Chemical Hygiene Plan

Department of Environmental Health & Safety

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SECTION 1 - SCOPE

This ***Chemical Hygiene Plan*** (CHP) is required by the Occupational Safety and Health Administration's (OSHA) *Laboratory Safety Standard* (29CFR 1910.1450). The CHP covers all College of Southern Nevada (CSN) employees, including staff and faculty, as well as any other parties that work with chemicals and/or may be exposed to the effects of such chemicals at CSN. Department-specific Chemical Hygiene Plans may also be incorporated into the overall plan, as needed, but shall be at least as stringent as this general plan. **The scope of this plan includes all facilities owned or operated by CSN**.

SECTION 2 - PURPOSE

The purpose of this CHP is to establish a working safety plan for use within the laboratory atmosphere. Safety is a collective responsibility that requires the full cooperation of everyone in the laboratory. However, the ultimate responsibility for safety rests with each individual, especially the person carrying out the procedure.

Accidents often result from an indifferent attitude, failure to use common sense, or failure to follow instruction. Each individual within the laboratory should become familiar with what other people are doing within the lab because all can be victims of one individual's mistake. Do not hesitate to point out to fellow lab personnel that they are engaging in an unsafe practice or operation, if needed.

SECTION 3 - RESPONSIBILITIES

The College President has been granted the authority and responsibility for institutional level health and safety planning by the NSHE Board of Regents.

The CSN Director of Environmental Health & Safety is responsible for developing, reviewing, updating and overseeing implementation of the CHP. This includes activities such as acting as a consultant/resource for departments and programs within the College regarding implementation and enforcement, evaluating work practices and use of personal protective equipment (PPE), providing relevant safety program materials, providing and documenting related training, recommending environmental monitoring and response actions, and coordinating any compliance activities, as appropriate.

Division deans and department/program directors are ultimately responsible for compliance with the CHP requirements within their functional units, and for coordination with the CSN Department of Environmental Health & Safety, regarding compliance with the plan. Responsibility for compliance with the CHP shall not be delegated to unqualified personnel.

Supervisors and managers are responsible for ensuring that all requirements of the CHP that apply to their functional work areas are carried out properly. Responsibility for ensuring adherence to the CHP shall not be delegated to non-management personnel without prior consultation with the Director of Environmental Health & Safety.

Supervisors, with assistance from Environmental Health & Safety, shall ensure that all appropriate personal protective equipment (PPE) is available to employees, shall review safe work practices with their employees and, if necessary, post signage in appropriate areas to indicate the hazards and to limit access if necessary.

Each functional work area shall have a responsible (managerial) person designated to:

a. Ensure that the CHP is followed in their work area.
b. Conduct chemical inventories and update the chemical inventory in their work area as needed (with assistance from Environmental Health & Safety).
c. Maintain MSDSs (Material Safety Data Sheets) for all chemicals in their work areas, and ensure their availability to employees and students.
d. Review and update any site specific CHP information annually, at a minimum, or more frequently as needed.
e. Ensure that chemical hygiene training is conducted for all employees within the functional work unit

SECTION 4 - GENERAL GUIDELINES

The following are general guidelines, dos and don'ts to minimize safety and health problems associated with lab work.

a. Follow all safety instructions carefully
b. Become thoroughly acquainted with the location and use of safety facilities such as safety showers, exits and eyewash fountains.
c. Before undertaking any laboratory work
    1) Become familiar with the hazards of chemicals involved. Know the safety precautions and emergency procedures that protect you from those hazards.
    2) Become familiar with the hazards of the apparatus and the operations involved. Know what to do to protect yourself and others from those hazards.

SECTION 5 - PERSONAL PROTECTION

5.1 EYE PROTECTION

All persons in the laboratory including visitors must wear safety goggles/glasses at all times, even when not performing a chemical operation. Wearing of contact lenses in the laboratory is normally forbidden because contact lenses can hold foreign materials against the cornea. Furthermore, they can be difficult to remove in case of a splash. Soft contacts present a particular hazard because they can absorb and retain chemical vapors. If required, face shields and standing shields that protect the face, neck and ears should be used if the operation calls for **full** coverage.

5.2 CLOTHING

Clothing worn in the laboratory should offer protection from splashes and spills; it should be easily removed in case of an accident and should be at least fire resistant. Nonflammable, nonporous aprons offer the most satisfactory and least expensive protection. If worn instead of an apron, lab jackets or coats should have snap fasteners, rather than buttons so they can be readily removed.

