Ragon Institute
of MGH, MIT and Harvard

Chemical Hygiene Plan

The Ragon Institute

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LIST OF ABBREVIATIONS AND ACRONYMS

CFR Code of Federal Regulations
CHO Chemical Hygiene Officer
CHP Chemical Hygiene Plan
EH&S Environmental Health and Safety
IARC International Agency for Research on Cancer
LD lethal dose
mg/kg milligrams per kilogram
NFPA National Fire Protection Association
NTP National Toxicity Program
OSHA U.S. Occupational Safety and Health Administration
PEL permissible exposure limit
PI Principal Investigator
PPE personal protective equipment
Ppm parts per million
SAA Satellite Accumulation Area
SDS safety data sheet
SOP standard operating procedures
STEL short-term exposure limit
TLV threshold limit value
°F degrees Fahrenheit

1.0 POLICY AND PURPOSE

1.1 POLICY

It is the policy of the Ragon Institute (Ragon) to provide a safe and healthy workplace in compliance with the Occupational Safety and Health Act of 1970 and with regulations of the U.S. Department of Labor, including Title 29 Code of Federal Regulations (CFR) Section 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*. The full U.S. Occupational Safety and Health Administration (OSHA) standard can be found on the following link and a copy may be obtained by contacting Environmental Health and Safety (EH&S): https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=10106 .

1.2 PURPOSE

The purpose of the Chemical Hygiene Plan (CHP) is to describe proper practices, procedures, equipment, and facilities for laboratory workers (employees, students, visitors, or other persons) working in each laboratory at Ragon to protect them from potential health hazards presented by chemicals used in the laboratory workplace and to keep exposures below specified limits. It is the responsibility of laboratory workers and supervisors to know and to follow the provisions of this CHP.

Ragon will appoint a Chemical Hygiene Officer (CHO) who is responsible for developing, implementing, monitoring, and updating the plan annually. Affected departments are all those maintaining laboratories that contain and use hazardous chemicals, as defined by the regulations.

2.0 RESPONSIBILITY, AUTHORITY, AND RESOURCES

2.1 ENVIRONMENTAL HEALTH & SAFETY

Ragon has designated a member of the EH&S Staff as the CHO. The current CHO is Matt Bedford. The CHO has the responsibility and the authority to ensure that the Ragon CHP is written, updated, and implemented.

EH&S serves a variety of other functions. These include:

- Provide advice and consultation on safety issues
- Evaluate hazards and provide safety information
- Provide advice on proper protective equipment and protective measures
- Assist in determining the proper protective equipment and clothing for laboratory operations
- Facilitate hazardous waste disposal
- Provide safety training
- Conduct laboratory safety inspections
- Liaise with regulatory agencies on the local, state, and federal levels, as well as non-regulatory accrediting groups

For further information concerning the EH&S Office, please contact the CHO at mbedford@eheinc.com or 617-293-0333.

2.2 CHEMICAL HYGIENE OFFICER

The CHO has the responsibility for overseeing the safety and health of the employees conducting work in Ragon laboratories and the visitors to Ragon. The CHO will provide assistance to the Principal Investigators (PIs) and Laboratory Managers in fulfilling responsibilities.

- **Requirements.** The OSHA Laboratory Standard (29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*) **requires** the designation of a CHO. The Ragon CHO is Matt Bedford.

- **Definition.** The CHO is a person designated by the employer, who is qualified by training or experience to *provide technical guidance* in the development and implementation of the written CHP.

- **Duties.** The CHO assists the responsible Ragon PIs and Laboratory Managers to accomplish the following (where feasible):

  - Work with PIs to implement the CHP at the individual laboratory level.
  - Work with PIs to monitor safe procurement, use, and disposal of chemicals.
  - Assist responsible PIs with required safety audits and documentation therein (which includes documentation of training).
  - Advise PIs on adequate facilities and procedures under the regulations.
  - Seek ways to improve the CHP.
  - In addition, the CHO is familiar with the contents of the OSHA standard 29 CFR 1910.1450, *Occupational Exposure to Hazardous Chemicals in Laboratories*.

- **Resources.** The CHO may call upon EH&S colleagues, PIs and Laboratory Managers to provide specific information concerning the laboratories.

2.3 PRINCIPAL INVESTIGATORS

Principal Investigators should ensure that all safety policies and procedures outlined in the CHP are followed by laboratory personnel, and that all staff under their direction are trained in safe work practices appropriate to their areas. PIs or their designated Laboratory Managers should ensure that the following duties are performed:

- Prior to conducting experiments, notify the CHO if laboratory personnel will be working with hazardous chemicals to ensure proper procedures are in place.

- Assure that work is conducted in accordance with the CHP.

- Identify the location of work areas where hazardous substances and potential carcinogens will be used and maintain an inventory of these substances.

- Obtain, review, and approve Standard Operating Procedures (SOPs) detailing proposed research activities that involve hazardous chemical substances.

- Prepare an SOP for the use of test/experimental substances when this use involves alternate procedures not specified in these guidelines. The SOP shall include a description of the alternate procedures and an assessment of alternate controls that will be used.

- Define hazardous operations, designate safe practices, and assist with selection of protective equipment.

- Ensure that laboratory and support staff receive instructions and training in safe work practices, use of personal protective equipment, and in procedures for dealing with accidents involving chemical substances.

- Ensure that employees understand the training received.

- Ensure that all personnel obtain the medical examinations, if necessary, and protective equipment required for the safe performance of their job tasks.

- Coordinate with EH&S any necessary workplace evaluations that include air samples, swipes, or other tests to determine the amount and nature of airborne and/or surface contamination. EH&S will inform employees of the results and use data to aid in the evaluation and maintenance of appropriate laboratory conditions.

- Periodically monitor and audit compliance status. Follow up on findings from formal laboratory inspections performed by EH&S to ensure compliance.

- Investigate accidents and report them to the CHO and/or EH&S. Include recommendations for procedures that will minimize the future occurrence of a similar accident.

- Report to the CHO incidents that cause: 1) personnel to be seriously exposed to hazardous chemicals or materials, such as may occur from accidental skin penetration, ingestion, or probable inhalation of a chemical, or 2) constitute a danger of environmental contamination.

- Ensure that action is taken to correct work practices and conditions that may result in the release of hazardous chemicals.

- Properly dispose of unwanted and/or hazardous chemicals and materials.

- Make copies of the CHP available to the laboratory and support staff.

2.4 LABORATORY STAFF, VOLUNTEERS, AND STUDENTS

Laboratory staff members, as defined by the CHP, are those staff under the direction of the PI. Staff not under the direction of the PI, but who are in an area under their direction, are also subject to the CHP, including SOPs, in effect in that area. Non-employees, such as volunteers and visiting scientists, are equally subject to the plan, as described below. The primary responsibility of the employee is to follow the procedures in the CHP and all SOPs. These include the following:

- Understand and follow all SOPs.
- Participate in all required training, and understand all training received.
- Understand the function and proper use of all personal protective equipment and clothing. Wear personal protective equipment and clothing when mandated or necessary.
- Report, in writing, any significant problems arising from the implementation of the SOPs.
- Report all facts pertaining to every accident that results in the exposure to hazardous chemicals and any action or condition that may exist that could result in any accident.
- Contact the PI or the CHO if any of the above procedures are not clearly understood.

3.0 CHEMICAL HYGIENE PLAN

3.1 DEVELOPMENT, IMPLEMENTATION, AND UPDATE

The CHO oversees the preparation of the CHP and specific SOPs, if required, for the laboratory. The CHO is responsible (per OSHA regulation) for ensuring that the plan meets the requirements set forth in 29 CFR 1910.1450 and is fully implemented.

The CHO is responsible for ensuring that the CHP is reviewed on an annual basis and updated as necessary to accommodate changes in the OSHA standard 29 CFR 1910.1450, departmental procedures, and personnel policy. In addition, the CHO will ensure that the CHP update includes procedures regarding new hazards and new processes as they are introduced.

The CHO will ensure that the CHP and updates are distributed or made available to those affected by the changes.

The CHP and updates will be reviewed on an annual basis by the CHO. A copy of the CHP is available in Room 963 on the EH&S desk shelf.

3.2 IDENTIFICATION AND CLASSIFICATION OF HAZARDOUS CHEMICALS

All laboratories must maintain an inventory of their hazardous chemicals, updated on an annual basis or whenever inventories change.

Hazardous chemicals can be easily classified into several generic categories (e.g., corrosive, reactive, flammable, toxic, etc.) and are labeled on the primary container as such. Definitions and other hazardous properties and health effects of chemicals can be found in Appendix A or online at the following link: http://www.osha.gov/SLTC/laboratories/

Alternate means of classifying and identifying hazardous chemicals include the following:

- Lists of known or suspect human carcinogens, prepared by the International Agency for Research on Cancer (IARC) and the National Toxicology Program (NTP), available through EH&S.

