examples of open systems for solids and liquids include dispensing from or into open beakers or containers, dip tank and plating tank operations.
>
> *CLOSED SYSTEM:* The use of a solid or liquid hazardous material involving a closed vessel or system that remains closed during normal operations where vapors emitted by the product are not liberated outside of the vessel or system and the product is not exposed to the atmosphere during normal operations; and all uses of compressed gases. Examples of closed systems for solids and liquids include product conveyed through a piping system into a closed vessel, system or piece of equipment.

Additional definitions are supplied at the end of this Appendix. When viewing Table C1 note the footnotes below the Tables. These indicate building or containment features that may increase the MAQs or, in some instances, are required. Table C1 assumes the laboratory is on the ground floor.

Table C1. International Fire Code (IFC 2003) Maximum Allowable Quantities (MAQ) In Storage per Fire Control Areas

Hazardous Material	Class	Storage	Use (open system)
Flammable Liquid (gallons)	IA IB or IC	30[1,2]	10[1] 30[1]
Combustible liquids (gallons)	II IIIA	120[1,2] 330[1,]	30[1,] 80[1,]
Flammable gas, gaseous (cubic feet)		1000[1,2]	NA
Flammable gas, liquefied (pounds)		30[1,2]	NA
Flammable solid (pounds)		125[1,2]	NA
Cryogenics, flammable (pounds)		45[1]	10
Cryogenics, oxidizing (pounds)		45[1]	10
Organic peroxide (pounds)	UD I II	1[2,4] 5[1,2]	0.25[4] 1[1] 10[1]
Highly Toxic, gases (cubic feet)		20[3]	3[3]
Highly Toxic, liquids (gallons)		10	3
Highly Toxic (pounds)		10	3
Toxic, gases (cubic feet)		810	810
Toxic, liquids (gallons)		500	500
Toxic		500	125

Hazardous Material	Class	Storage	Use (open system)
(pounds)			
Oxidizing gas, gaseous (cubic feet)		1500[1,2]	NA
Oxidizing gas, liquefied (pounds)		NA	NA
Pyrophoric materials (pounds)		8[2,4]	0[2,4]
Pyrophoric materials gaseous (cubic feet)		100[2,4]	0[2,4]
Unstable (reactive) (pounds)	4	2[1,4]	0.25[4]
	3		1[1]
	2	20[1,2]	50[1]
Water reactive (pounds)	3	5[1,2]	1[1]
	2	[illegible]	10[1]
Corrosive (cubic feet)		810	100
Highly toxic (cubic feet) (needs EH& S) approval		20	20
Toxic (cubic feet)		810	25

NA = Not applicable; a cubic foot = 0.023 m^3; 1 pound = 0.454 kg.; 1 gallon = 3.785 L.

1. Maximum quantities shall be increased 100% (Table C1) for buildings equipped throughout with an automatic sprinkler. Where note 2 also applies the increase for both notes are to be applied accumulatively.
2. Maximum allowable quantities are to be increased up to 100% when stored in approved storage cabinets, gas cabinets, exhausted enclosures or safety cans as specified in IFC. Where note 1 also applies the increase for both notes are to be applied accumulatively.
3. Allowed only when stored in approved exhausted gas cabinets or exhausted enclosures as specified in the International Fire Code.
4. Permitted only in buildings equipped throughout with an automatic sprinkler system.

Additional Notes:

- The combined amounts of all classes (IA, IB, and IC) of flammable liquids cannot exceed the limits for the limits stated for (IB and IC).
- For chemicals that fit into multiple categories, the most restrictive limits apply
- The MAQs are dependent on the floor level as follows:
  - At ground level, MAQs are 100% of the listed values
  - On 2nd floor, MAQs are 50% of the listed values
  - On 3rd floor, MAQs are 25% of the listed values
  - On 4th MAQs are 12.5% of the listed values
  - On 5th floor and above, MAQs are 5% of the listed values

Table C2. NFPA 45 *Standard on Fire Protection for Laboratories Using Chemicals* sets limits on the quantities of flammable and combustible liquids that can be stored in any one container based on the construction of the container. Aggregate quantities must still be below the amounts listed in Table C1.