5.3 GLOVES

Gloves serve as an important part of personal protection, but they must be used correctly. Check to ensure the absence of cracks or small holes in the gloves before each use. In order to prevent the unintentional spread of chemicals, gloves should be removed before leaving the

work area and before handling such things as telephones, doorknobs, pens/pencils and lab notebooks. Gloves may be re-used, cleaned or discarded, consistent with their use and contamination. If in doubt as to appropriate gloves for specific protection, consult with the lab Manager and/or CSN Environmental Health & Safety

5.4 PERSONAL HYGIENE

Everyone working within the laboratory should be aware of the dangers of ingesting chemicals. These common sense precautions will minimize the possibility of such exposure:

a. Do not prepare, store (even temporarily), or consume food or beverages in any chemical laboratory.
b. Do not smoke in any chemical laboratory. Additionally, be aware that tobacco products in opened packages can absorb chemical vapors
c. Do not apply cosmetics when in the laboratory.
d. Wash hands and arms thoroughly before leaving the lab, even if gloves have been worn.
e. Wash lab coats or jackets on which chemicals have been spilled separately from personal laundry.
f. Never wear or bring lab coats or jackets into areas where food is consumed.
g. Never pipette by mouth. Always use a pipette aid or suction bulb.

5.5 LABORATORY PROTOCOL

The chemical laboratory is a place for working, not for horseplay. Horseplay cannot be tolerated. Variations in procedures, including changes in quantities or reagents may be dangerous. Such alterations may only be made with the knowledge and approval of the lab supervisor.

5.6 LABORATORY VISITORS

All laboratory visitors, no matter how brief their visit, should wear eye protection. Professional persons will be expected to observe a safe behavior. Other persons, such as friends, or children who visit may not be aware of the hazards and may inadvertently commit unsafe acts. Persons who are not authorized to be in the lab should be denied permission to enter. Those who are authorized to be in the lab should be asked to leave immediately if their behavior proves to be unsafe.

5.7 HOUSEKEEPING

In the laboratory and elsewhere, keeping things clean and neat generally leads to a safer environment. Avoid un-necessary physical hazards by keeping drawers and cabinets closed while working. Never store materials especially chemicals, on the floor, even temporarily. Work spaces and storage areas should be kept clear of broken glassware, leftover chemicals and scrapes of paper. Keep aisles free of obstructions such as chairs/stools, boxes, and waste cans. Avoid slipping hazards by keeping the floor clear of spilt ice cubes/water, glass beads or rods, and other small items. Use the required procedures for the proper disposal of chemical wastes.

5.8 CLEANING GLASSWARE

Clean glassware at the laboratory sink. Use hot water, soap or another detergent. If necessary, use a mild scouring powder. Wear appropriate gloves that have been checked to ensure that

no holes are present; use brushes of suitable stiffness and size. Avoid accumulating too many articles in the cleanup area. Avoid a pileup of dirty glassware around the sink as this can lead to breakage. Remember that turbid water in the sink may hide jagged edges on a piece of broken glassware that was intact when placed into the sink. Drain out standing water. Then use a heavy pair of gloves to remove the broken glass. To minimize breakage of glassware, sink bottoms should have a rubber or plastic mat in place, but will not block the drain.

Avoid the use of strong cleaning agents such as nitric acid, chromic acid, sulfuric acid or other strong oxidizers. If the oxidizers are to be used, wear the proper protective equipment.

5.9 TRANSPORTING CHEMICALS

Transport chemicals using the container-within-a-container concept. This will shield them from shock during any sudden change of movement. Large containers of corrosives should be transported from central storage in a chemically resistant or another container designed for this purpose. Any movement/transport of chemicals must be negotiated carefully. Smoking is never allowed around chemicals.

When moving in the lab, anticipate sudden backup or changes in direction by others. If you should stumble or fall while carrying glassware or chemicals, try to project them away from yourself and others.

When a flammable liquid is withdrawn from a drum, or when a drum is filled from another source, both the drum and other equipment must be electrically wired to each other and to a ground in order to avoid the possible buildup of static charge. Only small quantities should be transferred to glass, plastic, or other non-electrically conductive containers. When a flammable liquid is transferred from a metal container to glass, the metal container should be grounded.

5.10 DISPOSAL

The handling of reaction by-products, surplus and waste chemicals/materials, and contaminated materials is an important part of laboratory safety procedures. Each individual is responsible for ensuring wastes are handles in a manner that minimizes personal hazard and recognizes the potential for environmental contamination.

Typically, reaction by-products and surplus chemicals will be neutralized or deactivated as part of the procedure. Waste materials must be handled in specific ways designed by federal, state, and local regulations. Consult with CSN Environmental Health & Safety if needed.

General Guidelines include:

a. Disposal of waste material promptly. When disposing of chemicals, one basic principle applies; Keep each different class of chemical in a separate clearly marked/labeled disposal container. Never combine organic and inorganic chemicals or strong acids and strong bases in the same container. Transfers from smaller waste containers to disposal containers for carriage offsite should be performed under a fume hood.
b. Never put chemicals into the sink or down the drain unless they are deactived or neutralized and they are allowed by federal and local regulations to be put into the sanitary sewer system. For example, only water or dilute aqueous solutions of non-toxics (e.g. sodium chloride, sugar, soap) from the lab should be disposed of in the sink.
c. Put ordinary water paper in a waste paper basket or trash can separate from the chemical waste. If a piece of paper is contaminated, such as paper toweling used to

d. clean up a spill; put the contaminated paper into a special container marked for this purpose (solid waste container). Such paper is to be labeled and treated as chemical waste.
e. Broken glass belongs in its own container and marked as such. Broken thermometers may contain mercury fragments and these belong in their own special container marked "broken thermometers."