- The NFPA has categorized a wide variety of chemicals found in industrial settings. This list is available through EH&S.

- Safety data sheets (SDSs) are available by contacting EH&S and are also available on the Internet and by accessing the Partners Safety Data Sheet online database. Laboratories should

be aware of how to find an SDS. Note that prior to 2013, SDSs were known as Material Safety Data Sheets (MSDSs).

3.3 SELECTION OF REQUIRED CONTROL METHODS AND AUTHORITY FOR CHEMICAL USE

- SDSs for many chemicals used in the laboratories indicate recommended exposure limits (e.g., threshold limit value or TLV), OSHA-mandated exposure limits (e.g., permissible exposure limit or PEL, short-term exposure limit or STEL, and action limit or AL), or both as guidelines.

  When such limits are stated, they will be used in the laboratories by the CHO to assist in determining the safety precautions and control measures necessary when handling toxic materials.

  A chemical fume hood must be used when the following occurs:

  - When working with a compound that has a reported TLV or PEL less than 50 ppm.
  - If the LD_{50} is less than 500 mg/kg or the median inhalation dose, LC_{50}, is less than 200 ppm.
  - When working with or handling toxic or malodorous materials (e.g., 2-mercaptoethanol) with moderate or high vapor pressure.
  - When the SDS recommends use.

- Personal Protective Equipment: The Ragon Laboratory Dress Code policy should be referenced for information specific to the Ragon laboratories.

  - Whenever any hazardous chemical is used in the laboratory, the PI for that laboratory must assure the appropriate types and sizes of gloves are readily available and worn by all laboratory staff. Glove compatibility charts are available as a reference through EH&S.

  - Safety glasses must be worn in the laboratory when pouring or handling hazardous chemicals or when there is potential for splash hazards. Safety glasses must meet the specifications of the American National Standards Institute (ANSI) Z87.1 standard. Information on types and sizes of safety glasses is also available through EH&S.

  - Long-sleeved laboratory coats must be worn in the laboratory whenever infectious, chemical, or radioactive hazards exist.

  - Sandals or open-toed shoes and other clothing which do not protect the laboratory worker from accidental spills of hazardous materials are prohibited in the laboratory.

- Respirators are not to be used in any area at Ragon without prior approval from EH&S. Respirators require medical clearance by Massachusetts General Hospital (MGH) Occupational Health. Refer to the Ragon Institute Respiratory Protection Plan. Currently, the only approved respirator use is within the Biosafety Level Three (BSL-3) laboratory where Powered Air Purifying Respirators are utilized.

- Staff members must obtain prior approval from the CHO whenever a new use of extremely toxic (refer to Section 3.4), carcinogenic, or physically hazardous chemical is being considered.

3.4 SPECIAL PROVISIONS FOR PARTICULARLY HAZARDOUS SUBSTANCES (CARCINOGENS, REPRODUCTIVE TOXINS, AND ACUTELY AND EXTREMELY TOXIC CHEMICALS)

The procedures described in this section must be followed when performing laboratory work with any carcinogen, reproductive toxin, substances with a high degree of acute toxicity, or chemical whose toxic properties are unknown.

These substances must be handled, used, and stored only in areas designated areas of restricted access. Appropriate areas include chemical fume hoods, designated portions of a laboratory, or an entire laboratory if it is specifically dedicated for that purpose. A designated area must be clearly posted with signs warning that a specific, extremely hazardous material is in use and that only those trained to work with it are allowed to enter the area while procedures using it are ongoing. The boundaries of the designated area must be clearly defined.

In addition to establishing the physical boundaries that define the designated area, procedures used in a designated area have special provisions. These include storage, use of protective equipment, containment, equipment disposal, and decontamination procedures.

Please note: A designated area may be posted with a removable sign if work with extremely hazardous agents is not continuous in the laboratory. The area must be decontaminated before removing signage.

The smallest amount of a chemical that is required by a procedure should be purchased, used and stored. Whenever possible, material should be ordered in amounts equal to that required in a given procedure to avoid unnecessary weighing out of the material.

Spill procedures must be developed and posted in the designated area. Staff should be familiar with and have available materials that will inactivate, neutralize, or safely absorb the chemical.

The designated area must be decontaminated when work is completed. Contact EH&S for more information.

Liquid wastes must be put into screw-top containers that are compatible with the chemical. Hazardous waste containers must be labeled with the words, *Hazardous Waste*, the chemical name, the type of hazard (toxic, ignitable, corrosive, and/or reactive), and dated only when full. Hazardous waste tags are available from EH&S. Hazardous waste must be removed from the laboratory within three business days after dating the container. Please contact EH&S for hazardous waste removal.

3.5 ELIMINATION OR SUBSTITUTION

The first step in evaluating the safety of a new experiment, process or operation is to investigate the possibility of eliminating hazardous materials or substituting with a less hazardous material. When selecting alternate products, care must be taken that one hazard is not being substituted for another that may be greater.

The particular process, experiment, or operation may also be modified to reduce the quantity of the hazardous material(s) necessary or limit the potential emission release rate or exposure time. The use of a secondary containment device, such as a pan, can also be helpful in preventing or minimizing the effects of chemical spills. Consult EH&S for advice.

3.6 EDUCATION AND TRAINING

The CHO or designated individual(s) shall provide information and training concerning the handling of hazardous chemicals in the laboratory.

Employees shall be informed of the presence of hazardous chemicals when assigned to a work area and prior to new exposure situations. This information must include the following:

1. Contents of the OSHA Laboratory Standard.
2. Applicable details and location of the CHP.
3. Emergency and personal protective equipment training.
4. Physical and chemical properties of hazardous substances used in the work place.
5. Proper handling of hazardous chemicals to minimize exposure.
6. Signs and symptoms of exposure associated with hazardous chemicals used in the work place.
7. Availability of reference material, including SDSs.

Training should be provided immediately for new employees in the affected work area and annually thereafter for all personnel. The name of each person trained shall be recorded together with the date, time, and the trainer.

It is the responsibility of the PI to assure that all staff members attend the required training sessions. Further, if English is not the primary language spoken by a staff member, the PI should

ensure that an interpreter accompanies the non-English speaking staff or that other steps are taken to ensure comprehension of the information.

Ragon laboratory staff must complete all required laboratory safety and chemical hygiene training as assigned. Ragon-specific training is provided by the CHO or appointed individual(s) during Ragon New Employee training.

3.7 GENERAL WORK PRACTICES AND STANDARD OPERATING PROCEDURES FOR CHEMICALS OR CLASSES OF CHEMICALS

Before developing general work practices and standard operating procedures, it is important to consult the SDS for the chemical.

3.7.1 General Work Practices

3.7.1.1 Spills or Incidents With or Without Exposure

- *Eye contact:* Eyes should be promptly flushed with water for 15 minutes (unless the chemical is water reactive, consult the CHO to develop procedures if water reactive substances will be handled). Medical attention should be sought immediately after flushing.

- *Skin contact*: Contaminated clothing should be removed as quickly as possible and the affected area flushed with water for 15 minutes. Medical attention should be sought immediately after flushing.

- *Cleanup with no injury:* If no one is injured, the cleanup of the spill should begin immediately. For assistance with large spills, call the Alexandria Real Estate Management Office at 617-661-6962, M-F 8:30 – 5:30 p.m. or Security at Technology Square after hours at 617-577-9177. They will contact the appropriate individuals to provide assistance.

- *Cleanup with injury:* If someone is injured, that person should seek medical assistance immediately. Cleanup should be initiated by someone other than the injured person. For assistance, call the Alexandria Real Estate Management Office at 617-661-6962, M-F 8:30 – 5:30 p.m. or Security at Technology Square after hours at 617-577-9177. They will contact the appropriate individuals to provide assistance.

- Notify EH&S at 857-268-7116 (Tuesdays and Fridays) or 617-293-0333 for advice and assistance, and to report spills and injuries no matter how minor.

3.7.1.2 Avoidance of Routine Exposure

- Work should be conducted in a chemical fume hood whenever possible.

- Smelling chemicals to determine their identity should be avoided.
- **Never** place your head inside of a chemical fume hood to check on an experiment.
- Select gloves that will protect against the chemical(s) to be handled; refer to Appendix E for more information. Inspect gloves before use for holes, cracks, or other damage.
- Handling or storage of toxic chemicals or dry ice in cold or warm rooms must be avoided, as these rooms contain recirculated atmospheres.
- Exhaust of an apparatus (e.g., vacuum pumps) that may discharge toxic chemicals should be vented into a chemical fume hood or filter.
- When transporting hazardous chemicals, carriers or carts designed to prevent bottles from breaking and spilling must be used. A cart can be borrowed from EH&S; contact Matt Bedford at mbedford@eheinc.com or Justin Warrener jwarrener@eheinc.com

3.7.1.3 Choice of Chemicals

- Less toxic substances should be substituted in place of more toxic ones wherever possible.
- Only those amounts necessary for immediate work should be ordered.