Table C2. Maximum Allowable Size of Containers

	Flammable Liquids			***Combustible***	
	Class IA	Class IB	Class IC	Class II	Class III
Glass or approved plastic	1 pt.	1 qt.	1 gal.	1 gal.	1 gal.
Metal (other than DOT drums)	1 gal.	5 gal.	5 gal.	5 gal.	5 gal.
Safety cans	2 gal.	5 gal.	5 gal.	5 gal.	5 gal.
Metal drums (DOT	60 gal.	60 gal.	60 gal.	60 gal.	60 gal.
Approved portable tanks	660 gal.	660 gal.	660 gal.	660 gal.	660gal.

Table C3. The following chart lists the maximum volume of flammables and combustibles that can be stored in a single flammable storage cabinet. Again, quantities in a given control area cannot exceed MAQs listed above.

Table C3. Maximum Storage Quantities for a Flammable Storage Cabinet

MAXIMUM STORAGE QUANTITIES FOR	
Liquid Class	***Maximum Storage***
Flammable/Class I	60
Combustible/Class II	60
Combustible/Class III	120
Combination of classes	120

Not more than 60 gallons may be Class I and Class II liquids. No more than 120 gallons of Class III liquids may be stored in a storage cabinet, according to OSHA 29 CFR 1910.106(d)(3) and NFPA 30 Section 4-3.1.
NOTE: *Not more than three such cabinets may be located in a single fire area, according to NFPA 30 Section 4-3.1.*

Table C4. The IFC limits the quantities of flammable liquids that can be stored in a control area. The MAQs are based on the classification of the flammable liquids. The following table provides NFPA classification information for some common solvents. The NFPA fire diamond information is often found on containers or in MSDSs. Liquids with a flammability rating of 3 are considered Class IB and IC liquids while those with a flammability rating of 4 are Class IA. Note that Class IA, IB, and IC are flammable liquids. Class II liquids are combustible.

Table C4. Flammable Liquid Storage, Properties and Classification

Chemic	Flash Point $^{o}F/ ^{o}C$	Boiling Point	NFPA Classification
Acetic acid	103/39	245/118	II
Acetone	-4/-20	133/56	1B
Acetaldehyde	-38/-39	70/21	IA
Acetonitrile	42/6	179/82	IB
Acrylonitrile	32/0	171/77	IB
Benzene	12/-11	176/80	IB
t-Butyl Alcohol	52/11	181/83	IB
Cyclohexene	20/-7	181/83	IB
Dioxane	54/12	214/101	IB
Ethyl Acetate	24/-4	171/77	IB
Ethyl Alcohol	55/13	173/78	IB
Ethyl Ether	-49/-45	95/35	IA
Gasoline	-45/-43	100-400/38-204	IB
Hexane	-7/-22	156/69	IB
Isopropanol	53	183/83	IB
Methanol	52/11	174/64	IB
Methylene Chloride		104/40	-

Chemical	Flash Point ^{0}F/ ^{0}C	Boiling Point	NFPA Classification
Methyl Ethyl Ketone	16/-9	176/80	IB
Pentane	-40/	97/36	IA
Petroleum Ether	0/-18	95-140/35-60	IA-IB
Propyl Alcohol	74/23	207/97	IC
n-Propyl Ether	70/21	194/90	IB
Pyridine	68/20	239/115	IB
Tetrahydrofuran	6/-14	151/66	IB
Toluene	40/4	230/111	IB
Triethylamine	16/-7	193/89	IB
m-Xylene	77/25	282/38	IC

Table C5. The following table provides information on the hazards associated with common gases. This will aid risk assessments and also help determine MAQs. Since gases can fall into multiple categories (such as flammable and highly toxic) the most restrictive MAQ applies.