5.11 UNATTENDED OPERATIONS OF EQUIPMENT

Reactions that are left to run unattended overnight or at other times are prime sources for fires, spills, and explosions. Do not let equipment such as power stirrers, hot plates, heating mantels, and water condensers run overnight without fail-safe provisions. Check unattended reactions periodically. Always leave a note plainly posted with a phone number where you can be reached in case of an emergency.

5.12 FUME HOODS AND VENTILATION

A large number of common substances present acute respiratory hazards and should not be used in a confined area. They should be dispensed and handled only where there is adequate ventilation, such as in a hood. Adequate ventilation is defined as ventilation that is sufficient to keep the concentration of a chemical below the threshold limit value (TLV) or permissible exposure limit (PEL). The recommended velocity, in feet per minute (fpm) flow across a hood face is a minimum of 100 fpm.

If you smell a chemical, it is obvious that you are inhaling it. However, odor does not necessarily indicate that a dangerous concentration has been reached. Many chemicals have a very low odor threshold. On the other hand, many chemicals can present a hazardous concentration without noticeable odor.

5.13 REFRIGERATORS

Chemicals stored in refrigerators should be sealed, double packaged, if possible and labeled with the name of the material, date placed in the refrigerator, and the name of the person who stored the material. Food should never be stored in the same refrigerator that chemicals are stored in. A label on the door of the refrigerator should read, "NO FOOD – CHEMICAL STORAGE ONLY." For refrigerators used to store food, a label on the front of the door should read, "FOOD STORAGE ONLY – NO CHEMICALS."

SECTION 6 - RECOMMENDED LABORATORY TECHNIQUES

6.1 GENERAL EQUIPMENT SETUP/GLASSWARE AND PLASTIC WARE

Borosilicate glassware is recommended for all laboratory glassware except for special experiments that use UV or other light sources. The only soft glass provided in the laboratory should be reagent bottles, measuring equipment, stirring rods, and tubing.

Any glass equipment to be evacuated, such as suction flasks, should be specially designed with heavy walls. Dewer flasks and large vacuum vessels should be taped or otherwise screened or contained in a metal jacket to prevent flying glass in case of an implosion. Household thermos bottles have thin walls and are not acceptable substitutes for Dewer flasks.

Bottles, jars, and other container of acids, alkalis, flammable or combustible substances, and toxic, reactive or corrosive chemicals should be transported in carriers to protect them because plastic can be punctured, fail under pressure or heat, or crack through aging.

6.2 PREPARATION OF GLASS TUBING AND STOPPERS

To cut glass tubing hold the tubing against a firm support and make one quick form stroke with a sharp triangular file or glass cutter long enough to extend approximately one-third around the circumference. Cover the tubing with a cloth and hold the tubing in both hands, away from the body. Place the thumbs on the tubing opposite the nick 2 to 3 cm (1 inch) apart and extended toward each other. Push out on the tubing with the thumbs as you pull the sections apart, but do not deliberately bend the glass with your hands. If the tubing does not readily pull apart, the nick is probably too shallow or rounded. Make a fresh sharp file scratch in the same place and repeat the operation.

All glass tubing and rods, including stirring rods, should be fire polished before use. Unpolished cut glass has razor sharp edges, which not only can lacerate the skin, but will cut into a stopper or rubber hose, making it difficult to insert the glass properly.

When drilling a stopper, use only a sharp borer one size smaller than what will just slip over the tube to be inserted. For rubber stoppers, lubricate with water or glycerol. Holes should be bored by slicing through the stopper, twisting with moderate forward pressure, grasping the stopper only with fingers, and keeping the hand away from the back or bottom of the stopper.