3.7.1.4 Personal Hygiene

- No eating, drinking, smoking, or applying cosmetics is allowed. Storage of food, beverages, medications, etc. in the laboratory is prohibited. The use of contact lenses in the laboratory should be avoided.
- Mouth pipetting of **any** substance is prohibited.
- Hands must be washed after removing gloves and before leaving the laboratory. Solvents must never be used to wash hands.
- Laboratory coats and safety glasses should be worn in the laboratory whenever there is a potential for exposure to infectious, chemical, or radioactive hazards. Appropriate gloves must be worn when handling chemicals. Refer to Appendix E, Effective Use of Gloves.

3.7.1.5 Appropriate Storage of Chemicals

- Incompatible chemicals must be segregated (see Appendix F for lists of incompatible materials and Appendix H for Chemical Storage Guidelines).
- Glass bottles must not be stored on high shelves or on the floor.
- Chemicals should be stored in containers with which they are compatible.
- All bottles must be labeled with the correct chemical name. Abbreviations are not permitted. Bottles should be dated upon receipt and again upon opening.

3.7.2 Procedures for Flammable Chemicals

3.7.2.1 General Use and Handling

- Flammable liquids are defined as those liquids with a flash point of 140 degrees Fahrenheit (°F) or less and having an absolute vapor pressure of not more than 40 pounds per square inch at 100 °F. Some examples commonly found at Ragon are acetone, ethanol, hexanes, and ethyl acetate. All flammable liquids should be handled carefully and stored appropriately.

- Flammable substances should be handled only in areas free of ignition sources (e.g., away from electric ovens, burner flames, and hot surfaces).

- Flammable substances should never be heated using an open flame. Heating mantles, oil baths, safety hot plates, and steam baths should be used. When heating either by steam bath or hot plate, use a filter or distilling flask as a receiver. Such distillations must be carried out in a chemical fume hood.

- Smoking is not permitted where flammable liquids are used. The 400 Technology Square building is a non-smoking building.

- Boiling chips or glass beads are helpful in distilling or evaporating flammable substances to prevent superheating and bumping.

- Ground cylinders or equipment when transferring flammables from one container to another. Contact EH&S if there are questions about proper grounding.

3.7.2.2 Storage

- Bottles of flammable or combustible liquids should not be stored near heat sources or in direct sunlight.

- Quantities of flammable solvents stored in the laboratory should be kept to a minimum. The Cambridge Fire Department limits storage based on the type of liquid and the size of the laboratory. Contact EH&S regarding the limit for a specific laboratory.

- Whenever possible, flammable liquids should be stored in approved storage cabinets. Flammable liquids must never be stored on the floor.

- Adequate ventilation must be provided where flammable liquids are used.

- When flammable liquids are stored in a refrigerator, it must be a *Laboratory-Safe* Refrigerator (as defined in NFPA 45). These are designed for safe storage of flammable

liquids, and have all electrical equipment mounted on the outside surface of the refrigerator. Laboratory-safe refrigerators will be prominently labeled as such.

- Flammable liquids must not be stored with chemicals that are considered to be incompatible with them (e.g., oxidizers, oxidizing acids, etc.).

3.7.3 Procedures for Reactive Chemicals

- Reactive materials include oxidizers, organic peroxides, explosives, and those ranked 3 or 4 for reactivity by the NFPA.
- For peroxide-forming chemicals (e.g., ethyl ether, dioxanes, and tetrahydrofuran), containers should be dated upon opening and disposed of as hazardous waste by the expiration date or within six months, whichever is sooner.
- All reactive materials must be handled with caution, personal protective equipment must be used, and, where possible, work should be done in a chemical fume hood.

3.7.4 Procedures for Corrosive Chemicals

- Extreme care must be exercised in handling and pouring corrosive materials. This includes appropriate gloves, a laboratory coat, and safety glasses. The use of a faceshield is recommended when splash hazards may exist.
- Acids and similar chemicals should not be stored above laboratory bench level.
- Corrosive chemicals should only be used in areas where an eyewash is immediately accessible.
- Corrosive materials should not be heated or handled in large, fragile containers (e.g., four-liter beakers) without providing a secondary containment to catch the contents in case of breakage.
- Porcelain dishes should not be used as cleaning baths.
- Strong alkalis should not be stored next to strong acids.
- If strong acids or alkalis come in contact with skin or clothing, affected parts should be washed quickly and thoroughly with large quantities of water. If such materials are splashed in the eyes, they should be flushed thoroughly with a continuous stream of cold water for at least 15 minutes. In either case, medical attention should be sought immediately.

3.7.5 Special Procedures: Work with Formaldehyde

The OSHA formaldehyde standard, Occupational Exposure to Formaldehyde, 29 CFR 1910.1048, states that the permissible exposure limit (PEL) for exposure to formaldehyde is 0.75 parts per million (ppm). The PEL is a time-weighted average exposure for an eight-hour period. The short-term exposure limit (STEL; 15 minute time-weighted average) is 2 ppm.

The Hazard Warning, including labeling requirements, falls under the OSHA Hazard Communication Standard, 29 CFR 1910.1200. If formaldehyde is to be used, all staff should be informed of the health hazards of formaldehyde upon initial orientation to the work site. Notify EH&S if you work with formaldehyde containing chemicals.

3.8 PERSONAL PROTECTIVE EQUIPMENT

Personal protective equipment (PPE) is designed to serve as a barrier between laboratory workers and hazardous materials, to prevent personal injury and illness. Examples of PPE include safety glasses or goggles, face shields, gloves, rubber aprons, laboratory coats, and respirators. It is the responsibility of the PI to ensure that laboratory staff uses necessary PPE.

The use of PPE shall be included in all SOPs. The type and level of equipment can be determined with the aid of the Chemical Hygiene Officer. The use of PPE should only be considered after exercising all options for reducing the hazards. If in doubt about the potential danger of an experiment or activity, all available safety devices should be employed. Information on such devices can be obtained from EH&S upon request.

Required PPE will be provided free of charge. It will be replaced free of charge if damaged or defective. PPE must remain within the laboratory area and is not to be worn outside of laboratory areas or taken offsite for any reason.

3.8.1 Respirators

The Ragon Respiratory Protection Program (binder located at EH&S desk, room 963) must be followed when respiratory protection is required. All staff must follow these elements.

- Selection of a respirator type must be performed in consultation with EH&S.
- A medical clearance is required for each employee before a respirator is worn. This is provided by MGH Occupational Health.
- Fit testing and training shall be performed under the direction of EH&S for all negative pressure respirators before use.

Currently the use of respirators at Ragon is limited to personnel assigned to the Biosafety Level Three (BSL-3) laboratory. Powered Air Purifying Respirators are used.

3.8.2 Eye Protection

Eye protection must be worn in the laboratory whenever there is a potential for eye contact with liquids and/or particulates. Safety glasses with side shields must be worn when handling chemicals with the potential for splash or splatter. It is recommended that safety glasses be worn at all times when working in the laboratory. Safety glasses can be obtained by contacting EH&S or a Laboratory Manager.

Goggles are recommended when working with volatile substances that irritate the eyes (e.g., chlorine, strong ammonia, irritating dusts) as well as for protection against spattering or splashing of hazardous materials. It is also advisable to wear a faceshield when distilling at high temperatures, under reduced pressures, or when distilling corrosive liquids. Safety glasses and goggles have only a limited application and do not offer full protection against all hazards. For particularly dangerous operations, full face shields of an approved type are to be worn.

Contact EH&S if you need information on available eye protection and/or require prescription safety glasses.

3.8.3 Protective Clothing

The use of protective clothing, including laboratory coats, is required when working with hazardous chemicals. Contact a Laboratory Manager for information on laboratory coats.

- Protective clothing is chosen, with the aid of EH&S, on the basis of the potential for chemical exposure.
- Contaminated protective clothing must be disposed of properly.
- Open-toed shoes or sandals must not be worn in the laboratory.
- Skin exposure should be minimized when working with hazardous materials.

3.8.4 Protective Gloves

When handling toxic or hazardous chemicals, protective gloves are required. To protect against accidental spills or contamination, workers should refer to glove manufacturers' compatibility charts to select a glove appropriate for use with the reagent in question (see Appendix E for glove selection). There is no glove currently available that will protect against all chemicals for all types of tasks. If gloves become contaminated, they should be removed and discarded as hazardous waste as soon as possible. Remove at least one glove before leaving the immediate work site to prevent contamination of public areas (e.g., doorknobs, light switches, telephones, etc.).

LATEX ALERT: Latex (i.e., several protein antigens) has been shown to be a sensitizer, meaning that workers can develop an allergic reaction to latex over time. In order to best protect workers from becoming sensitized, latex gloves are discouraged in laboratories.

3.8.5 Other Personal Protective Equipment

Other PPE shall be used, as needed.

