Volunteer State Community College

Chemical Hygiene Plan

Environmental Health & Safety

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Emergency Contact Information

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PURPOSE AND SCOPE

Volunteer State Community College is committed to preserving and protecting the health and safety of students, faculty, staff, the surrounding community, and the environment. Believing that it is prudent to minimize all chemical exposure, Environmental Health and Safety (EH&S) provides this Chemical Hygiene Plan as guidance regarding the safe use, storage, and handling of chemicals that may be present in campus laboratories. This Plan applies to all laboratories at Volunteer State Community College where chemicals are stored or used, including Highland Crest, Livingston and Cookeville campuses.

REGULATORY REQUIREMENTS

This Chemical Hygiene Plan sets forth procedures, equipment, personal protective equipment, and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in the workplace. This plan includes all required elements to satisfy the requirements of the Occupational Safety and Health Administration (OSHA) laboratory safety standard 29 CFR 1910.1450 and the Resource Conservation and Recovery Act (RCRA) of 1984.

ROLES AND RESPONSIBILITIES

According to OSHA, The chief executive officer of the institution has ultimate responsibility for chemical hygiene within the institution and must provide continuing support for institutional chemical hygiene. EH&S is responsible for assisting Principal Investigators, laboratory supervisors, laboratory technicians and other employees with implementation of appropriate chemical hygiene guidelines and practices.

EH&S is also responsible for monitoring the use and disposal of chemicals used in the lab, overseeing a program for regular audits of laboratories and other units using chemicals, helping program directors develop precautions and adequate facilities for specific projects, knowing the current legal requirements concerning regulated substances, and for seeking ways to improve the chemical hygiene program.

The Chemical Hygiene Plan is a product of EH&S. It is reviewed annually, and any appropriate revisions are made by EH&S. EH&S provides timely and relevant information regarding safety and regulatory requirements, conducts compliance inspections, and coordinates hazardous waste pick-up/disposal.

Implementation of this chemical hygiene program is mandatory and is designed to minimize exposures. The plan is to be a regular, continuing effort in academic teaching laboratories. The Principal Investigator (PI), or Division Dean, has the overall responsibility for compliance with the Chemical Hygiene Plan in his or her laboratory.

The PI must know the legal requirements applicable to his or her laboratory and must assure:

- Laboratory workers and others entering the laboratory know and follow chemical hygiene standard operating procedures (SOP's).
- Proper management of the hazardous waste satellite accumulation site(s) located in his or her area.
- Appropriate laboratory attire is worn and that appropriate personal protective equipment is available.
- Appropriate training is provided to all occupants of the laboratory.
- Unsafe conditions or inadequate facilities are reported to EH&S and/or Plant Operations.
- Accurate and timely chemical inventory records are maintained, and restricted quantities are not exceeded.

- Safety Data Sheets (SDS's) for all chemicals in the inventory are current and readily available at all times.

Individual laboratory workers are responsible for:
Planning and conducting each operation in accordance with the SOP outlined in the Chemical Hygiene Plan.
Wearing appropriate personal protective equipment including, but not limited to, long pants, safety glasses, and appropriate shoes in the laboratory.
Developing good laboratory hygiene habits.
Promptly reporting unsafe behavior or conditions to the PI, lab supervisor or to EH&S.

DESIGN REQUIREMENTS FOR LABORATORIES

The laboratory facility must have an appropriate general ventilation system with air intakes and exhausts located to avoid intake of contaminated air. Stockrooms and storerooms must be well-ventilated. The general laboratory ventilation system must provide a source of air for breathing and for input to local ventilation devices. However, the general ventilation system, or building ventilation, should not be relied upon for protection from toxic substances released into the laboratory. The ventilations system should be balanced so that the laboratory air is continually replaced, preventing increase of air concentrations of toxic substances during the working day. The laboratories should be under negative pressure with respect to hallways and other non-laboratory areas; that is, there must be direct air flow into the laboratory from non-laboratory areas and out to the exterior of the building.

The laboratory must be equipped with appropriate laboratory hoods and sinks, and with safety equipment that includes plumbed in eyewash fountains and drench showers. A laboratory hood with 2.5 linear feet of hood space per person should be provided for every 2 workers if they spend most of their time working with chemicals. Each hood should have a continuous monitoring device for confirmation of adequate hood performance before use. If this is not possible, work with substances of unknown toxicity must be avoided or other types of local ventilation devices should be used, such as ventilated storage cabinets, canopy hoods, snorkels, or glove boxes.

Exhaust air from glove boxes and isolation rooms should be passed through scrubbers or other treatment before release into the regular exhaust system. Cold rooms and warm rooms should have provisions for rapid escape and for escape in the event of electrical failure.

MAINTENANCE REQUIREMENTS FOR LABORATORIES

Equipment – Chemical-hygiene-related equipment, such as hoods, eyewashes, safety showers, should be continually appraised and should be modified if inadequate. This equipment must undergo scheduled maintenance by Plant Operations, but there may be routine maintenance tasks that must be performed by the laboratory staff. For example, for sanitation reasons, the eyewashes must be tested and flushed monthly. Workspaces must be kept clean and uncluttered.

Ventilation -- Alteration of the ventilation system should only be made if thorough testing indicates that worker protection from airborne toxic substances will continue to be adequate. Four to twelve room air changes/hour is normally adequate general ventilation if local exhaust systems such as hoods are used as the primary method of control. General airflow should not be turbulent and should be relatively

uniform throughout the laboratory, with no high velocity or static areas. Airflow into and within fume hoods should not be excessively turbulent, and hood face velocity should be adequate (100 cfu/min +/- 20%). Ventilation should be evaluated, qualitatively and quantitatively, upon installation, regularly monitored and maintained, and reevaluated whenever a change in local ventilation devices is made.

Housekeeping – Benches and other work areas should be kept clean. Floors should be cleaned regularly. Inspections by the laboratory supervisor should be performed daily. Stairways and hallways are not to be used as storage areas. Access to exits, emergency equipment, and utility controls must never be blocked.

GENERAL STANDARD OPERATING PROCEDURES

These procedures are general laboratory procedures that must be followed in all laboratories. Enforcement of these procedures is the responsibility of the PI or his or her designated laboratory supervisor. The PI is also responsible for ensuring that the work conducted, and its scale must be appropriate to the physical facilities available, particularly with respect to the quality of ventilation.

Reporting accidents

Accidents with personal injury must be reported to the laboratory supervisor and Campus Police on the day in which the injury occurred. Campus Police will complete an incident report and when necessary, contact the Manager of EH&S.

Immediate action in the event of a spill

First aid for any exposed personnel is a priority. First Aid information can be found on the Safety Data Sheet (SDS) for all chemicals on campus.