6.3 ASSEMBLING APPARATUS

The following recommendations will make apparatus assembly easier and equipment use safer.

a. Keep your work area free from clutter.
b. Set up lean, dry apparatus, firmly clamped and well back from the edge of the bench with due regard to the proximity of reagent bottles and other equipment.
c. Use only equipment that is free from flaws such as cracks, chips, frayed wire, and obvious defects
d. A properly placed pan under a reaction vessel or container will act as a secondary containment to confirm spilled liquids in the event of glass breakage.
e. When working with flammable gases or liquids, do not allow burners or other ignition sources in the vicinity. Use appropriate traps, condensers, or scrubber to minimize release of material into the environment. If a hot plate is used, ensure that the temperature of all exposed surfaces is less than the auto-ignition temperature of chemicals likely to be released and that the temperature of chemicals likely to be released and that the temperature control device and the stirring/ventilating motor do not spark.
f. Whenever possible, use controlled electrical heaters in place of gas burners.
g. Additional and separatory funnels should be properly supported and oriented so that the stopcock will not be loosened by gravity. A retainer ring should be used on the stopcock glug. Glass stopcocks should be freshly lubricated. Teflon stop-cocks should not be lubricated.
h. Condensers should be properly supported with securely positioned clamps and attached water hoses secured with wire or clamps.
i. Stirrer motors and vessels should be secured to maintain proper alignment. Magnetic stirring is preferable. Only non-sparking motors should be used in chemical laboratories. Air motors may be an option.

j. Apparatus attached to a ring stand should be positioned so that the center of gravity of the system is over the base and not to one side. There should be adequate provision for removing burners or baths quickly. Stands bearing heaving loads should be secured to the bench top.
k. Apparatus, equipment, or chemical bottles should not be placed on the floor.
l. Never head a closed container. Provide a vent as part of the apparatus for chemicals that are to be heated. Prior to heating a liquid, place boiling stones/ships in unstirred vessels (except test tubes). If a burner is to be used, distribute the heat with ceramic-centered wire gauze. Use a thermometer with its bulb in the boiling liquid if there is a possibility of a dangerous exothermic decomposition as in some distillations. This will provide a warning and may allow time to remove the heat and apply external cooling, the setup should allow for fast removal of the heat.
m. Whenever hazardous gases or fumes are likely to be evolved, an appropriate gas trap should be used and the operation confined to a fume hood.
n. Fume hoods are recommended for all operations in which toxic or flammable vapors are evolved as in many distillations, most vapors have a density greater than that of air and will settle on the bench top or floor where they may diffuse to a distant burner or ignition source, these vapors will roll out over astonishingly long distances and, if flammable, an ignition can cause a flash back to the source of the vapors. Once diluted with a significant amount of air, vapors move in air essentially as air itself.
o. Use a hood when working with a system under reduced pressure (which may implode). Close the sash to provide a shield. If a hood is not available, use a standing shield. Shields that can be knocked over must be stabilized with weights or fasteners. Standing shields are preferably secured near the top. Proper eye and face protection must be worn even when using the shield or hood.

SECTION 7 – EQUIPMENT USE

7.1 LABORATORY FUME HOODS

Fume hoods serve to control exposure to toxic, offensive, or flammable vapors. Apparatus used in hoods should be fitted with condensers, traps, or scrubbers to contain or collect waste solvents or toxic vapors, the hood is not an appropriate means of disposing of chemicals, nor is it a storage cabinet. Storage of too many items can interfere with efficient hood operation, and in the event of an accident or fire, every item in the hood may become involved.

Before each use, be sure that the hood is working properly. Although not providing assurance that the hood is operating properly, a continuous monitoring device such as a narrow strip of tissue paper can be used to ensure that the hood fan is pulling some air into the duct. Adequate air flow and the absence of excessive turbulence are necessary for safe operations. Exhaust ports from the hood should be kept to a minimum while the hood is in use. Horizontal sashes or combined horizontal and vertical sashes make this easier to do. A hood's air flow can be disrupted by drafts from windows or doors and even positions of the worker in the hood. Users should keep their faces outside the plane of the hood sash and remain alert to changes in the air flow. Equipment should be placed as far back in the hood as practical and activities carried out at least 15 cm (6 inches) from the front edge of the hood. Sash height should be as low as achievable while still making manipulations within the hood comfortably.

Never rely on the hood for protection when conducting a reaction that could result in an explosion. Such work should be carried out behind barrier that are designed and built for this

purpose. Ordinary hoods are not strong enough to withstand the forces released in any but the mildest explosions. If perchloric acid is to be used, it should be used only in a perchloric acid hood. This hood is a stainless steel hood especially designed for perchloric acid use. If the hood is equipped with filters, the filters should be changed every 3-4 months. Each hood should be checked for its velocity at least every six (6) months. The minimal flow rate is 100 fpm. Once the hood is checked for its velocity, a sticker may be placed on the hood showing the flow rate, date, and initials/name of the person verifying the test.

7.2 PRECAUTIONS FOR USING ELECTRICAL EQUIPMENT

Electrical currents of very low amperage and voltage under certain circumstances may result in fatal shock. Voltages as low as 24 volts AC can be dangerous and present a lethal threat. Comparably low voltage DC circuits do not normally present a hazard to human life, although severe bums are possible. The time of contact with a live circuit affects the degree of damage, especially as far as bums are concerned. Recommendations for minimizing electrical hazards are as follows:

a. Only individuals qualified by training or experience should maintain electric or electronic equipment.
b. Electric wires should never be used as supports. Live wires should not be pulled when removing a plug from its socket, holding the plug, not the wire when you disconnect.
c. Any electrical failure or any evidence of undue heating of equipment should be reported immediately.
d. All electrical equipment should be periodically inspected to be certain that cords and plugs are in a safe condition and that only three (3) wire grounded double insulated wire and plugs are used. If necessary, replace tow (2) prong plugs.