3.9 VENTILATION, CHEMICAL FUME HOODS, AND PROPER OPERATIONS

Local exhaust ventilation through the use of a chemical fume hood is the primary method used to control inhalation exposures to hazardous substances in the laboratory. Other types of local exhaust include vented enclosures for large pieces of equipment or chemical storage and snorkel types of exhaust for capturing contaminants near the point of release.

A chemical fume hood should be used when working with hazardous substances. A properly operating and correctly used chemical fume hood will control the vapors released from volatile liquids, as well as unpropelled dusts and mists.

Do not make any modifications to chemical fume hoods or ductwork without first contacting EH&S at 857-268-7116 (Tuesdays and Fridays) or 617-293-0333. A chemical fume hood should not be used for large pieces of equipment unless the chemical fume hood will be dedicated for this use since it will change airflow patterns and render it potentially unsafe for other uses. It is generally more effective to install a specially designed enclosure for large equipment so that the chemical fume hood can be used for its intended purpose.

A chemical fume hood should not be used for chemical or other miscellaneous storage, as this also restricts airflow. Chemicals should be stored in an appropriate chemical storage cabinet. All freestanding cabinets should have bungs in place and the doors should close properly.

EH&S oversees the chemical fume hood program and annual recertification of each fume hood. Before you begin using a chemical fume hood, check to see that the hood has been certified within the last 12 months. If a chemical fume hood requires certification or if you have questions regarding safe operation, contact EH&S at 857-268-7116 (Tuesdays and Fridays) or 617-293-0333.

Some of the basic guidelines for working safely in a chemical fume hood include the following:

- Work at least six inches behind the sash.
- If it is necessary to store materials in a chemical fume hood, they should be elevated so air can pass under them.

- **Never** put your head (or face) inside an operating chemical fume hood.
- Work with the sash in the lowest position possible. The sash will act as a barrier and provide containment should a problem arise with the work being done in the hood.
- Do not clutter the chemical fume hood with bottles or equipment. Only materials actively in use should be in the chemical fume hood.
- Clean the grille along the bottom slot of the chemical fume hood regularly so it does not become clogged with paper and dirt.
- Do not dismantle or modify the physical structure of the chemical fume hood or exhaust system in any way without first consulting EH&S.
- Report any suspected chemical fume hood malfunctions to EH&S at 857-268-7116 (Tuesdays and Fridays) or 617-293-0333.

3.10 HOUSEKEEPING

It is essential for both safety and efficiency that the laboratory facilities be kept neat and orderly. Floors, shelves, and benches should be free from dirt and unnecessary apparatus and tools. Equipment should never obstruct exits, passages, fire extinguishers, eyewashes/showers, etc.

Care should be exercised when disposing of materials. Flammable, toxic, ignitable and/or corrosive materials should be collected for disposal as hazardous waste and, therefore, should not be placed in the regular waste stream. Refer to Section 3.14 for information regarding waste disposal at Ragon.

General guidelines for good housekeeping include the following:

- Never block access to emergency equipment, showers, eyewashes, and exits.
- Label all chemical containers with the identity of the contents (no abbreviations or chemical formulas) and the hazards at the very least.
- All work areas should be kept clear of clutter.
- All aisles, hallways, and stairs must be kept clear.
- All chemicals should be returned to their proper storage area at the end of the day.
- Liquid wastes should be kept in spill-proof containers and stored off the floor in an appropriate storage area.
- BE PREPARED FOR SPILLS. Small spills should be cleaned up promptly using the spill kits located in the laboratory hallways. All clean up materials must be collected for disposal

as hazardous waste. Refer to Appendix C, Chemical Spill Response/Release of other Hazardous Materials.

3.11 SIGNS AND LABELS AND SAFETY DATA SHEETS

3.11.1 Signage

- *Eye Protection Required* signs are recommended at entrances to laboratories using acids and corrosive chemicals. Safety glasses for visitors must be provided and are available from EH&S.
- Signs indicating the location of eyewash units, safety showers, fire extinguishers, and other safety devices are required.
- Entrances to laboratories, storage areas, and associated facilities must have signs as necessary to warn emergency personnel and custodians of unusual or severe hazards.

3.11.2 Chemical Container Labeling

All containers must be labeled with the chemical contents. Chemicals received from outside vendors must have labels indicating the name, along with other physical and chemical data. Toxicity warning signs or symbols should be prominently visible on the labels.

All chemical containers that have been decanted from an original container must be labeled with the full chemical name (no abbreviations!), the primary hazard(s), the name of the responsible person, and the date. EH&S can be contacted for further information regarding labels for this purpose.

All chemical waste containers must be labeled with the words *Hazardous Waste*, the full chemical name(s) with no abbreviations, the type of hazard (i.e., toxic, ignitable, corrosive, and/or reactive), the responsible person and the date the container became full. Labels are available from EH&S. Labeling must be provided for chemicals synthesized in the laboratory or prepared by other processes, such as distillation or extraction. For information about obtaining hazard labels, please contact EH&S.

Chemicals developed in the laboratory must be assumed to be toxic if no data on toxicity are available. Suitable handling procedures must be prepared and implemented, including training of users in controls necessary to handle a material safely. If the substance is produced for another user outside of the laboratory, an SDS and labels must be prepared and provided to such users (in accordance with OSHA 29 CFR 1920.1200).

3.11.3 Safety Data Sheets

Safety Data Sheets (SDSs) are documents prepared by manufacturers to summarize the health and safety information associated with their products. The manufacturer or supplier should provide SDSs for each chemical. Laboratory staff can access the Partners online SDS Database from their Partners computers at http://intranet.massgeneral.org/ehs/ehs_links.htm. Please contact the CHO if you have questions regarding accessing the Database or need assistance with locating an SDS.

3.12 MONITORING AND EMPLOYEE ASSESSMENT

EH&S will perform exposure monitoring, when appropriate, in accordance with paragraph (d) of OSHA 29 CFR 1910.1450. Other qualified consulting service providers may be employed by EH&S to conduct such monitoring. All monitoring results will be kept on file with EH&S and communicated to employees.

3.12.1 Employee Exposure Determination

- **Initial monitoring** will be performed if there is reason to believe that exposure levels for a substance could routinely exceed the OSHA-defined action level (or OSHA permissible exposure limit in the absence of an action level).

- **Periodic monitoring** will be performed **if** the initial monitoring performed discloses employee exposure over the action level (or PEL in the absence of an action level).

- Monitoring may be terminated in accordance with the relevant standard.

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

Anyone with a reason to believe that exposure levels for a substance routinely exceed the action level, or PEL in the absence of an action level, may request that EH&S initiate the monitoring process.

It will be the responsibility of the CHO to ensure that periodic monitoring requirements are satisfied, when necessary.

EH&S will maintain records in accordance with the record-keeping requirements of OSHA 29 CFR 1910.1450.

3.13 WASTE DISPOSAL

3.13.1 Policy

Every effort should be made to dispose of hazardous waste in a proper, safe and efficient manner. It is the responsibility of the individual creating the waste to properly identify and handle waste chemicals.

3.13.2 Main Accumulation/Storage Area

EH&S maintains a Main Accumulation Area (MAA) on the seventh floor for the storage of chemical hazardous wastes removed from the laboratories. Once the waste container has been filled and dated in the laboratory, it must be transported to the waste room within three business days (as per Massachusetts Department of Environmental Protection requirements).

3.13.3 Satellite Accumulation Areas

EH&S maintains Satellite Accumulation Areas (SAAs) in the laboratories for the storage of chemical hazardous waste. The following guidelines must be followed at all SAAs.

- Once a waste container has been filled and dated in the laboratory, it must be transported to the main accumulation area within three business days.
- Waste chemicals stored in containers of one gallon or larger sizes shall be *break resistant* whenever possible.
- Waste chemicals stored in breakable containers of one gallon or larger sizes shall be kept in *approved secondary containers.*
  - Break resistant shall mean a container made of metal, plastic, plastic-coated glass or metal overpack of glass.
  - An approved secondary container is a bottle carrier made of rubber, metal, or plastic with carrying handle(s) which is of large enough volume to hold the contents of the chemical container. Rubber or plastic should be used for acids/alkalines; and metal, rubber, or plastic for organic solvents.
- Wastes must be packaged and placed in containers in a manner that will allow them to be transported without the danger of spillage, explosion, or hazardous vapors escaping. Wastes that have not been properly packaged and identified will not be accepted for disposal.

3.13.4 Chemical Identification and Unknown Waste Chemicals

All waste chemicals must be identified by full chemical name, including the proportions of a mixture. Do not use symbols or abbreviations. All containers must be labeled prominently

because the safe transportation of chemicals is possible only when everyone who handles the containers knows the identity of the contents.