Spill Cleanup

Small spills must be cleaned up immediately and under the supervision of the laboratory supervisor, using a readily accessible spill kit. In the event of a larger spill, call EH&S at 230-3617. If conditions are thought to present an immediate danger to life and health, vacate the area and call Campus Police at 230-3595 or *0 from a campus phone.

Emergency Response

A written, laboratory specific emergency plan should be established and communicated to all personnel. The plan should include procedures for ventilation failure, evacuation of the laboratory, first aid and securing medical care, and reporting. Regular laboratory safety meetings and drills are recommended. There must be procedures for alerting all personnel in the laboratory, including areas such as growth chambers and cold rooms. Contact EH&S at 230-3617 for assistance in developing such a plan.

Minimize exposure

Minimize exposure by careful use of chemicals and by good housekeeping. Key provisions should include a prompt cleanup of equipment and work area, as well as the washing of hands prior to leaving the laboratory. Almost all laboratory chemicals involve some degree of hazard. Do not underestimate the risk. Exposure should be minimized, even for substances not known to be hazardous. Some chemicals involve particular hazards, and for these, special precautions may be necessary. Always assume that any mixture of chemicals is more toxic than its most toxic component. The Permissible Exposure Limits (PEL) of OSHA and the Threshold Limit Values (TLV) of the American Conference of Governmental Industrial

Hygienists should not be exceeded. Avoid "routine" exposure by developing and encouraging safe habits; avoid unnecessary exposure to chemicals by any route. Do not smell or taste chemicals. Vent any apparatus that may discharge toxic chemicals (vacuum pumps, distillation columns, etc.) into local exhaust devices. Inspect gloves and test glove boxes or other containment equipment before use. Be especially careful of releasing toxic substances in cold rooms and warm rooms, since these have contained recirculated atmospheres.

Knowledge of the chemicals used
Before a substance is received, information on proper handling, storage, and disposal should be made known to those who will be involved. No container should be accepted without an adequate identifying label. Chemical names and labels on each container should be carefully checked and double-checked prior to use. All chemical use should be preceded by knowledge of the chemical characteristics and its potential hazards.

Chemical Storage
Toxic substances must be segregated in a well-identified area with local exhaust ventilation. Chemicals that are highly toxic or reactive, or chemicals in containers that have been opened, should be in unbreakable secondary containers. Stored chemicals should be examined at least once a semester for expiration date, deterioration, and container integrity. Stockrooms and storerooms should not be used as preparation or repackaging areas. They should be open only during normal working hours, and should be controlled by one responsible individual. Amounts kept in inventory should be as small as practical. Storage on bench tops and in hoods is inadvisable. Exposure to heat or direct sunlight should be avoided. Periodic inventories should be conducted, with unneeded items being discarded or returned to the storeroom/stockroom.

Food, Drinking, Smoking, Cosmetics
Eating, drinking, smoking, or the applying of cosmetics is not permitted in any laboratory. All food and drink materials, -- e.g., coffee cups, glasses -- are to be left outside the laboratory.

Horseplay - is not permitted.

Pipetting by mouth suction - is not permitted.

Appropriate personal apparel - must be worn in the laboratory. In particular, loose sleeved shirts and blouses should be avoided, as should sandals or open footwear of any type.

Work area
Good housekeeping is of paramount importance for maintaining a safe laboratory environment. Lab benches and workspaces must be kept clean and neat. Items such as coats and backpacks must be stored appropriately. Individual employee/student responsibility for maintaining a safe and clean work area should be emphasized by the PI and/or laboratory supervisor.

Eye protection
Contact lenses should not be worn in laboratories. Goggles or safety glasses with splash shields are required and must be worn at all times.

Careful planning - must precede all laboratory operations.

Unattended operations
Require careful prior planning and consideration and must have prior approval of the PI or laboratory supervisor.

Containment
When chemicals are hand carried, the container should be placed in a secondary container or bucket. Freight-only elevators should be used if possible. Provisions also must be made for secondary containment in the event of spills or container breakage.

Laboratory fume hoods
All laboratory facilities must be engineered to provide adequate ventilation. Containment of airborne substances is best prevented by use of fume hoods or similar EH&S approved ventilation devices. Fume hoods must be used for all operations that have the potential to release fumes, gases, or volatile solvent vapors in excess of recommended exposure levels.

Laboratory and teaching assistants - are to be instructed in laboratory safety practices.

Appropriate safety precautions - are to be stressed in laboratory lectures whenever specific hazards are anticipated.

Storage of flammable solvents - is to be kept to a minimum, in laboratories, and such solvents are to be stored in a flammable cabinet. See Appendix II for specific information regarding the handling of flammable and combustible liquids.

Compressed gas cylinders - used in the laboratory are to be secured (chained or strapped) at all times. When cylinders are being transported, they must be secured, and the protective caps must be in place. For additional information, see Appendix III.

Acids and bases - are to be stored separately in clearly labeled containers.

Hydrides and active metals - will be stored separately.

All hazardous conditions - are to be corrected immediately upon discovery.

Teaching labs - must be supervised at all times. If the Teaching Assistant (TA) must leave, the lab must be left under the supervision of a qualified designee.

No solitary work - is permitted in laboratories. A "buddy system" will be used unless written permission is given by the PI or laboratory supervisor. Permission will be required for after hours work.

Work with corrosive agents - such as acids and bases must be conducted with particular care to avoid skin and eye contact.

AIC powered laboratory equipment – must be equipped with safety grounds and three prong plugs unless internally grounded by the manufacturer.

Laboratory operations - that have the potential to create fires or explosions require special procedures and safety equipment. Such operations must have prior approval of the laboratory supervisor. Safety equipment such as fire extinguishers, shields and safety showers must be checked prior to such operations.

Low temperature operations - such as procedures using dry ice or liquid gas require special care to avoid frostbite, container rupture, or condensation of liquid oxygen. Glass Dewar flasks should be taped to avoid flying glass resulting from failure. Such operations require prior approval of the PI or laboratory supervisor.

Pressurized or vacuum operations - often require special protective equipment such as shielding. Such operations require prior approval of PI or laboratory supervisor.

Chemicals with limited shelf life – may require special handling or storage procedures. Examples include solvents that form peroxides, such as diethyl ether; chemicals that decompose upon storage to form potentially dangerous pressures, such as formic acid; and chemicals that become unstable upon storage, such as picric acid.

Special hazards – Some chemicals pose special hazards. The effects of exposure to these chemicals may not be immediately or readily apparent, but may nevertheless, be serious. Examples of such substances include allergens and embryotoxins. Allergens (examples: diazomethane, isocyanates, bichromates) require the use of suitable gloves to prevent hand contact with known allergens or substances of unknown allergenic activity. Examples of embryotoxins include organomercurials, lead compounds, and formamide. Women of childbearing age should handle these substances only in a hood whose satisfactory performance has been confirmed, using appropriate protective apparel (especially gloves) to prevent skin contact. Some substances are chemicals of high chronic toxicity. Examples of these substances include dimethylmercury and nickel carbonyl, benzo-a-pyrene, N-nitrosodiethylamine, many chemicals classified as human carcinogens. Access to these chemicals should be controlled, and all transfers and work with these substances should take place in a "controlled area", with a restricted access hood, glove box, or portion of a lab, designated for use of highly toxic substances, for which all people with access are aware of the substances being used and necessary precautions. These chemicals require a plan for use and disposal of these materials and require express approval of the laboratory supervisor. Contact EH&S for additional information.