7.3 STATIC ELECTRICITY AND SPARK HAZARDS

Some protection from static electricity and sparks in hazardous are and handling flammable solvents and other chemical is obtained by proper grounding of containers and equipment and by blanketing with inert gas when needed. Static electricity is magnified by low absolute humidity such as is likely in cold weather. Some common potential sources of sparks and electrostatic discharges are:

a. Ungrounded metal tasks and containers
b. Clothing or containers made of plastic or synthetic materials
c. The making and breaking of an electric circuit while the circuit is energized (switching, pulling plugs)
d. Temperature control systems in hot plates
e. Metal based clamps, nipples, or wire used with non-conducting hoses
f. High pressure gas cylinders upon discharge of gas
g. Brush motors, often used in hot air dryers, stirrer motors and hot plates

7.4 CENTRIFUGES

If a tabletop centrifuge issued, make certain that it is securely anchored in a location where its vibration will not cause bottles or equipment to fall. In most cases, centrifuges come equipped with suction cup feet and once placed on the lab bench will adhere to the bench. The following rules apply to the safe operation of centrifuges:

a. Always close the centrifuge lid during operations
b. Do not leave the centrifuge until full operating speed is attained and the machine appears to be running safely without vibration

c. Stop the centrifuge immediately and check the counterbalance load if vibration occurs. Check swing-out buckets for clearance and support.
d. Regularly clean the rotors and buckets with non-corrosive cleaning solutions
e. Do not remove the inserts and use in another centrifuge, always check to insure that the inserts are in place.

7.5 COMPRESSED GASES

Gases used in laboratories are often conveniently supplied in cylinders at high pressure. Their use compounds potential chemical hazards. The rules for proper use of compressed gasses include:

a. Handle cylinders of compressed gases as high energy sources and therefore as potential explosives
b. Restrain cylinders of all sized, whether empty or full. Use straps, chains or s suitable stand to prevent them from falling.
c. When storing or moving cylinders, have the protective cap securely in place to protect the valve stem. The cap should remain on the cylinder until placed into use.
d. When moving compressed gas cylinders, strap them to properly wheeled carts to ensure stability.
e. Do not expose cylinder to temperatures higher than about 50^{o} C (148^{o} F). Some rupture devices on cylinders will release at about 65^{o} C (148^{o} F). Some small cylinders such as lecture bottles are not filled with rupture devices and may explode if exposed to high temperatures.
f. Never use cylinders if their contents cannot be identified positively.
g. Never lubricate, modify, force, or tamper with cylinder valves.
h. Use toxic, flammable, or reactive gases in fume hoods only.
i. Cylinders awaiting use should be stored outdoors, protected from the weather.
j. Never direct high pressure gases at a person
k. Do not use compressed gas or compressed air to blow away dust or dirt, as the resultant flying particles are dangerous.
l. Be aware that rapid release of a compressed gas will cause an unsecured gas hose to whip dangerously and may also build up a static charge that could ignite a combustible gas.
m. Do not extinguish a flame involving a highly combustible gas until the source of the gas has been shut off; otherwise, it can re-ignite causing an explosion.
n. Close main cylinder valves tightly when not in use.
o. Promptly remove the regulators from the empty cylinders and replace the protective cap at once. Label the cylinder to how that it is empty.
p. Never bleed cylinders completely empty. Leave a slight pressure to keep contaminant out and the stabilizer (if used) from leaking.
q. Use the appropriate regulator on each cylinder. The threads on regulators are designed to avoid improper use. Adapters or homemade modifications can be dangerous; never use these devices.
r. Do not put oil or grease on the high pressure side of oxygen, chlorine, or other oxidizing agent cylinder. A fire or explosion can result.
s. Always wear safety glasses when handling and using compressed gas.
t. Observe the special rules when working with acetylene cylinders:
    1. Always store acetylene cylinders upright. They are partially filled with liquid acetone, which can be discharged instead of or along with acetylene.

2. Do not use acetylene cylinder that has been stored or handled in a non-upright position until it has remained in an upright position for at least 30 minutes.
3. Ensure that the outlet of an acetylene cylinder is protected with a flash arrestor
4. Never exceed the pressure limit indicated by the warning red band on the acetylene pressure gauge.
5. Use the correct type of tubing to transport gaseous acetylene. Some tubing materials such as copper form explosive acetylides.