Every effort should be made by the PI or his/her designee to identify unknown waste. It is the responsibility of the department to identify all chemicals. The PI may need to question laboratory personnel, students, and volunteers, or send a sample to an analytical laboratory with the assistance of EH&S, to ascertain the contents of unknown wastes. Laboratory personnel must be constantly reminded to identify and label all wastes and project products. If unknown waste has been discovered and cannot be identified, immediately contact EH&S. The costs associated with analyzing and disposing of "unknown" chemicals is extremely expensive, therefore everyone must do their part to identify chemicals.

NOTE: Never Mark a container "UNKNOWN".
Label unknown waste streams with the words "Pending Analysis" and contact EH&S.

3.13.5 Guidelines for Waste Reduction/Management

Procedures for waste disposal should be prepared *before* beginning a project. Waste must be labeled properly. Each department, group, or researcher must properly identify waste materials prior to disposal; inadvertent mixing of incompatible materials could have serious consequences.

Waste minimization is very important to protect the environment and to reduce the disposal costs charged to the laboratory. The following suggestions should be considered in an effort to minimize the amount of waste generated by the laboratory.

- Only order and store the amount of material needed for the project or experiment. The Cambridge Fire Department has significant restrictions on flammable liquid storage in laboratories.
- Use only the amount of material that is needed for conclusive results.
- Date containers upon receipt and again upon initial opening.
- Before disposing of unwanted, unopened, or uncontaminated chemicals, check with others at Ragon who may be able to use them.
- On termination of a research project, all unused chemicals to be kept by the laboratory shall be labeled and dated. All chemicals for disposal must be in proper containers and labeled with the words *Hazardous Waste*, the chemical name, type of hazard (toxic, ignitable, corrosive, and/or reactive), and the date when the container is full and/or ready for removal and disposal.

3.13.6 Types of Chemicals and Their Disposal

Regulations prohibit the discharge of most organic solvents and many other substances into the sewer system. Always assume that drain disposal for a given chemical is not permitted if you are not sure. Consult with EH&S to determine which chemicals can be disposed in this manner. The Massachusetts Water Resources Authority (MWRA) has issued a permit to Ragon for wastewater discharge. Requirements include prohibiting the discharge of hazardous chemicals into the sewer system.

Table 3.1 Types of Chemicals and Their Disposal

Chemical Class	Disposal
Organic solvents	• Placed in suitable containers that prevent vapors or liquids from escaping. • Cap tightly. • Prominently label containers. • Disposed as hazardous waste.
Mixtures of organic solvents	• If compatible they can be combined in one container. • Container must have estimated percentages of each solvent in the mixture.
Ether (di-ethyl) in cans	• Do not move it over a year beyond the expiration date or beyond six months from the date of opening. • EH&S must be contacted immediately (mbedford@eheinc.com or 617-293-0333).
Acids and alkaline solutions	• These may be neutralized and disposed in the drain if they do not contain heavy metals or toxic contaminants. • Concentrated acids and caustics must be treated as hazardous waste. • Store in tightly capped and labeled containers.
Inorganic and organic solids	• If in original containers may be placed in the SAA.
Mercury	• Put broken mercury thermometers into a jar or secondary container. • Clean-up materials from a mercury spill may be placed in a container, labeled, and placed in the SAA. • Mercury-containing compounds must be placed in the SAA.
Cyanide compounds, arsenic, lead, and heavy metal wastes	• Place in bottles or containers. • Seal tightly. • Label and place in the SAA.
Pyrophoric metals (e.g., magnesium, strontium, thorium, zirconium, and other pyrophoric chips and fine powders)	• Place in a metal container. • Seal tightly. • Label properly, seal, and dispose as hazardous waste and place in the SAA.
Waste Oil (e.g., vacuum pump oil or lubricating oils)	• Collect in one-gallon containers or less. • Dispose of as hazardous waste and place in the SAA.

EH&S Environmental Health and Safety
SAA satellite accumulation area

EH&S may be consulted if there is any question concerning the toxicity or packaging of any wastes. EH&S must also be contacted *before* any laboratories are moved, either within the Ragon or to another facility.

3.13.7 Other Types of Wastes—Special Procedures Required

- **Gas cylinders** are to be returned to the proper vendor. Some small lecture bottles are of the non-returnable type and become a disposal problem when empty or near empty with a residual amount of gas. When ordering gases in lecture bottle size, be sure to order the gases in a returnable cylinder.

- **Controlled drugs** to be disposed of as waste must **not** be sent to the waste accumulation area. The handling, records, and disposal of controlled drugs are the responsibility of the department and must be conducted within U.S. Drug Enforcement Agency (DEA) regulations. Contact EH&S for assistance.

- **Radioactive material** disposal is handled in accordance with procedures established by the Radiation Safety Office at 617-726-5128.

- Biological waste and physically dangerous waste (sharps) must be placed in proper containers. Contact EH&S at 857-268-7116 (Tuesdays and Fridays) or 617-293-0333 for proper disposal procedures.

- **Polychlorinated biphenyls (PCBs)** found in capacitors, transformers, equipment, and oil are the responsibility of the department. Information on possible disposal contractors can be obtained by contacting EH&S.

3.14 MEDICAL SURVEILLANCE

Medical consultations/examinations are coordinated for Ragon employees through the Occupational Health Service at MGH under the following circumstances:

- Whenever an employee develops signs or symptoms potentially associated with a hazardous chemical to which the employee may have been exposed in the laboratory.

- Where exposure monitoring reveals an exposure level routinely above the OSHA action level or permissible exposure limit for an OSHA-regulated substance requiring such medical monitoring and medical surveillance.

- Whenever an event occurs, such as a chemical spill, leak, or explosion that results in the likelihood of a hazardous exposure. First aid issues are handled by the MGH Occupational Health Services during business hours or through the MGH Emergency Room during off-hours.

- Whenever an employee is exposed to human materials such as blood or visibly bloody fluids by a needlestick, cut or splash to exposed skin.

3.15 EXPOSURE REPORTING

Employees who believe they have had an exposure should contact the CHO for evaluation. The online MGH Incident Reporting system is to be used.

If any employee exhibits adverse health effects, they should report immediately to the MGH Occupational Health Services (7:30 a.m. – 4:30 p.m., Monday through Friday 617-732-8501) or the MGH Emergency Room when Occupational Health Services is closed. EH&S will evaluate the situation and conduct monitoring, if necessary, to determine actual exposures. The results of all hazard evaluations and any air sampling data will be available to all occupants of the affected areas. The CHO can be contacted directly for information. In addition, the results of any personal air sampling will be given to the employee and kept on file with EH&S.

3.16 EMERGENCY SITUATIONS

Emergencies that may occur in a laboratory include fire, explosion, chemical spill or release, or medical or other health threatening accidents. General procedures to be followed in any emergency are the following:

1. Assist person(s) involved. Remove person(s) from exposure to further injury or a life-threatening situation, if it can be done safely.
2. Notify nearby persons who may be affected and call Security at Tech Square Office at 617-577-9177 to report the emergency and seek assistance.
3. If there is a hazardous spill or release, evacuate the area until help arrives.
4. Wait for emergency responders and assist them in handling the emergency.
5. Assist in the follow-up investigation of the emergency.

For specific emergencies that may occur in the laboratory space (i.e., chemical spills, fire, explosion, etc.), refer to the specific procedures established by the laboratory. Refer also to Appendix B.

3.17 EMERGENCY EQUIPMENT

In any emergency, it is critical that all employees are familiar with the use and location of emergency equipment, and that the equipment is kept accessible and free of obstruction. These include fire extinguishers, fire alarm pull stations, fire strobes, safety showers, and eyewash stations.

All emergency equipment is on a preventive maintenance schedule. Fire alarms are tested periodically, and extinguishers are inspected monthly by Alexandria Real Estate. Safety showers

and eyewash stations are checked semi-annually by Alexandria Real Estate. Eyewash stations are also checked weekly by EH&S and records are maintained in room 963.

3.18 SHIPPING DANGEROUS GOODS

Any Ragon laboratory or entity that sends materials designated as Dangerous Goods to international or domestic recipients must label and package these materials according to the standards of the U.S. Department of Transportation (DOT) and the International Air Transport Association (IATA). There are nine classes of Dangerous Goods recognized by these authorities:

Class	Division	Description
1	1-6	Explosives
2	1-3	Gases
3	–	Flammable Liquids
4	1-3	Flammable Solids
5	1-2	Oxidizing Substances/Oxidizing Materials
6	6.1, 6.2	Toxic/Infectious Substances
7	–	Radioactive
8	–	Corrosive
9	–	Miscellaneous

Special training and certification is required to send ANY dangerous good to ANY domestic or international location, regardless of the method of transportation (aircraft, boat, rail, or motor vehicle). Employees must not ship or receive dangerous goods without the proper training. MGH offers training to prepare staff to properly prepare packages that contain class 6.2 dangerous goods (infectious substances).