Chemical inventory – The kinds and amounts of chemicals in the laboratory must be documented and the record kept current. **The OSHA Laboratory Standard requires that an itemized inventory be available for each laboratory**. The PI, or his/her designee, is responsible for maintaining an accurate and current list of materials in his or her laboratory. It is recommended that each department maintain a separate copy of the inventory list in the departmental office.

Safety Data Sheets –SDS's are required for each and every chemical in the laboratory and must be readily accessible on site for all employees/students at all times. The PI has responsibility for maintaining current SDS's and ensuring that all new chemicals have been uploaded into the electronic database. Instructions to access our Electronic library must be provided to all employees and shared with all students at the beginning of each semester. See Appendix IV for Instructions for accessing our library.

Environmental monitoring – Regular instrumental monitoring of airborne concentrations is not usually justified or practical in College laboratories, but may be appropriate when testing or redesigning hoods or other ventilation devices, or when a highly toxic substance is stored or used regularly. Please consult EH&S for advice or assistance.

Contact information - Signs must be in place for adequate notification of emergency responders, including EH&S, the PI or laboratory supervisor, responsible experimenter, and backup personnel.

All persons in the laboratory should remember these basics rules

1. Think in terms of safe practice continuously.
2. Be familiar with every step of the job you are going to do.
3. Check each apparatus item and chemical at least twice before proceeding.
4. Maintain an awareness of the danger in handling chemicals
5. Remember that the safe way is the best way to accomplish any job.
6. Guard your own safety and that of co-workers.
7. Prepare your response to possible accidents by forethought.
8. Act promptly and in a calm manner when confronted with an emergency.
9. Suggest a safe practice immediately when you see the need for one.
10. Be certain that your laboratory has the appropriate safety equipment.

MANAGEMENT PRACTICES

Principal Investigators, laboratory supervisors and laboratory technicians have the responsibility for maintaining safe standard operating procedures and for making specific revisions to the procedures as appropriate and necessary. Principal Investigator is the department Dean responsible for research laboratories and specific laboratory sections. Laboratory supervisor is the department Chair who reports directly to the PI. Laboratory Technicians may be responsible for the day-to-day activities in the lab.

Management practices should take into consideration the following in order to prevent or minimize exposure to chemicals:

General principles - Many chemicals, because of concentration, toxicity, flammability, carcinogenicity, or other characteristics, are potential health hazards or safety hazards. The intent of the Chemical Hygiene Plan is to provide guidelines for handling and using chemicals without causing harm to the user, other personnel, or to the laboratory environment. Any revision or deviation from the SOP should reflect the same intention.

Minimize exposure – Exposure should be minimized, even for substances with no known significant hazard. When working with substances that are known to be hazardous, special precautions must be taken.

Do not underestimate risk - Always assume that a mixture presents at least all the hazards of its components and that all substances of unknown toxicity are toxic.

Assess employee and student exposure - Maintain employee and student exposure below the OSHA Permissible Exposure Limits (PEL) and other applicable exposure limits by informed assessment of exposure potential and monitoring of the workplace exposure as appropriate.

Apply engineering controls - Engineering controls and personal protective equipment should be used to minimize exposure. Control methods, such as laboratory hoods, local exhaust ventilation, enclosures, wet methods, etc., should be applied in preference to depending on personal protective equipment such as respirators.

Chemical inventory - Chemical inventories should be kept to a minimum in working laboratories. These minimal inventories must be stored in a safe manner using chemical safety cabinets for flammable chemicals and acid cabinets (or other appropriate storage such as secondary containment trays lined with clay absorbent) for corrosives. Chemicals must be segregated by chemical characteristics to avoid incompatibilities. Strong acids and bases must not be stored adjacent to each other. For example, ammonium hydroxide is not to be stored adjacent to acetic acid or hydrochloric acid. Nitric acid (an oxidizer) must not be stored adjacent to glacial acetic acid (a flammable). Alphabetical storage sequences are not adequate if chemical characteristics are ignored. See Appendix V Chemical Compatibility & Storage Groups

Hazardous chemical inventory – In the event of an emergency, it is imperative that emergency responders know what hazards they may encounter. Therefore, the PI, laboratory supervisor or Lab Tech. must maintain a current hazardous chemical inventory list in the laboratory. This hazardous chemical list should be reviewed and updated, at a minimum, each semester or as necessary for chemical removal and new chemical additions. <u>This inventory must be posted in the laboratory, near the door, and a copy should be kept on file in the departmental office.</u> In addition, copies should be forwarded to EH&S.

Chemical containers. - All chemical containers must be kept capped or lidded at all times, except when chemicals are actually being transferred. All chemical containers must be in good condition, not leaking, and accurately and completely labeled with respect to contents. The identity of the chemical(s) must be spelled out.

Adequate ventilation. - Adequate ventilation is essential for minimizing exposure. It is the responsibility of the PI or laboratory supervisor to terminate laboratory operations if ventilation is judged to be inadequate for any reason such as equipment malfunction or accidental spillage. Annual Fume Hood Testing/Certification is scheduled by EH&S. Plant Operations is responsible for contracting out routine maintenance on fume hoods. Any known or suspected malfunction of a fume hood should be promptly reported to Plant Operations.

The following guidelines should govern the use of fume hoods and should be posted on each hood:

- ***Confirm that hood is operational.*** If hood is equipped with a local on/off switch, make sure switch is in the on position. Check the air flow gauge if hood is so equipped. If not, attach a telltale (a one inch by six inch piece of crepe paper or tissue attached to the bottom of the sash). The telltale should be noticeably pulled toward the back of the hood.

- ***Set up work at least six inches from the face opening.*** This will avoid turbulence at the sash edge and provide greater protection.

- ***Separate and elevate each instrument inside hood.*** Use blocks or racks to elevate equipment one to two inches off the hood deck surface so that air can easily flow around all apparatus with no disruption.

- ***Lower sash to the optimum height.*** The sash will then act as a physical barrier in the event of an unplanned incident in the hood. The Optimum height for each fume hood is marked on each individual hood.

- ***Keep hood storage to an absolute minimum.*** Excess materials in the hood disrupt airflow and can act as a barrier or cause airflow to bounce back across the face of the hood. Keep the back bottom slot clear at all times as it serves as an exhaust port for fumes and heat generated near the surface.