SECTION 8 – GUIDE TO CHEMICAL HAZARDS

8.1 TOXICITY

It has been long known that anything when ingested in sufficient quantity can be lethal. Toxicity is frequently subdivided into acute and chronic effects. Acute toxins usually produce an immediate effect, generally from a single dose. Hydrogen sulfide in high concentrations would be considered an acute toxin. Chronic effects result from low doses repeated over a long period of time. Carcinogens and some neurotoxins are generally considered chronic toxins.

There are four (4) main routes by which hazardous chemicals enter the body:

a. **Inhalation**: Absorption through the respiratory tract (lungs) through inhalation. This is the most important route in terms of severity
b. **Ingestion**: Absorption through the digestive tract. This can occur through eating or smoking with contaminated hands or in a contaminated work area.
c. **Absorption**: Absorption through the skin often causes dermatitis. Some toxins that are absorbed through the skin or eyes, can damage the liver, kidney, or other organ systems.
d. **Injection**: Percutaneous injection of a toxic substance through the skin can occur in handing sharp-edged pieces of broken glass and through misuse of sharp materials such as hypodermic needles. This is sometimes referred to as “perenteral” exposure.

The toxic effects can be immediate or delayed reversible or irreversible, local or system. The toxic effects can vary from mild to reversible (e.g., a headache from a single episode of inhaling the vapors or petroleum naphtha that disappears when the victim inhales fresh air) to serious and irreversible (e.g., exposure to a carcinogen).

There are several types of toxic effects:

a. Acute poisoning is characterized by rapid assimilation of the substance. The effect is sudden and severe. Normally a single large exposure is involved. Example: carbon monoxide or cyanide poisoning.
b. Chronic poisoning is characterized by prolonged or repeated exposure of a duration measured in weeks, months, or years. Symptoms may not be immediately apparent. Example: lead or mercury poisoning and pesticide exposure.
c. Cumulative poisons are characterized by materials that tend to build up on the body as a result of numerous chronic exposures; the effects are not seen until a critical body burden is reached. Example: heavy metals
d. Substances in combination – When two or more hazardous materials are acting at the same time, the resulting effect can be greater than the additive effect predicted based on the individual substances. This is called a “synergistic” effect. Examples: exposure to alcohol and chlorinated solvents, or asbestos and tobacco smoke.

8.2 Exposure limits

Most exposure standards are based on time-weighted averages. The Time Weighted Average (TWA) is based on the average exposure weighted for an eight (8) hour work day. Ceiling limits (CLVs) are maximum concentrations which should never be exceeded in the work place. High peak exposures may have special health implications even when the average exposure may not be especially high.

Exposure limits are expressed as the Threshold Limit Value (TLV) or the Permissible Exposure Limit (PEL). The TLV is a recommended occupational exposure limit which is published by the American Conference of Governmental Industrial Hygienists (ACGIH). The TLV is the average concentration of a chemical that is thought most people can be exposed to eight hours a day, five days a week for a working lifetime with no ill effects. The TLV is an advisory guide. TLVs have been established for approximately 850 chemicals. They are expressed as part per vapor gas per million parts of air by volume (PPM) or as milligrams of mist or dust particulates per cubic meter of air (mg/m3). If applicable, a ceiling concentration that should not be exceeded or a skin absorption hazard will be indicated with the TLV. The PEL is a legal standard issued by OSHA. PELs have been established for approximately 550 chemicals. The PEL for a given chemical is sometimes the same, or nearly the same (but often higher than) the TLV. MSDSs cite the PEL and/or TLV for the subject chemicals or mixtures, if such exposure limits have been established.

8.3 READING AND UNDERSTANDING THE MATERIAL SAFETY DATA SHEET (MSDS)

A MSDS must be available for every hazardous chemical used in the laboratory. The MSDS represents a starting point reflection information known for a specific chemical or compound. The following provides a breakdown of the MSDS.

a. **Chemical Name** – Often the IUPAC (International Union of Pure and Applied Chemistry) or Chemical Abstracts Service (CAS) chemical name is given, but it also may be a common name for the chemical (e.g., ethylene glycol is acceptable instead of 1, 2-ehtanediol), trade names may be supplies, but the chemical name is also required unless it is considered to be a trade secret. Synonymous names are often included.
b. **CAS Registry** – A number assigned to each chemical by the Chemical Abstracts Service. It is not required by OSHA, but most state Right-To-Know laws require it. There are a few chemicals that may have more than one CAS number, a few chemicals that have no assigned CAS number and most mixtures do not have an assigned CAS number.
c. **Date Prepared** – OSHA requires that the date of preparation or latest update be on the MSDS.
d. **Composition of Mixtures** – this includes all hazardous materials over 1% and all carcinogens over 0.1%. Trade names can be used, but chemical names must also be included unless this information is considered a bona fide trade secret.
e. **OSHA PEL** – this is either a time-weighted average limit for an eight (8) hour day or a maximum concentration exposure limit for those items on the OSHA list. This figure may be in parts per million (ppm) or milligrams per cubic meter (mg/m^3)
f. **AGGIH TLV** – Maximum exposure limits recommended by the American Conference of Governmental Industrial Hygienists. The same measuring units specified in the OSHA PEL are applicable. ACGIH TLV lists are up-dated each year.
g. **Health Effects** – Identification of target organs or systems adversely affected by overexposure.