3.19 OVERSIGHT, ANNUAL REVIEW, RECORDKEEPING, COMPLIANCE, AND ENFORCEMENT

EH&S is responsible for establishing and maintaining records for employee training, employee and environmental monitoring, and type and quantity of chemicals stored in the work place.

The **Principal Investigator** enforces the CHP by making sure the Chemical Hygiene requirements are known and followed. The CHO advises and assists in this work and helps with documentation.

The **Chemical Hygiene Officer** will assist with chemical hygiene and housekeeping inspections. When there are significant changes in existing policies or work practices, an inspection will be conducted soon after the new process is implemented.

The **Chemical Hygiene Officer** annually reviews and updates the CHP and notifies PIs when any significant changes to the CHP are made.

4.0 LABORATORY STANDARD OPERATING PROCEDURES

Laboratories may insert their individual SOPs in this section.

APPENDIX A

HAZARDOUS PROPERTIES/HEALTH EFFECTS OF CHEMICALS

HAZARDOUS PROPERTIES/HEALTH EFFECTS OF CHEMICALS

Adverse health effects are generally classified into eight categories. The extent of the damage to the body depends on the concentration and duration of the exposure. It is also important to recognize that some chemicals may exhibit more than one toxic property and this must be considered when choosing protective equipment.

1. **Poisons** interfere with vital bodily processes. Examples include the following.
   a. Cyanide ions interfere with tissue oxidation by combining with cytochrome oxidase. Overdose leads to death by chemical asphyxiation.
   b. Arsenic compounds combine with enzyme sulfhydryl groups and interfere with enzymatic action.
   c. Methyl butyl ketone and acrylamide can cause peripheral neuropathy.
   d. Chromates, fluorides, and corrosive gases can be absorbed or particles can act as poisons.
   e. Silica and asbestos are considered poisonous particulates as they form fibrosis (scar tissue formation) in the lung, which then interferes with normal pulmonary functions.

2. **Irritants** cause immediate pain or reddening of exposed areas. The most common sites of exposure are the eyes, skin, throat, and breathing passages. Their major long-term effect is scar tissue formation at the site of injury. Site of action depends on solubility. Examples include the following.
   a. Upper respiratory irritants include soluble gases such as ammonia, hydrogen chloride, and sulfur dioxide.
   b. Upper respiratory/lung tissue irritants include bromine, chlorine, cyanogen bromide, dimethyl sulfate, and ozone.
   c. Lung tissue irritants include poorly soluble agents such as nitrogen dioxide, phosgene, and arsenic trichloride.

3. **Asphyxiants** interfere with oxygen and/or its availability and include the following.
   a. Simple asphyxiants may not normally be dangerous (e.g., nitrogen, argon, helium, or nitrous oxide), but if present in high enough concentrations, can displace oxygen in air and cause suffocation.
   b. Chemical asphyxiants chemically combine with oxygen carrying sites (carbon monoxide) or with oxygen utilization (cyanide).

4. **Anesthetics/narcotics** depress the central nervous system. Many solvents (chloroform, ether) have an anesthetic effect.

5. **Sensitizers** may not harm the body upon first exposures, but upon re-exposure can do so, often at extremely low levels. Response is generally of an allergic nature, with skin, eye, or lung reactions. Examples are formaldehyde, glutaraldehyde, and latex.

6. **Corrosives** cause rapid death of the body cells they contact. Exposure may cause pain, burning, bleeding, and fluid loss. Acids and bases are corrosives. Bases and some acids may cause pain only after exposure. Any contact with acids or bases requires careful washing with water for at least 15 minutes.

7. **Reproductive Toxins** defines a broad class of chemicals that can:
   a. Affect the reproductive organs (e.g., atrophied testicles, enlarged breasts, etc.)
   b. Affect adult sexual functions (e.g., libido, fertility, menstruation, ovulation, etc.)
   c. Affect the offspring of males or females who were exposed by causing structural abnormality, functional deficiencies, altered growth, or death of the conceptus.

   Some **mutagens** can affect the offspring due to parental exposures before conception takes place.

   Teratogens affect the developing embryo or fetus due to exposures in the womb. Exposure to teratogens during the first three weeks of pregnancy may result in severe damage or death of the embryo. Exposure to teratogens during weeks four through nine may result in birth defects since this is the period of organogenesis. Special precautions may be needed to ensure that exposures do not occur during these critical periods.

8. **Carcinogens** cause cancer, which is the irreversible, uncontrolled growth of cells in an organ or tissue. It is believed that there is no known minimum dose that can remove all danger of cancer. Benzene and formaldehyde are known carcinogens.

When will health effects occur? Another factor that should be considered in evaluating the health hazards of chemicals is *when the effect will occur*, immediately after the exposure or sometime after.

An acute reaction is one that occurs in the body as an immediate response to exposure. Effects are apparent and can often be traced without difficulty. Acute reactions are normally short lived and may be followed by recovery or occasionally cause permanent damage.

A chronic effect can result from repeated exposures to a chemical over an extended period of time. Unlike an acute effect, a chronic effect may not be obvious. The onset of symptoms can be gradual. It is much harder to trace the cause of a chronic effect, since the initial exposure could have occurred as long as 20-30 years before an effect becomes apparent.

APPENDIX B

EMERGENCY RESPONSE FOR LABORATORY ACCIDENTS

EMERGENCY RESPONSE FOR LABORATORY ACCIDENTS

EMERGENCY PROCEDURES IN THE EVENT OF A SERIOUS INCIDENT IN A LABORATORY

It is the policy of the Ragon Institute (Ragon) that all occupants are informed and aware of the correct emergency procedures to take in the event of a serious laboratory incident or accident.

Participation in laboratory work may present exposure to potentially hazardous materials or situations. Some of the more serious accidents/incidents that can occur in laboratories include: fire, explosion, chemical spills (toxic or corrosive), release of toxic compressed gases, or failure of power that may adversely affect chemical fume hoods and/or the ventilation system.

While the procedures outlined below tend to be general in nature, there are instances where handling hazardous materials will require that detailed safety procedures be followed (in the event of an accident/incident). Detailed procedures for every possible situation would be too lengthy to be contained in general emergency procedures. Therefore, it is the responsibility of the Principal Investigator (PI) and Chemical Hygiene Officer (CHO) to ensure specific emergency procedures and appropriate decontamination methods are available and utilized for all potential hazards associated with materials used within their particular laboratories (i.e., refer to the Ragon Chemical Hygiene Plan). They must also inform and train all laboratory personnel of these specific hazards and procedures. Detailed emergency procedures should be maintained, and procedures should be conspicuously posted in the laboratory. Copies of specific procedures must be sent to EH&S and the Facility Manager.

FIRES INVOLVING ONE OR MORE LABORATORIES

Follow normal fire procedures as outlined in the Ragon Institute Emergency Action Plan. Specifically:

Rescue

- Remove person(s) from fire room, only if you do not put yourself in danger by doing so.
- Close door(s) to the fire room.

Alarm

- Pull the nearest fire alarm **and** call out FIRE and room location.
- Dial Security at Technology Square Office at 617-577-9177 (or 911), give the exact location of the fire, and identify yourself.

Contain

- Close doors to all rooms in zone.
- Close smoke/fire doors.

Evacuate

- Move injured persons to safe zones, **when** directed by a responsible person. Prepare for evacuation in accordance with fire plan procedures.

Procedures Specific to Laboratories

Person reporting the fire must alert on scene fire and emergency response personnel of particular hazards (chemical, toxic, radioactive, biological) present in the laboratory of concern.

FAILURE OF POWER INVOLVING CHEMICAL FUME HOODS AND/OR VENTILATION

The failure of electrical power serving chemical fume hoods and/or building ventilation systems in a laboratory building can present a serious and formidable hazard. Emergency procedures should include:

1. Alert the Alexandria Real Estate Management Office at 617-661-6962 from 8:30 a.m. to 5:30 p.m. or the Security at Technology Square Office after hours at 617-577-9177 immediately of the power failure.
2. Alert the EH&S Office, the Alexandria Management Office at 617-661-6962 from 8:30 a.m. to 5:30 p.m. or the Security at Technology Square Office after hours at 617-577-9177 if hazardous or toxic materials are stored in affected area.
3. Close containers and lower sashes on chemical fume hoods.
4. Be prepared to evacuate the building if necessary.

APPENDIX C

CHEMICAL SPILL RESPONSE/
RELEASE OF OTHER HAZARDOUS MATERIALS

CHEMICAL SPILL RESPONSE/RELEASE OF OTHER HAZARDOUS MATERIALS

It is the policy of the Ragon Institute (Ragon) that all staff working at Ragon are aware of the correct emergency procedures to take in the event of a chemical spill.

Chemical spills, whether flammable/combustible, toxic or corrosive, can present a potential exposure hazard to Ragon staff, even in small quantities.