Table C5. Hazards of Common Gases

Gases	Asphyxiant	Flammable	Oxidizer	Corrosive	Toxic	Highly Toxic	Pyrophoric
Argon	**X**						
Ammonia (NH_3)		**X**		**X**	**X**		
Arsine (AsH_3)		**X**				**X**	
Boron Tribromide (BBr_3)				**X**	**X**		
Boron Trichloride (BCl_3)				**X**	**X**		

Gases	Asphyxiant	Flammable	Oxidizer	Corrosive	Toxic	Highly Toxic	Pyrophoric
Bromine (Br_2)			**X**	**X**		**X**	
Carbon Dioxide	**X**						
Chlorine			**X**	**X**	**X**		
Chlorine Dioxide (ClO_2)			**X**		**X**		
Chlorine Trifluoride (ClF_3)			**X**		**X**		
Diborane (B_2H_6)		**X**				**X**	**X**
Dichlorosilane (SiH_2Cl_2)		**X**		**X**	**X**		
Ethylene Oxide (C_2H_4O)		**X**					
Fluorine (F_2)			**X**			**X**	
Helium	**X**						
Germane (GeH_4)		**X**			**X**		
Hydrogen	**X**	**X**					
Hydrogen Bromide (HBr)				**X**			
Hydrogen Chloride				**X**			

Gases	Asphyxiant	Flammable	Oxidizer	Corrosive	Toxic	Highly Toxic	Pyrophoric
(HCl)							
Hydrogen Cyanide (HCN)		**X**				**X**	
Hydrogen Fluoride (HF)				**X**	**X**		
Methyl Bromide (CH_3Br)		**X**			**X**		
Nickel Carbonyl [Ni $(CO)_4$]		**X**				**X**	
Nitrogen	**X**						
Nitrogen Dioxide			**X**		**X**		
Oxygen			**X**				
Phosgene						**X**	
Phosphine (PH_3)						**X**	**X**
Silane		**X**			**X**		**X**
Sulfur Dioxide (SO_2)				**X**			

DEFINITIONS:

COMBUSTIBLE LIQUID. A liquid having a closed cup flash point at or above 100°F (38°C). Combustible liquids shall be subdivided as follows:

Class II. Liquids having a closed cup flash point at or above 100°F (38°C) and below 140°F (60°C).
Class IIIA. Liquids having a closed cup flash point at or above 140°F (60°C) and below 200°F (93°C).
Class IIIB. Liquids having a closed cup flash point at or above 200°F (93°C). The category of combustible liquids does not include compressed gases or cryogenic fluids.

CONTROL AREA. Spaces within a building that are enclosed and bounded by exterior walls, fire walls, fire barriers and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the maximum allowable quantities per control area are stored, dispensed, used or handled.

CORROSIVE. A chemical that causes visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. A chemical shall be considered corrosive if, when tested on the intact skin of albino rabbits by the method described in DOTn 49 CFR, Part 173.137, such a chemical destroys or changes irreversibly the structure of the tissue at the point of contact following an exposure period of 4 hours.
This term does not refer to action on inanimate surfaces. Highly acidic and basic compounds are typical examples of corrosive materials.

CRYOGENIC FLUID. A liquid having a boiling point lower than -150°F (-101°C) at
14.7

FLAMMABLE LIQUID A liquid having a closed cup flash point below 100°F (38°C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

Class IA. Liquids having a flash point below 73°F (23°C) and a boiling point below 100°F (38°C).
Class IB Liquids having a flash point below 73°F (23°C) and a boiling point at or above 100°F (38°C).
Class IC. Liquids having a flash point at or above 73°F (23°C) and below 100°F (38°C).
This category of flammable liquids does not include compressed gases or cryogenic fluids.

FLAMMABLE SOLID. A solid, other than a blasting agent or explosive, that is capable of causing fire through friction, absorption or moisture, spontaneous chemical change, or retained heat from manufacturing or processing, or which has an ignition temperature below 212°F (100°C) or which burns so vigorously and persistently when ignited as to create a serious hazard. A chemical shall be considered a flammable solid as determined in accordance with the test method of CPSC 16 CFR; Part 1500.44, if it ignites and burns with a self-sustained flame at a rate greater than 0.1 inch (2.5 mm) per second along its major axis.