h. **Physical/Chemical Effects** – This usually includes the following items:
    1. Boiling point – the value may be reduced pressure and expressed in either degrees F or C.
    2. Melting point – either in degrees C or F.
    3. Vapor pressure – usually in mm HG at a specified temperature or if not specified, understood to be approximately room temperature (standard conditions).
    4. Specific gravity – density with respect to water at a specified temperature or if not specified, understood to be approximately room temperature.
    5. Solubility in water – approximate values are acceptable
    6. Evaporation rate – usually relative to n-butyl acetate ("<" or ">")
    7. Appearance and odor – self explanatory

i. **Fire and explosion Hazard Data** –
    1. Flash point – there are several methods of establishing the flash point; therefore the method should be specified. In general, the flash point of a chemical is the lowest temperature at which its vapor can be ignited by a flame when the chemical is slowly heated in a special apparatus.
    2. Whether chemical ignites spontaneously in the air
    3. The air temperature below and above which the chemical may be ignited
    4. Extinguishers; appropriate media/type

j. **Reactivity Hazard Data Information** – This should include whether the material is unstable and if so, under what conditions it is unstable, incompatibilities with other chemicals, and whether hazardous decomposition products can be produced.

k. **Health Hazard Data** – this includes one or more of the following:
Definitions – In various sections of the MSDS words and phrases such as "avoid contact", "flammable", are used. Generalized descriptions of many of these phrases and the precautions to be practiced are as follows:
    1. **LD50 (Lethal Dose 50)** - This is the dose (usually by ingestion) in mg/kg (milligrams of chemical per kilogram of animal body weight) of a chemical that is expected to kill 50% of the test animal population.
    2. **LC50 (Lethal Concentration 50)** – this is the concentration of a chemical in air expressed per ppm from gases and vapors or as micrograms of material per liter of air for dusts and mists expected to kill 50% of the test animal population by inhalation in one exposure.
    3. **Carcinogen** – These substances are suspected or known to cause cancer. Some have threshold limits of exposure.
    Follow these precautions: Exercise extreme care when handling! Do not breathe vapors and avoid all contact with the skin, eyes, and clothing by wearing suitable protective equipment and using appropriate confining apparatus.
    4. **Avoid Contact** – This is a general rule for all chemicals, even if they are considered nonhazardous
    Follow these precautions: do not breathe vapors and avoid contact with skin, eyes, and clothing for all chemicals handled.
    5. **Corrosive** – Living tissue as well as equipment is destroyed on contact with these chemicals.
    Follow these precautions: Do not breathe vapors and avoid contact with the skin, eyes and clothing. Use suitable protective equipment.
    6. **Skin** – This is a notation for substances that can be absorbed sufficiently through the skin as to cause possible toxic effects.
    Follow these precautions: Do not allow contact with skin, eyes or clothing
    7. **Danger** – These substances can have serious harmful effects (e.g., loss of use of the limb or digit, loss of sight, loss of life).

Follow these precautions: Considered to be a dangerous chemical. There are serious hazards associated with these chemicals labeled as such.

8. **Explosive** – Substances known to explode under some conditions.
   Follow these precautions: Avoid shock (dropping), friction, sparks, and heat. Isolate from other chemicals that become hazardous when spilled.
9. **Flammable or Combustible** – Substances that give off vapors that can readily ignite under usual working conditions.
   Follow these precautions: Since the vapors can travel several feet, keep these liquids several feet away from heat, sparks, and other sources of ignition.
10. **Irritant** – Substances that have an irritant effect on skin, eyes, respiratory tracts, etc.
    Follow these precautions: Do not breathe vapors and avoid contact with skin and eyes.
11. **Lachrymator** – Substances that have an irritant or burning effect on the skin, eyes or respiratory tract. These are dangerous in very small quantities (opening the cap on a bottle can have an immediate effect on the eyes.
    Follow these precautions: Open on in the hood! Do not breathe the vapors. Avoid contact with skin and eyes. Avoid heating.
12. **Mutagen** – Chemicals or physical agents that cause genetic alterations.
    Follow these precautions: Handle with extreme care! Do not breathe the vapors and avoid contact with skin, eyes and clothing.
13. **Peroxide Former** – Substances that form peroxides or hydro peroxides upon standing or when in contact with air.
    Follow these precautions: Many peroxides are explosive! Do not open the container without permission from a trained (HAZMAT) person.
14. **Poison** – Substances that have very serious and often irreversible effects on the body. These substances are extremely dangerous (toxic), often deadly when they reach a target organ.
    Follow these precautions: Avoid all contact with the body, when handling use suitable protective equipment.
15. **Stench** – Substances that have or generate foul odors.
    Follow these precautions: Open only in the hood.
16. **Teratogen** – Substances that cause production of physical defects in a developing fetus or embryo.
    Follow these precautions: Handle with extreme care! Do not breathe the vapors and avoid contact with skin, eyes and clothing. Use suitable protective equipment when handling.
17. **Toxic** – substances that are hazardous to health when breathed, swallowed, ingested, or in contact with skin. There is danger of serious damage to health by short or prolonged exposure.
    Follow these precautions: Avoid contact with the body. Do not breathe the vapors, dust, or mist. When handling, use suitable protective equipment.