- ***Minimize foot traffic near and around the hood.*** Persons walking past the hood can create competing air currents.

- ***Keep laboratory doors closed.*** Cross drafts due to open doors or the use of fans should be eliminated.

- ***Use extreme caution with ignition sources inside a fume hood.*** Ignition sources, (e.g., electrical connections and equipment, hot plates, open flames) will ignite flammable vapors or explosive particles from materials inside the hood. All electrical equipment used inside a fume hood must be designed or certified as intrinsically safe unless it can be absolutely established (and enforced) that flammable or explosive materials will not be used in a particular hood.

- ***Persons must never put their heads inside a hood that is in use.*** The plane of the sash is a boundary that should not be crossed except to set up or dismantle equipment.

- ***Clean up spills as soon as possible.***

- ***Lower the sash completely*** when the hood is unattended.

- ***Do not dismantle or modify the hood or exhaust system in any way.***

- ***Promptly report airflow and/or structural problems with the hood*** to Plant Operations Maintenance Department at 3601.

- ***Never use a hood that has been tagged out of service.***

Food & **beverages. -** No food or beverages intended for human consumption may be stored or consumed in the laboratory at any time. Likewise, the application of cosmetics in the laboratory is prohibited.

Contact lenses -The wearing of contact lenses while working in the laboratory is strongly discouraged. Particles or caustic chemicals can become trapped under the lens, causing physical damage or chemical burns to the cornea. The gas-permeable type contact lens may absorb vapors that interact with eye lens moisture to cause a burn.

Personal Protective Equipment - Routine laboratory personal protective equipment should include protective eyewear. Goggles are preferable, as they provide a seal around the eye, protecting it from splashes. It should be noted that pending OSHA regulations require eye protection to include side shields, Ordinary glasses or safety glasses without side shields would not be adequate under the proposed regulations. Polycarbonate glasses should be worn if the work being performed involves the risk of impact to the eye. Gloves should be worn for work with strong corrosives or with acutely toxic chemicals. Nitrile gloves offer greater protection from chemicals and are more puncture resistant than latex. Special procedures may require additional or special protective equipment.

Eye Wash Stations & **Drench Showers. -** Eye wash stations and emergency drench showers are necessary in order to minimize exposures in the event of an emergency. Eye wash stations must be flushed monthly to maintain them in a sanitary condition. The laboratory supervisor, or designee, is responsible for performing monthly testing of safety showers and eye wash stations and providing documentation of results. Access to both eyewash stations and safety showers must be free and unobstructed at all times. In an emergency, personnel must be able to access the stations within 10 seconds. EH&S will audit documentation during routine inspections.

Air Quality Monitoring - Air quality monitoring will be performed if the laboratory supervisors report conditions that might lead to excessive exposure. This air quality monitoring will be performed by qualified personnel, either from EH&S or by an outside consultant.

SIGNS AND LABELS

Appropriate signage is required for all hazard areas, and all chemicals and waste containers must be appropriately labeled. Questions regarding labeling requirements should be addressed to EH&S (230-3617).

Laboratory Entrances – An NFPA diamond must be posted on all laboratory entry doors stating the classes of hazardous chemicals used or stored in the laboratory. If there are any other hazards in the laboratory, e.g., lasers, magnetic field, radiation, these also must be listed on the door in accordance with the regulations pertaining to them. In addition, there must be a placard listing the names and telephone numbers of the person(s) to be contacted in the event of an emergency.

"Eye Protection Required Beyond This Point" (or equivalent) must be posted at the entry to all laboratories and chemical storage areas. Protective eyewear, in the form of splash goggles or safety glasses with side shields, is required at all times in laboratories or chemical storage areas.

Bottles & **Containers -** All bottles or other containers of chemicals in the laboratory work or storage areas shall be labeled with the NFPA standard warning label, or similar warning label, so that the potential hazard is obvious. Labels must be maintained in a legible condition. Labeling and maintenance of the labeling are the responsibility of the laboratory supervisor or designee.

Waste Accumulation Areas – Each laboratory generating hazardous waste must designate an appropriate area as a satellite accumulation area and must label the area as such. Waste accumulation must be restricted and limited to these areas, and not stored in any other area in the laboratory. The location of satellite accumulation areas must not be changed without prior notification to EH&S.

Waste Accumulation Containers - All hazardous waste accumulation containers must be specifically labeled with the words "HAZARDOUS WASTE" and with the identity of the contents. The names of the chemicals must be spelled out. Chemical symbols or abbreviations are not acceptable. When the container is full, it must be labeled with the final fill date. EH&S must be notified, so that the container is picked up. It is important to remember to leave sufficient head-space in filled waste containers to avoid breakage due to excess pressure.

Emergency Contact Information – Telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers must be posted near the telephone. Emergency response agencies are best contacted by dialing 911.

Warnings – Signs must be posted designating safety showers, eyewash stations, other safety and first aid equipment, exits, and for areas where food and beverage consumption and storage are permitted. Warnings must be posted in areas or near equipment where special or unusual hazards exist.

Lockout/tagout – It will occasionally be necessary to take a fume hood or other piece of equipment out of service for maintenance or safety reasons. When this happens, a sign or tag will be placed on the equipment advising users that the equipment is out of service. **DO NOT REMOVE THESE TAGS. DO NOT USE EQUIPMENT THAT HAS BEEN TAGGED OUT**. The tags will be removed when the equipment is ready for use.

TRAINING

Each employee covered under this Chemical Hygiene Plan must be provided with information and training concerning the hazards of the chemicals present in his or her work areas. Hazard Communication training and Lab Safety training must be provided at the time of initial assignment and prior to any new assignments involving different exposure situations. Additional, job-specific training may be required for persons whose duties involve particular hazards, such as those associated with laboratories. Providing and documenting this training is the responsibility of the Principal Investigator or his/her designee. Documentation of the training must be kept in the laboratory and a copy must be provided to EH&S.

Refresher training is required annually. The responsibility for providing and documenting the refresher training is the responsibility of the Principal Investigator or designee. Copies of the training materials and documentation (sign-in sheets, etc.) must be forwarded to EH&S.

Student laboratory assistants must receive training prior to their supervision of other students. This training must be provided at the beginning of their employment by their laboratory supervisor or course instructor. Copies must be forwarded to EH&S.

Custodians and other Plant Operations personnel who work in laboratory areas must be provided site-specific training under the Hazardous Communication Standard. This training is available from EH&S, but arranging for and documenting the training is the responsibility of the Supervisor.

Outside contractors, or college workers from such areas as Plant Operations must be informed of the hazards to which they might be exposed while working in the laboratory environment. The department

that contracts for the work has the responsibility for informing workers of these hazards and for providing any associated training that will be site-and job-specific.