FLASH POINT. The minimum temperature in degrees Fahrenheit at which a liquid will give off sufficient vapors to form an ignitable mixture with air near the surface or in the container, but will not sustain combustion. The flash point of a liquid shall be determined by appropriate test procedure and apparatus as specified in ASTM D 56, ASTM D 93 or ASTM D 3278.

HIGHLY TOXIC. A material which produces a lethal dose or lethal concentration that falls within any of the following categories:

1. A chemical that has a median lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

2. A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2 milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highly toxic. While this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

ORGANIC PEROXIDE. 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 have been replaced by an organic radical. Organic peroxides can pose an explosion hazard (detonation or deflagration) or they can be shock sensitive. They can also decompose into various unstable compounds over an extended period of time.

Class I. Those formulations those are capable of deflagration but not detonation.
Class II. Those formulations that burn very rapidly and that pose a moderate reactivity hazard.
Class III. Those formulations that burn rapidly and that pose a moderate reactivity hazard.
Class IV Those formulations that burn in the same manner as ordinary combustibles and that pose a minimal reactivity hazard.
Class V Those formulations that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard. Peroxides pose an extremely high explosion hazard through rapid explosive decomposition.

OXIDIZER: A substance capable of oxidizing a reducing agent. Oxidizers are chemicals such as oxygen, chlorine, perchlorate and permanganates that support combustion but do not burn independently. Oxidizers can react violently with flammable and combustible materials.
Oxidizers are subdivided as follows:

Class 4: An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock. Additionally, the oxidizer will enhance the burning rate and can cause spontaneous ignition of combustibles.
Class 3: An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes in contact or that will undergo vigorous self-sustained decomposition due to contamination or exposure to heat.
Class 2: An oxidizer that will cause a moderate increase in the burning rate or that causes spontaneous ignition of combustible materials with which it comes in contact.
Class 1: An oxidizer whose primary hazard is that it slightly increases the burning rate but which does not cause spontaneous ignition when it comes in contact with combustible materials.

OXIDIZING GAS: A gas that can support and accelerate combustion of other materials

PYROPHORIC: A chemical with an auto-ignition temperature in air, at or below a temperature of 130°F (54.4°C).

TOXIC: A chemical falling within any of the following categories:

1. A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram, but not

more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

2. A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.
3. A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

UNSTABLE (REACTIVE) MATERIAL: A material, other than an explosive, which in the pure state or as commercially produced, will vigorously polymerize, decompose, 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 materials. Unstable (reactive) materials are subdivided as follows:

Class 4: Materials those in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This class includes materials that are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

Class 3: Materials that in themselves are capable of detonation or of explosive decomposition or explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

Class 2: Materials that in themselves are normally unstable and readily undergo violent chemical change but do not detonate. This class includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures, and that can undergo violent chemical change at elevated temperatures and pressures.

Class 1: Materials that in themselves are normally stable but which can become unstable at elevated temperatures and pressure.

WATER-REACTIVE MATERIAL: A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

Class 3: Materials that react explosively with water without requiring heat or confinement

Class 2: Materials that may form potentially explosive mixtures with water

Class 1: Materials that may react with water with some release of energy, but not violently, include bromine, chlorine and fluorine.

Appendix D: EPCRA and DHS Laboratory Inventory Requirements

The UAHuntsville is subject to two key regulations which require it to have knowledge of chemical inventories. The Emergency Planning and Community Right-to Know Act (EPCRA) requires the university to report quantities above specified thresholds for listed chemicals to state and local emergency planners. The Department of Homeland Security (DHS) also has created a list of Chemicals of Interest (COI) based on threat criteria such as sabotage, theft, and release. All chemical facilities in the U.S. must report any COIs maintained above the screening threshold quantities (STQs). In order to remain compliant the university requires that laboratory inventories of the specific chemicals (listed in the tables below) be maintained. Since most laboratories work with low quantities of material the lists have been truncated to include only those chemicals which have a low reporting threshold. Chemical spills involving chemicals on the EPCRA list should be reported to UAHuntsville OEHS since specific reporting requirements may apply.