l. **First Aid** – Appropriate procedures for emergency first aid will be shown on the MSDS
m. **Precautions for Spills and Cleanup** – Appropriate steps for safe cleanup of a spill or release. Appropriate waste disposal method is usually described in this section of the MSDS.
n. **Control Measures** – Types of protective clothing, gloves, and respiratory protection should be listed. If the material should be handled in a hood, glove-box, or with extra ventilation, it should be described under this heading.

APPENDIX I

INCOMPATIBLE CHEMICALS

ACETIC ACID	chromic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates, strong bases
ACETYLENE	chlorine, bromine, copper, fluorine, silver, mercury
ACETONE	concentrated nitric and sulfuric acid mixtures, oxidizers
ALKALI & ALKALINE EARTH METALS (powdered aluminum or magnesium, Calcium, lithium, sodium, and potassium)	water, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens
AMMONIA (anhydrous)	mercury (e.g., in manometers), chlorine, calcium hypochlorite, iodine, bromine, hydrofluoric acid (anhydrous), strong inorganic acids
AMMONIUM NITRATE	acids, powdered metals, flammable liquids, chlorates, nitrites, sulfur, finely divided organic or other combustible materials
ANILINE	nitric acid, hydrogen peroxide
ARSENICAL MATERAIALS	any reducing agent
AZIDES	acids
BROMINE	ammonia, acetylene, butadiene, butane, methane, propane (or other petroleum gases), hydrogen, sodium carbide, benzenes, finely divided metals, turpentine
CALCIUM OXIDE	water
CARBON (ACTIVATED)	calcium hypochlorite, all oxidizing agents
CHLORATES	ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
CHROMIC ACID & CHROMIUM TRIOXIDE	acetic acid, naphthalene, camphor, glycerol, alcohol, flammable liquids in general
CHLORINE	See Bromine
CHLORINE DIOXIDE	ammonia, methane, phosphine, hydrogen sulfide

COPPER	acetylene, hydrogen peroxide
CUMENE HYDROPEROXIDE	acid (organic and inorganic)
CYANIDES	acids
FLAMMABLE LIQUIDS	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens, oxidizers
FLUORINE	all other chemicals
HYDROCARBONS (such as BUTANE, PROPANE, BENZENE)	fluorine, chlorine, bromine, chromic acid, sodium peroxide
HYDROCYANIC ACID	nitric acid, alkali
HYDROFLUORIC ACID (Anhydrous)	ammonia (aqueous or anhydrous)
HYDROGEN SULFIDE	fuming nitric acid, oxidizing gases
HYPOCHLORITES	acid, activated carbon
IODINE	acetylene, ammonia (aqueous or anhydrous), hydrogen
MERCURY	acetylene, fulminic acid, ammonia
NITRATES	acids, flammable or combustible materials
NITRIC ACID (concentrated)	acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids and gases, copper, brass, heavy metals, strong bases
NITROP ARAFFINS	inorganic bases, amines
OXYLIC ACID	silver, mercury
OXYGEN	oils, grease, hydrogen, flammable liquids, solids, gas
PERCHOLORIC ACID	acetic anhydrides, bismuth and its alloys, alcohols, paper, woo-grease, oils
PEROXIDES, ORGANIC	acids (organic or mineral), avoid friction, store cold
PHOSPHOROUS (white)	air, oxygen, alkalies, reducing agents
POTASSIUM	carbon tetrachloride, carbon dioxide, water, store in kerosene

POTASSIUM CHLORATE	sulfuric and other acids
POTASSIUM PERCHLORATE (see also chlorates)	sulfuric acid and other acids
POTASSIUM PERMANGANATE	glycerol, ethylene glycol, benzaldehyde, sulfuric acid
SELENIDES	reducing agents
SILVER	acetylene, oxalic acid, tartaric acid, ammonium compounds, fulminic acid
SODIUM	carbon tetrachloride, carbon dioxide, water, store in kerosene
SODIUM PEROXIDE	ethyl and methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural
SULFURIC ACID	potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds of light metals such as sodium, lithium), strong bases, flammables/combustibles
TELLURIDES	reducing agents