Site-specific training must include, at a minimum, the following information:

- contents and availability of the Chemical Hygiene Plan
- Permissible Exposure Limits (PEL) for OSHA regulated substances and recommended exposure limits for other hazardous chemicals where PEL do not exist.
- symptoms associated with exposure to the hazardous chemicals used in the laboratory
- physical properties and health hazards of chemicals in the work area
- location and availability of Safety Data Sheets (SDS)
- methods and observations that may be used to detect the presence or release of a hazardous chemical
- measures that employees and students can take to protect themselves from these hazards, including specifics such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

In addition to hazard communication training, all faculty, staff, and students who manage or handle hazardous waste must have documented Hazardous Waste (RCRA) Awareness Training. The laboratory supervisor, or designee, is responsible for providing this training to employees and students. The training must be provided and documented at the time of initial employment and annually thereafter. At a minimum, the training must include basic RCRA requirements for:

- Storage requirements for hazardous waste; e.g. closing containers, head space, etc.
- Labeling of waste containers
- Choosing appropriate containers
- Compatibility of wastes
- Classification and sorting
- Appropriate disposal procedures

Web-based Hazard Communication, Laboratory Safety and Hazardous Waste (RCRA) training is available through EH&S. Contact Michelle Boyd at ext 3617

MEDICAL SURVEILLANCE

The OSHA Laboratory Standard [29CFR 1910.1450 (g)] mandates that employers provide employees an opportunity for necessary medical attention, examinations, and follow-up examinations at the physician's discretion in the event that:

- an employee develops symptoms associated with a hazardous chemical to which they may have been exposed
- exposure monitoring reveals a persistent exposure level above the OSHA action level, or PEL for OSHA regulated substances
- an event takes place in the work area (such as a spill, leak, explosion or other occurrence) that results in the likelihood of a hazardous exposure.

The PI or designee must *provide the examining physician* the following:

- identity of the hazardous chemical to which employee may have been exposed

- description of conditions of exposure, including exposure date, if available
- description of the symptoms of exposure, if any, that the employee is experiencing
- A copy of the relevant SDS's

The PI or designee should *request and obtain a written opinion from the examining physician* including:

- results of examination and associated tests
- recommendations for further medical follow-up
- any medical condition revealed that may place the employee at increased risk as the result of a chemical exposure
- a statement that the employee has been informed by the physician of the results of the examination or consultation and told of any medical conditions that may require additional examination or treatment

The physician's statement will not include specific findings and/or diagnoses that are unrelated to occupational exposure. Copies of all documentation surrounding the event must be provided to EH&S.

RECORDKEEPING

Accident records must be written and retained. All accidents are to be promptly reported to the PI and/or laboratory supervisor. The PI or supervisor will document the incident and forward a copy to EH&S. Chemical Hygiene Plan records should document that the facilities and precautions were compatible with current knowledge and regulations. Inventory and usage records must be kept for high-risk substances. Medical records will be retained by the institution in accordance with the requirements of state and federal regulations.

APPENDIX I

Hazardous Waste Accumulation

For the Generator and Accumulation Areas:

1. Ensure controlled access to the hazardous waste accumulation area. The area should be locked when there is no one in the laboratory or work area.

2. All hazardous waste accumulation areas must be identified as such with a sign stating that the area is for the accumulation of hazardous waste materials, and containers must be correctly labeled and kept closed. Appendix I – Satellite Accumulation Area Sign

3. All hazardous waste containers must be labeled with the words "Hazardous Waste" with the chemical(s) in the container listed on the label.

4. The amount of hazardous waste permitted to be stored in the satellite accumulation areas is limited to 55 gallons. (Amount of Extremely Hazardous Waste is limited to one quart.) Operations expected to generate more than these amounts must be reported to EH&S immediately and the date the waste exceeded these amounts must be recorded.

5. When the container is 2/3 full, move to hazardous waste storage on Wallace Dock and notify EH&S when disposal is needed. *A detailed list of the waste must be provided to EH&S for disposal.

6. All chemicals must be separated with respect to compatibility.

7. All flammable materials must be stored in a "FLAMMABLES" cabinet.

8. All containers of chemicals must be labeled with the name of the chemical in the containers. (even bottles containing water.) Products with trade names must be kept in the original labeled container.

9. All containers of chemicals must be kept closed at all times, except when removing materials or (in the case of hazardous waste containers) adding waste. Be sure to leave adequate head space in the container (a minimum of 2-3 inches is recommended for most containers).

10. Emergency phone numbers must be posted by the telephone and at the door. If there is not a phone in the area where hazardous materials are used or stored, the emergency phone numbers must be posted at the door.

11. In areas that contain more than one hazardous chemical, a chemical list must be available at all times. Safety Data Sheets (SDS's) must be kept on site and available upon request.

12. All personnel working in an area that could generate hazardous waste must take the RCRA Training. The training must be updated annually.

13. All personnel handling hazardous materials must wear the appropriate personnel protective equipment; e.g., closed-toed shoes, long pants, gloves, eye protection, etc.

14. A spill kit must be readily available in each area. Small spills may be cleaned up by generator; large spills must be reported to EH&S. Catastrophic releases - call Campus Police at 3595 and EH&S at 3617.

To dispose of hazardous waste contact EH&S at 615-230-3617

APPENDIX II

Control Procedures for Flammable and Combustible Liquids

FLAMMABLE AND COMBUSTIBLE CHEMICALS

Flammable and combustible chemicals include liquids such as organic solvents, oils, greases, tars, oil base paints, and lacquers as well as flammable gases. Flammable and combustible liquids are defined by their flash points. The flash point of a liquid is the minimum temperature at which it gives off sufficient vapor to form an ignitable mixture with the air near its surface or within its containment vessel. As a general rule, the lower the flash points of a liquid, the greater the fire and explosion hazard. Flammable and combustible liquids are classified by and divided into classes by the National Fire Protection Association based on their flash points:

Flammable Liquids (Class I): Liquids having flash points below 100oF (37.8oC) and having vapor pressures not exceeding 40 pounds per square inch (absolute) at 100oF (37.8oC). Flammable Class I liquids are subdivided as follows:

Class IA: Liquids having flash points below 73oF (22.8oC) and boiling points below 100oF (37.8oC). Flammable aerosols (spray cans) are included in Class IA.
Class IB: Liquids having flash points below 73oF (22.8oC) and having boiling points at or above 100oF (37.8oC).
Class IC: Liquids having flash points at or above 73oF (22.8oC) and below 100oF (37.8oC). The boiling point is not considered.

Combustible Liquids (Classes II and III): Liquids having flash points at or above 100oF (37.8oC). Combustible liquids in Classes II and III are subdivided as follows:
Class II: Liquids having flash points at or above 100oF (37.8oC) and below 140oF (60.0oC).
Class IIIA: Liquids having flash points at or above 140oF (60.0oC) and below 200oF (93.4oC).
Class IIIB: Liquids having flash points at or above 200oF (93.4oC).