Laboratory staff should consult the complete *EPA List of Lists* (at http://www.epa.gov/oem/tools.htm#lol) and the complete DHS COI list (at http://www.safetec.net/resources/dhs-chemicals-of-interest/) when working with unusually large amounts of a hazardous chemical to determine whether the chemical should be included on their inventory. Contact the OEHS for any questions on inventory requirements.
The TPQs and STQs have been included for information purposes only.

Table D1. EPCRA Inventory Requirements
Below is listed a subset of the EPCRA extremely hazardous substances list which have low threshold planning quantities (TPQs).

Chemical	CAS #	Density (lbs/gal)[1]	Threshold Planning Quantity (lbs)	Reportable Volume (gal)	Reportable Volume (L)
Nickel carbonyl	1346339	11.01	1	0.1	0.3
2-Chloro-N-(2-chloroethyl)-N-methylethanamine/ Mechlorethamine / Nitrogen	51752	9.31	10	1.1	4.1
Carbonic dichloride / Phosgene	75445	11.43	10	0.9	3.3
Ethylene fluorohydrin	37162	9.20	10	1.1	4.1
Fluoroacetyl chloride	35906	11.27	10	0.9	3.4
Hydrogen selenide	778307	Gas	10		
Lewisite	54125	15.73	10	0.6	2.4
Methyl vinyl ketone	78944	7.19	10	1.4	5.3
Phorate	29802	9.63	10	1.0	3.9
Propargyl bromide	10696	13.15	10	0.8	2.9
Sarin	10744	9.07	10	1.1	4.2
Tabun	77816	8.94	10	1.1	4.2
2-Propenoyl chloride / Acrylyl	81468	9.28	100	10.8	40.8
Arsine	778442	Gas	100		

Benzene, 1,3-diisocyanato-2-methyl- / Toluene-2,6-	91087	10.16	100	9.8	37.2
Benzoic trichloride /	98077	11.46	100	8.7	33.0
Bis(chloromethyl) ether / Chloromethyl ether / Dichloromethyl ether /	54288	11.02	100	9.1	34.3
Chlorine	778250	Gas	100		
Chloromethyl methyl ether / Methane,	10730	8.83	100	11.3	42.9
Cyanuric fluoride	67514	13.33	100	7.5	28.4
Diborane / Diborane(6)	1928745	Gas	100		
Dicrotophos	14166	10.13	100	9.9	37.4
Diisopropylfluorophosphate /	55914	8.79	100	11.4	43.1
Diphosphoramide, octamethyl- /	15216	9.45	100	10.6	40.1
Formothion	254082	11.34	100	8.8	33.4
Hexachlorocyclopentadiene	77474	14.18	100	7.1	26.7
Hydrocyanic acid / Hydrogen	74908	5.72 /	100	17	66.2
Hydrofluoric acid / Hydrofluoric acid (conc. 50% or greater)	766439	8.35	100	12.0	45.4
Hydrogen fluoride / Hydrogen fluoride	766439	Gas	100		
Iron carbonyl (Fe(CO)5), (TB-5-11)- /	1346340	12.41	100	8.1	30.5
Lithium hydride	758067	Solid	100		
Manganese, tricarbonyl methylcyclopentadienyl	1210813	11.58	100	8.6	32.7
Methacryloyl chloride	92046	9.06	100	11.0	41.8
Methacryloyloxyethyl isocyanate	3067480	9.15	100	10.9	41.4
Methyl phosphonic dichloride	67697	11.58	100	8.6	32.7
Nicotine / Pyridine, 3-(1-methyl-2-pyrrolidinyl)-,(S)-	54115	8.41	100	11.9	45.0
Nitric oxide / Nitrogen oxide (NO)	1010243	Gas	100		
Nitrogen dioxide	1010244	12.06 /	100	8.3	31.4
Ozone	1002815	Gas	100		
Parathion / Phosphorothioic acid, O,O- diethyl-O-(4-	56382	10.50	100	9.5	36.7
Phosphamidon	1317121	10.11	100	9.9	37.5
Phosphonothioic acid, methyl-, S-(2-(bis(1-	5078269	8.40	100	11.9	45.1
Phosphorus / Phosphorus (yellow or	772314	Solid	100		
Plumbane, tetramethyl- /	75741	16.62	100	6.0	22.8
Potassium cyanide	15150	Solid	100		
Sodium cyanide (Na(CN))	14333	Solid	100		
Sulfur fluoride (SF4), (T-4)- / Sulfur tetrafluoride	778360	Gas	100		
Sulfur trioxide	744611	Solid	100		