MINOR CHEMICAL SPILLS

(Unlikely to Produce a Harmful Concentration in the Air)

- Alert people in immediate area of spill.
- Refer to the safety data sheet (SDS) for the spilled chemical, don personal protective equipment, including safety goggles, gloves, and long-sleeved lab coats.
- Confine spill to a small area.
- Use appropriate kit to neutralize and absorb inorganic acids and bases. Collect residue, place in container, label, and dispose as chemical hazardous waste.
- For other chemicals, use appropriate spill kit or absorb spill with absorbent spill pads. Collect residue, place in container, label, and dispose of as a chemical hazardous waste.
- Clean spill area with water.
- Contact EH&S at 857-268-7116 (Tuesdays and Fridays) or 617-293-0333 to report the spill and cleanup efforts.

CHEMICAL SPILLS INVOLVING 1 GALLON OR LESS

(Likely to Produce a Harmful Concentration in the Air)

- Attend to injured or contaminated persons and remove them from exposure, but only do so if you do not place yourself in danger.
- Alert people in the immediate area to evacuate.
- If spilled material is flammable, turn off ignition and heat sources (if you can do so without putting yourself at risk).
- Notify, from a safe location, EH&S at 857-268-7116 (Tuesdays and Fridays) or 617-293-0333 or Alexandria Real Estate Management Office at 617-661-6962 from 8:30 a.m. to 5:30 p.m. or the Security at Tech Square Office after hours at 617-577-9177. The EH&S representative will be contacted to respond to the spill.
- Be prepared to provide the following information:
  - Name of the material spilled.
  - Toxicity and flammability of the material.
  - Quantity of the material spilled.

  - Presence of other chemicals, ignition sources, etc., that could aggravate the problem.
  - Your location and phone extension.
- Close doors to affected area (post a warning sign or secure area to prevent unauthorized personnel from entering the room).
- Ensure that a person knowledgeable of the incident and work area is available to provide information to the emergency response personnel.

CHEMICAL SPILLS GREATER THAN 1 GALLON

- Notify, from a safe location, EH&S at 857-268-7116 (Tuesdays and Fridays) or 617-293-0333 or Alexandria Real Estate Management Office at 617-661-6962 from 8:30 a.m. to 5:30 p.m. or the Security at Tech Square Office after hours at 617-577-9177. If deemed necessary, EH&S will notify the proper agency or outside contractor to respond to the spill.

APPENDIX D

LIMITS FOR STORAGE OF COMBUSTIBLE AND FLAMMABLE LIQUIDS (HANDLING AND STORAGE)

Massachusetts Building Code
Table 308.2 with Table 417.2 Interpreted – Sprinklered and In Cabinets

		Sprinklered In Cabinets		Quantities Per Control Area by floor above grade						Sprinklered		Quantities Per Control Area by floor above grade						Sprinklered		Quantities Per Control Area by floor above grade					
Material	**Class**	**Storage**	**Adjusted Qty**	**1 (4)**	**2 (3)**	**3 (2)**	**4 thru 6 (2)**	**7 thru 9 (1)**	**Above 9 (1)**	**Closed Systems**	**Adjusted Qty.**	**1 (4)**	**2 (3)**	**3 (2)**	**4 thru 6 (2)**	**7 thru 9 (1)**	**Above 9 (1)**	**Open Systems**	**Adjusted Qty.**	**1 (4)**	**2 (3)**	**3 (2)**	**4 thru 6 (2)**	**7 thru 9 (1)**	**Above 9 (1)**
Combustible Liquid	II	120	480	480	360	240	60	24	24	120	240	240	180	120	30	12	12	30	60	60	45	30	7.5	3	3
	IIIA	330	13200	13200	9900	6600	1650	660	660	330	660	660	495	330	82.5	33	33	80	160	160	120	80	20	8	8
	IIIB	13200	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	13200	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	3300	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Cryogenics Flammable or Oxidizing		45	90	90	67.5	45	11.25	4.5	4.5	45	90	90	67.5	45	11.25	4.5	4.5	10	20	20	15	10	2.5	1	1
Flammable Gas	Gaseous cu.ft.	1000	4000	4000	3000	2000	500	200	200	750	3000	3000	2250	1500	375	150	150			0	0	0	0	0	0
	Liquefied	30	120	120	90	60	15	6	6	30	120	120	90	60	15	6	6			0	0	0	0	0	0
Flammable Liquid	IA	30	120	120	90	60	15	6	6	30	60	60	45	30	7.5	3	3	10	20	20	15	10	2.5	1	1
	IB	60	240	240	180	120	30	12	12	60	120	120	90	60	15	6	6	15	30	30	22.5	15	3.75	1.5	1.5
	IC	90	360	360	270	180	45	18	18	90	180	180	135	90	22.5	9	9	20	40	40	30	20	5	2	2
Combination IA, IB, IC		120	480	480	360	240	60	24	24	120	240	240	180	120	30	12	12	30	60	60	45	30	7.5	3	3
Flammable Solid	Pounds	125	500	500	375	250	62.5	25	25	25	50	50	37.5	25	6.25	2.5	2.5	25	50	50	37.5	25	6.25	2.5	2.5
Organic Peroxide	UD	1	2	2	1.5	1	0.25	0.1	0.1	0.25	0.25	0.25	0.1875	0.125	0.03125	0.0125	0.0125	0.25	0.25	0.25	0.1875	0.125	0.03125	0.0125	0.0125
	I	5	20	20	15	10	2.5	1	1	1	2	2	1.5	1	0.25	0.1	0.1	1	2	2	1.5	1	0.25	0.1	0.1
	II	50	200	200	150	100	25	10	10	50	100	100	75	50	12.5	5	5	10	20	20	15	10	2.5	1	1
	III	125	500	500	375	250	62.5	25	25	125	250	250	187.5	125	31.25	12.5	12.5	25	50	50	37.5	25	6.25	2.5	2.5
Oxidizer	4	1	2	2	1.5	1	0.25	0.1	0.1	0.25	0.25	0.25	0.1875	0.125	0.03125	0.0125	0.0125	0.25	0.25	0.25	0.1875	0.125	0.03125	0.0125	0.0125
	3	10	40	40	30	20	5	2	2	2	4	4	3	2	0.5	0.2	0.2	2	4	4	3	2	0.5	0.2	0.2
	2	250	1000	1000	750	500	125	50	50	250	500	500	375	250	62.5	25	25	50	100	100	75	50	12.5	5	5
	1	1000	4000	4000	3000	2000	500	200	200	1000	2000	2000	1500	1000	250	100	100	200	400	400	300	200	50	20	20
Oxidizer Gas	Gaseous	1500	6000	6000	4500	3000	750	300	300	1500	6000	6000	4500	3000	750	300	300			0	0	0	0	0	0
	Liquefied	15	60	60	45	30	7.5	3	3	15	60	60	45	30	7.5	3	3			0	0	0	0	0	0
Pyrophoric		4	8	8	6	4	1	0.4	0.4	1	1	1	0.75	0.5	0.125	0.05	0.05	0	0	0	0	0	0	0	0
Unstable Reactive	4	1	2	2	1.5	1	0.25	0.1	0.1	0.25	0.25	0.25	0.1875	0.125	0.03125	0.0125	0.0125	0.25	0.25	0.25	0.1875	0.125	0.03125	0.0125	0.0125
	3	5	20	20	15	10	2.5	1	1	1	2	2	1.5	1	0.25	0.1	0.1	1	2	2	1.5	1	0.25	0.1	0.1
	2	50	200	200	150	100	25	10	10	50	100	100	75	50	12.5	5	5	10	20	20	15	10	2.5	1	1
	1	125	500	500	375	250	62.5	25	25	125	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	25	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Water Reactive	3	5	20	20	15	10	2.5	1	1	5	10	10	7.5	5	1.25	0.5	0.5	1	2	2	1.5	1	0.25	0.1	0.1
	2	50	200	200	150	100	25	10	10	50	100	100	75	50	12.5	5	5	10	20	20	15	10	2.5	1	1

Notes

(1) Materials stored at this level are limited to 2 control areas with a minimum of a 2 hour fire rated separation. The amounts are 5% of the limits

(2) Materials stored at this level are limited to 2 control areas with a minimum of a 2 hour fire rated separation. The amounts are limited to 12.5% of the total allowed.

(3) Materials stored at this level are limited to 2 control areas with a minimum of a 1 hour fire rated separation. The amount of material is limited to 50% of the total allowed.

(4) Materials stored at this level are limited to 4 control areas with a minimum of a 1 hour fire rated separation. The amount of material is 100% of the total allowed.

Allowable Quantities in Flammable Storage Cabinets on Ragon Floors:

Class IA = 6 gal.
Class IB + IC = 24 gal.
Class IA + IB + IC = 24 gal.

Class IA includes the most volatile organics, such as ethyl ether and isopentane/2-methylbutane. Ragon typically has inventories of these chemicals well below the allowable limits.

Class IB includes most of the most common laboratory solvents, including ethanol, methanol, acetone, hexanes, isopropanol, acetonitrile, and ethyl acetate. This is the category for which the most vigilance is required to keep inventories below allowable limits.