CONTROL MEASURES
PIs and Supervisors are responsible for identifying flammable and combustible liquids used in their respective work areas. SDS's for specific compounds should be reviewed.
An evaluation of the controls in place is necessary to limit employee exposures to these agents. For assistance in performing evaluations, contact EH&S at 230-3617.

TRAINING AND INFORMATION

Employees who handle or who may be exposed to hazardous materials must be trained in the specific hazards and controls of the materials being handled. Providing for area-specific training for handling flammable and combustible materials is the responsibility of the Principal Investigator. EH&S is available to provide assistance.

Primary and secondary containers must be labeled with the identity and classification of the substance. The entrance to the work area shall be posted with a caution placard (NFPA diamond) depicting the hazards.

SUBSTITUTION/CHEMICAL MANAGEMENT
The PI or lab supervisor should determine whether a safer chemical alternative (i.e., materials with higher flash points and boiling points) is available.

Keep working quantities of flammable and combustible liquids to a minimum.

VENTILATION

An explosion-proof fume hood or other appropriate exhaust ventilation system must be used when handling flammable and combustible liquids in a manner that may produce vapors. This includes procedures such as transfer operations, preparation of mixtures, blending, sonication, spraying, heating, and distilling.

WORK PRACTICES
Control all ignition sources when handling flammable and combustible liquids.
Electrically bond and ground containers when transferring Class I flammable liquids and other flammable and combustible liquids at temperatures above their flashpoints.
Use a mechanical aid or a pipette bulb for pipetting.
Open bottles or carboys slowly and carefully and wear protective equipment to guard hands, face, and body from splashes and vapors/gases.
Wipe drips/residues from containers and work surfaces.
Wash hands before leaving the work area and prior to consuming food/beverages.

PERSONAL PROTECTIVE EQUIPMENT (PPE) General guidelines are presented below:
At a minimum, safety glasses with side shields, long pants and closed toed shoes will be worn when handling flammable and combustible materials.
Additional PPE such as face shields, chemical aprons, disposable coveralls, chemically resistant gloves and respiratory protection must be worn as appropriate.

STORAGE

Glass containers of no more than 1 gallon capacity may be used for Class IA or IB flammable liquids if such liquid would be rendered unfit for its intended use by contact with metal or would excessively corrode a metal container so as to create leakage hazard. **Note: this exemption does not apply to the accumulation of non-corrosive ignitable hazardous waste**.

EMERGENCY PROCEDURES
Laboratory/Shop personnel may clean up small spills of flammable and combustible liquids provided that all of the following conditions are met:

The hazards of the material(s) are known, and appropriate precautions can be taken to prevent personal exposure.
Ensure that all ignition sources are controlled during clean up.
There is no potential of a release to the environment.
There are no personal injuries.
The clean up procedures are known and the proper equipment (e.g., PPE and spill clean up materials) is available.
The spill can be cleaned up safely by two people in one hour or less.
The spill does not involve elemental mercury. Special cleanup and air monitoring is required. Contact EH&S for assistance.
If all of these conditions are not met then EH&S (230-3617) should be summoned for spill response.

OTHER CONSIDERATIONS
Never use combustible or reactive materials to clean up or absorb spills of flammable or combustible liquids. Laboratories and shop areas where flammable and combustible liquids are handled should have an adequate number of appropriate spill kits to meet anticipated needs.

An emergency eyewash and safety shower must be located in all areas where flammable and combustible liquids are used. In the event of skin or eye contact, flush the affected area for at least 15 minutes and report to the incident to your supervisor.

APPENDIX III

Safe Handling and Storage of Compressed Gas Cylinders

Gases may present a hazard because they are: flammable, asphyxiate, an oxidizer, corrosive, toxic, cryogenic and/or under pressure. Users of compressed gas should be familiar with procedures for the safe operation of cylinders and the properties and inherent hazards of the products they contain. Information concerning specific gases can be found on the product label and in the SDS.

RESPONSIBILITIES

- Compressed gases must be handled only by properly trained personnel in accordance with applicable regulations and the guidelines.
- The end user (Principal Investigator or Laboratory Supervisor) is responsible for the safe handling and use of compressed gas cylinders and their contents, and for placing and securing the cylinder in the lab.

GENERAL GUIDELINES

- Cylinders must be secured in an upright position at all times during storage, transport and use.
- A cylinder's contents must be identified at all times. Cylinder status (empty, full, in service, etc.) should also be specified.
- The prescribed markings on the cylinders shall be made and kept in a legible condition. The user must not remove or alter any of these markings. If these markings become illegible, the user must provide adequate labeling to identify the contents.
- The labels applied by the gas manufacturer to identify the cylinder contents must not be defaced or removed.
- The user must not modify, tamper with, obstruct, remove, or repair any part of the cylinder, including the pressure relief device and the cylinder valve or the valve protection device.
- Compressed gas streams must not be directed toward any person as this may cause serious injury to the eyes or body.
- Cylinder valve connections must have threads on the regulator connections or other equipment to match those on the cylinder valve.
- The cylinder valve must be kept closed at all times (charged or empty) except when the cylinder is in use. Valve outlets should be pointed away from all personnel when the valve is being opened.
- Piping, regulators, and other apparatus must be kept gas tight to prevent leakage, and this must be confirmed using compatible leak test solution or an appropriate leak-detection instrument. A leak test must be conducted every time the cylinder is reconnected such as during cylinder replacement.
- Before a regulator is removed from a cylinder, the cylinder valve should be closed and the regulator relieved of gas pressure.
- Regulators, gauges, hoses and other apparatus provided for use with a particular gas, or group of gases, must not be used on gas cylinders having different chemical properties unless information obtained from the gas manufacturer indicates that this can be done safely.
- Maintenance of cylinders and their valves or relief devices shall be performed only by trained personnel. This activity is best handled by the original manufacturer.
- An emergency response plan shall be implemented wherever compressed gas cylinders and products are used, handled or stored.

STORAGE

- Containers must not be placed where they might become part of an electrical circuit or arc.
- Compressed gas cylinders must not be exposed to temperature extremes. Storage area temperatures should not exceed 125 degrees F.
- The user must keep valve protection caps on cylinders at all times except when cylinders are secured and connected to dispensing equipment.
- Where valve outlet caps and/or plugs are provided, the user should keep the device on the valve outlet at all times except when the cylinders are secured and connected to dispensing equipment.
- Vented storage areas should be designed to accommodate the various gases required by the user. Adequate spacing or segregation by partitioning must be provided so that cylinders can be grouped together according to hazard class. Incompatible gases must be separated by a minimum distance of twenty feet, or by a wall with a thirty minute fire rating. Additional consideration should be given to separate storage of full and empty containers.
- Containers are not to be stored near readily ignitable substances or be exposed to corrosive chemicals or fumes.
- Containers must not be stored near elevators, walkways, building egresses, unprotected platform edges, or in locations where heavy moving objects may strike or fall on them. Cylinders are not to be stored in mechanical rooms, custodial closets, or utility spaces.
- All compressed gas cylinders in service or in storage at user locations must be secured to prevent falling/tipping/rolling and shall be stored and used valve end up. They can be secured with straps or chains connected to a wall bracket or other fixed surface, or by use of a cylinder stand.