Tellurium hexafluoride	7783804	Gas	100		
TEPP / Tetraethyl pyrophosphate	107493	9.87	100	10.1	38.3
Terbufos	13071799	9.20	100	10.9	41.1
Tetraethyl lead	78002	13.77	100	7.3	27.5
Tetraethyltin	597648	9.99	100	10.0	37.9
Titanium chloride (TiCl4) (T-4)- / Titanium tetrachloride	7550450	14.38	100	7.0	26.3
Trichloro(chloromethyl)silane	1558254	12.30	100	8.1	30.8
Tris(2-chloroethyl)amine	555771	10.29	100	9.7	36.8
The Items with two threshold planning quantities listed (e.g., 1/10,000) are those where the lower TPQ number applies if the substance is present as a solid in powder form with particle size less than 100 microns, in solution or in molten form. Inventories must be maintained only when they are in the low TPQ form.					
Chromic chloride	10025737	Solid	1/10,000[3]		
Emetine, dihydrochloride	316427	Solid	1/10,000		
4,6-Dinitro-o-cresol	534521	Solid	10/10,000		
Azinphos-methyl / Guthion	86500	Solid	10/10,000		
Benzenearsonic acid	98055	Solid	10/10,000		
Bis(chloromethyl) ketone	534076	Solid	10/10,000		
Carbofuran	1563662	Solid	10/10,000		
Cobalt carbonyl	10210681	Solid	10/10,000		
Colchicine	64868	Solid	10/10,000		
Digoxin	20830755	Solid	10/10,000		
Dimethyl-p-phenylenediamine	99989	Solid	10/10,000		
Dinitrocresol	534521	Solid	10/10,000		
Diphacinone	82666	Solid	10/10,000		
Endosulfan	115297	Solid	10/10,000		
Fenamiphos	22224926	Solid	10/10,000		
Fluoroacetic acid	144490	Solid	10/10,000		
Fluoroacetic acid, sodium salt	62748	Solid	10/10,000		
Monocrotophos	6923224	Solid	10/10,000		
Organorhodium Complex (PMN-82-147)	0	Solid	10/10,000		
Paraquat dichloride	1910425	Solid	10/10,000		
Paraquat methosulfate	2074502	Solid	10/10,000		
Sodium fluoroacetate	62748	Solid	10/10,000		

[1]Density (lb/gal) = specific gravity * 8.33

Table D2. DHS Chemical of Interest Inventory Requirements

Chemicals of Interest	Synonym	CAS Number	Min. Conc (%)	STQs (in pounds unless
Arsenic trichloride	Arsenous trichloride	7784-34-1	30	2.2
Arsine		7784-42-1	0.67	15
1,4-Bis(2-chloroethylthio)-		142868-93-7	NA	100g
Bis(2-chloroethylthio)methane		63869-13-6	NA	100g
Bis(2-		63918-90-1	NA	100g
1,5-Bis(2-chloroethylthio)-		142868-94-8	NA	100g
1,3-Bis(2-chloroethylthio)-		63905-10-2	NA	100g
2-Chloroethylchloromethylsulfide		2625-76-5	NA	100g
Chlorosarin	o-Isopropyl methylphosphonochloridate	1445-76-7	NA	100g
Chlorosoman	o-Pinacolyl methylphosphonochloridate	7040-57-5	NA	100g
DF	Methyl phosphonyl difluoride	676-99-3	NA	100g
N,N-(2-diethylamino)ethanethiol		100-38-9	30	2.2
o,o-Diethyl S-[2-(diethylamino)ethyl] phosphorothiolate		78-53-5	30	2.2
Diethyl methylphosphonite		15715-41-0	30	2.2
N,N-Diethyl phosphoramidic		1498-54-0	30	2.2
N,N-(2-diisopropylamino)ethanethiol N,N-diisopropyl-(beta)-aminoethane thiol		5842-07-9	30	2.2
N,N-Diisopropyl phosphoramidic dichloride		23306-80-1	30	2.2
N,N-(2-		108-02-1	30	2.2
N,N-Dimethyl phosphoramidic dichloride Dimethylphosphoramidodichlo		677-43-0	30	2.2
Dinitrogen tetroxide		10544-72-6	3.8	15

N,N-(2-dipropylamino)ethanethiol		5842-06-8	30	2.2
N,N-Dipropyl phosphoramidic		40881-98-9	30	2.2
Fluorine		7782-41-4	6.17	15
Germanium tetrafluoride		7783-58-6	2.11	15
HN1 (nitrogen mustard-1)	Bis(2-chloroethyl)ethylamine	538-07-8	NA	100g
HN2 (nitrogen mustard-2)	Bis(2-chloroethyl)methylamine	51-75-2	NA	100g
HN3 (nitrogen mustard-3)	Tris(2-chloroethyl)amine	555-77-1	NA	CUM 100g
Hydrogen cyanide	Hydrocyanic acid	74-90-8	4.67	15
Hydrogen selenide		7783-07-5	0.07	15
Isopropylphosphonothioic		1498-60-8	30	2.2

Chemicals of Interest	Synonym	CAS Number	Min. Conc. (%)	STQs (in pounds unless otherwise noted)
Isopropylphosphonyl difluoride		677-42-9	NA	100g
Lewisite 1	2-	541-25-3	NA	100g
Lewisite 2	Bis(2-	40334-69-8	NA	100g
Lewisite 3	Tris(2-chlorovinyl)arsine	40334-70-1	NA	100g
Methylphosphonothioic		676-98-2	30	2.2
Sulfur mustard (Mustard	Bis(2-chloroethyl)sulfide	505-60-2	NA	100g
O-Mustard (T)	Bis(2-chloroethylthioethyl)ether	63918-89-8	NA	100g
Nitric oxide	Nitrogen oxide (NO)	10102-43-9	3.83	15
Nitrogen mustard hydrochloride	Bis(2-chloroethyl)methylamine	55-86-7	30	2.2
Nitrogen trioxide		10544-73-7	3.83	15
Nitrosyl chloride		2696-92-6	1.17	15
Oxygen difluoride		7783-41-7	0.09	15
Phosgene	Carbonic dichloride;carbonyl	75-44-5	0.17	15
Phosphine		7803-51-2	0.67	15
Propylphosphonothioic		2524-01-8	30	2.2
Propylphosphonyl difluoride		690-14-2		100g
Selenium hexafluoride		7783-79-1	1.67	15
Sesquimustard	1,2-Bis(2-chloroethylthio)ethane	3563-36-8	NA	100g
Soman	o-Pinacolyl methylphosphonofluoridate	96-64-0	NA	100g
Stibine		7803-52-3	0.67	15
Sulfur tetrafluoride	Sulfur fluoride (SF4), (T-4)-	7783-60-0	1.33	15
Tabun	o-Ethyl-N,Ndimethylphosphoramido- cyanidate	77-81-6	NA	100g
Tellurium hexafluoride		7783-80-4	0.83	15
Thiodiglycol	Bis(2-hydroxyethyl)sulfide	111-48-8	30	2.2
VX	o-Ethyl-S-2-diisopropylaminoethyl methyl	50782-69-9	NA	100g