TRANSPORT

- Users of compressed gas cylinders must ensure that the cylinders are not rolled in the horizontal position or dragged. A suitable hand truck, forklift truck, or similar material handling device designed for cylinder transport should be used with the container properly secured to the device. Extreme caution should be used when handling cylinders to guard against dropping or permitting cylinders to violently strike against each other or other surfaces.
- It is necessary to take precautions so that gas cylinders are not dropped or allowed to strike each other or other objects. Dropping or striking may damage the cylinder valve, which could turn the cylinder into a dangerous torpedo with the potential to destroy property and/or injure personnel.
- Personnel who handle cylinders must be trained and instructed NEVER to lift cylinders by using the cylinder cap.

APPENDIX IV

Instructions for Accessing VSCC Safety Data Sheet's

Instructions for Accessing VSCC Safety Data Sheet's (SDS's):

EMPLOYEES - From the Volstate homepage (www.volstate.edu) click on Faculty & Staff. On the right hand side of the screen you will see "MSDSonline" clicking this link will take you to the database.

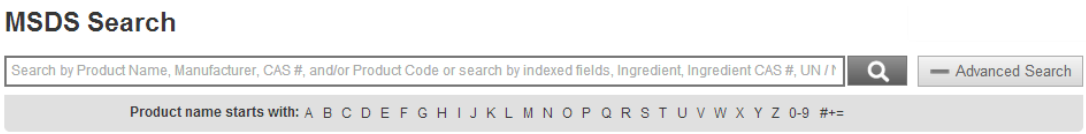
STUDENTS – From the Volstate homepage (www.volstate.edu) click on Current Students. On the right hand side of the screen you will see "MSDSonline" clicking this link will take you to the database.

In addition, the following link will also take you to our library:

https://msdsmanagement.msdsonline.com/company/bb43342e-ea61-43ae-b0fa-9d7ba85faf74/

Please highlight this link, then copy and paste it into your browser's address bar.

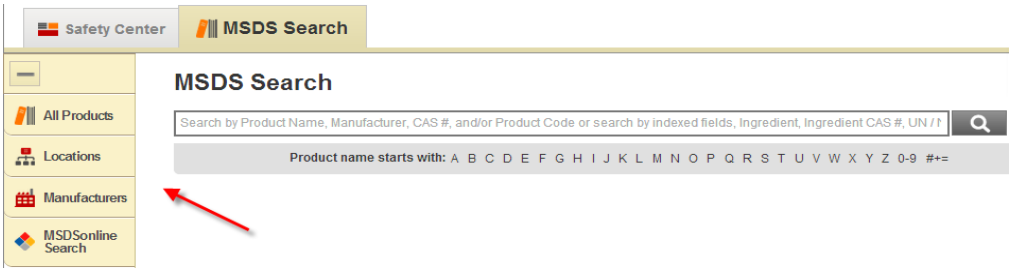
To Search for an SDS within the database:



Type the product information into the single search field and click Search.

Hint: You can search for multiple types of data at once. For example, if you are searching for Acetone manufactured by Sigma, you can type in Acetone Sigma in the single search field to search for both product and manufacturer.

If you are not able to spell the product name, click on the 1st letter of the product name to search for documents that begin with that letter.



To see a full display of documents by Product Name, by Location, or by Manufacturer, click on one of the tabs to the left of the search field.

Once the MSDS has been found:

View the MSDS by selecting the PDF icon to the left of the Product Name. You can print or save the MSDS after viewing the PDF.

If you are not able to find a document in VSCC's library, you will be prompted to either search MSDSonline for the document (where you can then view the MSDS and/or add it to the company database) or use the request tool to obtain an MSDS from your Administrator.

APPENDIX V

Satellite Accumulation Area Sign

HAZARDOUS WASTE

SATELLITE ACCUMULATION AREA

All Containers Must:

- **Be Labeled "HAZARDOUS WASTE"**
- **Closed When NOT Adding Waste**
- **Have Description Of Contents**
- **Maintain Secondary Containment**
- **Be Segregated from Incompatible Materials**

Inspect Area Weekly

In Case of Spill Contact:

Campus Police	**Dial Ext. 3911**
EH&S	**Dial Ext. 3617**

Fire or Medical Emergency - Dial 911 or 3911

APPENDIX VI

Chemical Compatibility Chart

Chemical Compatibility Chart

1	Inorganic Acids	1																						
2	Organic acids	X	2																					
3	Caustics	X	X	3																				
4	Amines & Alkanolamines	X	X		4																			
5	Halogenated Compounds	X		X	X	5																		
6	Alcohols, Glycols & Glycol Ethers	X					6																	
7	Aldehydes	X	X	X	X		X	7																
8	Ketone	X		X	X			X	8															
9	Saturated Hydrocarbons									9														
10	Aromatic Hydrocarbons	X									10													
11	Olefins	X				X						11												
12	Petrolum Oils												12											
13	Esters	X		X	X									13										
14	Monomers & Polymerizable Esters	X	X	X	X	X	X								14									
15	Phenols			X	X			X							X	15								
16	Alkylene Oxides	X	X	X	X		X	X							X	X	16							
17	Cyanohydrins	X	X	X	X	X		X									X	17						
18	Nitriles	X	X	X	X												X		18					
19	Ammonia	X	X					X	X					X	X	X	X	X		19				
20	Halogens			X			X	X	X	X	X	X	X	X	X	X				X	20			
21	Ethers	X													X						X	21		
22	Phosphorus, Elemental	X	X	X																	X		22	
23	Sulfur, Molten									X	X	X	X				X						X	23
24	Acid Anhydrides	X		X	X		X	X							X		X	X	X	X				24

X Represents Unsafe Combo

Represents Safe Combo

Group 1: Inorganic Acids Chlorosulfonic acid Hydrochloric acid (aqueous) Hydrofluoric acid (aqueous) Hydroge n chloride (anhydrous) Hydrogen fluoride (anhydrous) Nitric acid

Oleum Phosphoric acid Sulfuric acid

Group 2: Organic Acids

Acetic acid Butyric acid (n-) Formic acid Propionic acid Rosin Oil

Tall oil

Group 3: Caustics

Caustic potash solution Caustic soda solution

Group 4: Amines and Alkanolamines
Aminoethylethanolamine Aniline

Diethanolamine Diethylenetriamine Diisopropanolamine Dimethylamine Ethylenediamine Hexamethylenediamine

2-Methyl-5-ethylpyridine Monoethanolamine Monoisopropanolamine Morpholine

Pyridine Triethanolamine Triethlamine Triethylenetetramine Trimethylamine

Group 5: Halogenated Compounds

Allyl chloride Carbon tetrachloride Chlorobenzene Chloroform

Chlorohydrines, crude Dichlorobenzene (o-) Dichlorobenzene (p-) Dichlorodifluoromethane Dichloroethyl ether

Dichloropropane Dichloropropene Ethyl chloride Ethylene dibromide Ethylene dichloride Methyl bromide Methyl chloride Methylene chloride

Monochlorodifluoromethane Perchloroethylene

Propylene dichloride 1,2,4-Trichlorobenzene 1,1,1-Trichloroethane Trichloroethylene Trichlorofluoromethane

Group 6: Alcohols, Glycols and Glycol Ethers

Allyl alcoholAmyl alcohol 1,4-Butanediol

Butyl alcohol (iso, n, sec, tert) Butylene glycol

Corn syrupCyclohexyl alcohol Decyl alcohol (n, iso) Dextrose solution Diacetone alcohol Diethylene glycol

Diethylene glycol dimethyl ether Diethylene glycol monobutyl ether Diethylene glycol monoethyl ether Diethylene glycol monomethyl ether Diisobutyl carbitol

Dipropylene glycol DodecanolEthoxylated dodecanol

Ethoxylated pentadecanol Ethoxylated tetradecanol Ethoxylated tridecanol Ethoxytriglycol

Ethyl alcohol Ethyl butanol

2-Ethylbuytl alcohol2-Ethylhexyl alcohol Ethylene glycol

Ethylene glycol monobutyl ether Ethylene glycol monoethyl ether Ethylene glycol monomethyl ether Furfuryl alcohol

Glycerine Heptanol Hexanol

Group 6: Alcohols, Glycols and Glycol Ethers (cont.)

Hexylene glycol Isoamyl alcohol Isooctyl alcohol MethyoxytriglycolMethyl alcohol Methylamyl alcohol Molasses, all Nonanol

Octanol Pentadecanol

Polypropylene glycol methyl ether Propyl alcohols (n, iso)

Propylene glycol Sorbitol Tetradecanol Tetraethylene glycol Tridecyl alcohol Triethylene glycol Undecanol

Group 7: Aldehydes

Acetaldehyde Acrolein (inhibited) Butyraldehyde (n, iso) Crotonaldehyde Decaldehyde (n, iso)

2-Ethyl-3-proplyacroleinFormaldehyde solutions FurfuralHexamethylenetetramine Isooctyl aldehyde Methyl butyraldehyde Methyl formal Paraformaldehyde Valeraldehyde

Group 8: Ketones

Acetone Acetophenone Camphor oil Cylcohexanone Diisobutyl ketone Isophorone Mesityl oxide

Methyl ethyl ketone Methyl isobutyl ketone

Group 9: Saturated Hydrocarbons

Butane Cyclohexane

Ethane Heptane Hexane Isobutane

Liquified natural gasLiquified petroleum gas Methane

Nonane

n-ParaffinsPentane Petrolatum Petroleum ethers Petroleum naphtha Polybutene Propane

Propylene butylene polymer

Group 10: Aromatic Hydrocarbons

Benzene Cumene

p-CymeneCoal tar oil Diethybenzene

Dodecyl benzene DowthermEthylbenzene Naphtha, coal tar

Naphthalene (includesmolten) Tetrahdyronaphthalene Toluene

Triethyl benzene Xylene (m-, o-, p-)

Group 11: Olefins

Butylene 1-Decene

DicylcopentadieneDiisobuytlene Dipentene Dodecene

1-DodeceneEthylene

Liquified petroleum gas 1-Heptene

1-HexaneIsobutylene Nonene

1-Octene1-Pentene

Polybutene Propylene

Propylene butylene polymer

Group 11: Olefins (cont.)

Propylene tetramer (dodecene) 1-Tetradecene

1-TrideceneTurpentine 1-Undecene

Group 12: Petroleum Oils

Asphalt Gasolines

Casingead Automotive Aviation

Jet Fuels

JP-1 (kerosene) JP-3

JP-4

JP-5 (kerosene, heavy) Kerosene

Mineral spirits

Naphtha (non aromatic) Naphtha

Solvent Stoddard solvent VM&P

Oils

Absorption oil Clarified oil Crude oil Diesel oil Fuel oil

No. 1 (kerosene) No. 1-D

No. 2 No. 2-D No. 4

No. 5

No. 6

Lubricating oil Mineral oil Mineral seal oil Motor oil Penetration oil Range oil

Road oil Spindle oil Spray oilTransformer oil Turbine oil

Group 13: Esters

Amyl acetate Amyl tallate

Butyl acetates (n, iso, sec) Butyl benzyl phthalate Castor oil

Croton oil Dibutyl phthalate Diethyl carbonate Dimethyl sulfate Dioctyl adipate Dioctyl phthalate

Epoxidized vegetable oils Ethyl acetate

Ethyl diacetate

Ethylene glycol monoethyl ether acetate Ethylhexyl tallate

Fish oil

Glycol diacetate Methyl acetate Methyl amyl acetate Neatsfoot oil

Olive oil Peanut oil

Propyl acetates (n, iso) Resin oil

Soya bean oil Sperm oil Tallow Tanner's oil Vegetable oil Wax, carnauba

Group 14: Monomers and Polymerizable esters

Acrylic acid (inhibited) Acrylonitrile Butadiene (inhibited) Butyl acrylate (n, iso)

Ethyl acrylate (inhibited)

2-Ethylhexyl acrylate (inhibited) Isodecyl acrylate (inhibited) Isoprene (inhibited)

Methyl acrylate (inhibited) Methyl methacrylate (inhibited) o-Propiolactone

Styrene (inhibited) Vinyl acetate (inhibited)

Vinyl chloride (inhibited) Vinylidene chloride (inhibited) Vinyl toluene

Group 15: Phenols

Carbolic oil Creosote, coal tar Cresols Nonylphenol Phenol

Group 16: Alkylene Oxides

Ethylene Oxide Propylene Oxide

Group 17: Cyanohydrins

Acetone cyanohydrin Ethylene cyanohydrin

Group 18: Nitriles

Acetonitrile Adiponitrile

Group 19: Ammonia

Ammonium hydroxide

Group 20: Halogens

Bromine Chlorine

Group 21: Ethers

Diethyl ether (ethyl ether) 1, 4, Dioxane

Isoprophyl ether Ethers (cont) Tetrahydrofuran

Group 22: Phosphorus, elemental Group

23: Sulfur, molten

Group 24: Acid Anhydride Acetic anhydride Propionic anhydride