Class IC includes other chemicals which Ragon typically maintains low quantities of inventory, including xylenes and amyl alcohol.

APPENDIX E

EFFECTIVE USE OF GLOVES

EFFECTIVE USE OF GLOVES

REASONS FOR WEARING GLOVES

The hands are the part of the body that are most likely to come into contact with chemicals. Skin contact can result in dermatitis that is caused by a chemical or allergic irritation of the skin. In addition, some chemicals penetrate the skin and can cause illness in other parts of the body. Wearing gloves protects workers from skin irritation and other effects of chemical exposure.

CHOOSING THE RIGHT GLOVES

Safety data sheets (SDSs) may detail appropriate gloves for use with each chemical. In addition, chemical compatibility charts for specific glove materials can be obtained from glove manufacturers, often on their websites. Compatibility charts often use color coding such as green to indicate that a glove provides excellent protection against a certain chemical, yellow to indicate that it provides partial protection, and red to indicate that the gloves is not appropriate for a certain chemical. They may also use abbreviations such as E (excellent), VG (very good), and P (poor), and may include the amount of time in minutes that it takes a certain chemical to permeate a certain glove material. All compatibility charts are different; please contact EH&S if you have any questions about how to interpret the information. An example of a compatibility chart follows this section (Source: VWR Scientific).

EFFECTIVE USE OF GLOVES

Improper removal of gloves can be a source of contamination. The procedure, which works for thin gloves that may have to be changed often, is as follows:

1. Using the fingers of one gloved hand, pinch the material of the other glove at the base of the palm and peel off the glove.
2. Continue to hold the glove.
3. With the ungloved hand, reach about an inch under the other glove on the palm side of the wrist, pinch, and peel off the other glove.
4. Both gloves have now been removed without skin contact and the contaminated sides of the gloves are facing in.
5. Gloves used with highly toxic materials should be disposed as hazardous waste before leaving the work area.

Studies have shown that up to 5% of new gloves have holes in them. Substances leaking through gloves are held in contact with skin, increasing absorption into the body. Gloves that have been improperly selected or have holes in them can sometimes be worse than no gloves at all. Gloves used for dangerous chemicals can be tested for leaks by filling them with air and immersing them in water. This should not be done with PVA laminated gloves, since they may not be water resistant. If certain types of gloves consistently leak, the manufacturer should be notified.

APPENDIX F

INCOMPATIBLE CHEMICALS IN STORAGE AND REACTIONS

INCOMPATIBLE CHEMICALS—IN STORAGE AND REACTIONS

Acetic Acid:	with chromic acid, nitric acid, ethylene glycol, perchloric acid, peroxides, and permanganates.
Acetone:	with concentrated sulfuric and nitric acid mixtures.
Acetylene:	with copper (tubing) fluorine, bromine, chlorine, iodine, silver, mercury, and their compounds.
Alkali Metals:	such as calcium, potassium, and sodium with water, carbon dioxide, carbon tetrachloride, and other chlorinated hydrocarbons.
Ammonia, Anhydrous:	with mercury, halogens, calcium hypochlorite, hydrogen fluoride.
Ammonium Nitrate:	with acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, and finely divided organics or combustibles.
Aniline:	with nitric acid and hydrogen peroxide.
Bromine:	with ammonia, acetylene, butadiene, butane, hydrogen, sodium carbide, turpentine, and finely divided metals.
Carbon:	activated with calcium hypochlorate, all oxidizing agents.
Chlorates:	with ammonium salts, acids, metal powders, sulfur, finely divided organics, combustibles, or carbon.
Chromic Acid:	with acetic acid, naphthalene, camphor, alcohol, glycerine, turpentine, and other flammable liquids.
Chlorine Dioxide:	with ammonia, methane, phosphine, and hydrogen sulfide.
Chlorine:	with ammonia, acetylene, butadiene, benzene, and other petroleum fractions; hydrogen, sodium carbide, turpentine, and finely-divided powdered metals.
Copper:	with acetylene and hydrogen peroxide.
Cyanides:	with acids and alkalis.
Flammable Liquids:	with ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, and halogens.
Hydrogen Peroxide:	with copper, chromium, iron, most metals or their respective salts, flammable fluids and other combustible materials, aniline, and nitromethane.
Hydrogen Sulfide:	with fuming nitric acid and oxidizing gases.
Hypochlorites:	with acids and activated carbon.
Iodine:	with acetylene, ammonia (aqueous or anhydrous), and hydrogen.

Mercury:	with acetylene, fulminic acid, and ammonia.
Nitrates:	with sulfuric acid.
Nitric Acid:	with acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen (concentrated) sulfide, flammable liquids, flammable gases, copper, brass, and any heavy metals.
Nitrites:	with acids.
Nitroparaffins:	with inorganic bases and amines.
Oxalic Acids:	with silver and mercury.
Oxygen:	with oils, grease, hydrogen, flammable liquids, solids, or gases.
Perchloric Acid:	with acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, and oils.
Peroxides, organic:	with acids, (organic or mineral), avoid friction, store cold.
Phosphorous (white):	with air, oxygen, alkalis, and reducing agents.
Potassium:	with carbon tetrachloride, carbon dioxide, and water.
Potassium chlorate:	with sulfuric and other acids.
Potassium perchlorate (see also chlorates):	with sulfuric and other acids.

Potassium permanganate: with glycerol, ethylene glycol, benzaldehyde, and sulfuric acid.

Selenides:	with reducing agents.
Silver:	with acetylene, oxalic acid, tartaric acid, ammonium compounds, and fulminic acid.
Sodium:	with carbon tetrachloride, carbon dioxide, and water.
Sodium Nitrite:	with ammonium nitrate and other ammonium salts.
Sodium Peroxide:	with ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, and furfural.
Sulfides:	with acids.
Sulfuric Acid:	with potassium chlorate, potassium perchlorate, and potassium permanganate (similar compounds of light metals, such as sodium, lithium).
Tellurides:	with reducing agents.

SAFE CHEMICAL STORAGE

1. ACIDS

- Store large bottles of acids on low shelves or in acid cabinets.
- Segregate oxidizing acids from organic acids, flammables, and combustible materials.
- Segregate acids from bases and active metals such as sodium, potassium, etc.
- Use a bottle carrier for transporting acid bottles.
- Have spill control pillows or acid neutralizers available in case of spill.

Strong Oxidizing Acids

Chromic Acid	Nitric Acid
Hydrobromic Acid	Perchloric Acid
Iodic Acid	Sulfuric Acid

Organic Acids

Acetic Acid	Phenol
Trifluoroacetic Acid	Trichloroacetic Acid

2. BASES

- Segregate bases from acids.
- Store solutions of inorganic hydroxides in polyethylene containers.
- Have spill control pillows or caustic neutralizers available for spills.

Ammonium Hydroxide	Calcium Hydroxide
Bicarbonates	Potassium Hydroxide
Carbonates	Sodium Hydroxide

3. FLAMMABLES

- Store in approved safety cans or cabinets.
- Segregate from oxidizing acids and oxidizers.
- Keep away from any source of ignition, flames, heat, or sparks.
- Know where firefighting equipment is stored and how to use.
- If volatile flammable liquids are stored in a refrigerator, they must be in an explosion-proof (lab-safe) refrigerator.

Flammable Solids

Benzoyl Peroxide	Phosphorous, yellow
Calcium Carbide	Picric Acids

Flammable Gases

Acetylene	Ethylene Oxide
Ammonia	Formaldehyde
Butane	Hydrogen
Carbon Monoxide	Hydrogen Sulfide
Ethane	Methane
Ethyl Chloride	Propane
Ethylene	Propylene

Flammable Liquids

Acetone	Acetonitrile
Butanol	Diethyl Ether
Ethanol	Ethyl Acetate
Heptanes	Hexanes
Isopropanol	Methanol
Toluene	Xylenes

4. OXIDIZERS

- Store in a cool, dry place.
- Keep away from flammable and combustible materials, such as paper or wood.
- Keep away from reducing agents such as zinc, alkaline metals, formic acid.

Oxidizers—Solids

Ammonium Dichromate	Nitrates
Ammonium Perchlorate	Periodic Acid
Ammonium Persulfate	Permanganic Acid
Benzoyl Peroxide	Peroxides, Salts of
Bromates	Potassium Dichromate
Calcium Hypochlorite	Potassium Ferricyanide
Chlorates	Potassium Permanganate
Chromium Trioxide	Potassium Persulfate
Ferric Trioxide	Sodium Chlorite, Hypochlorite
Ferric Chloride	Sodium Dichromate
Iodates	Sodium Nitrate
Iodine	Sodium Perborate

5. PYROPHORIC SUBSTANCES

These ignite spontaneously on contact with air. Store in cool, dry place.

Boron	Diborane	Manganese*
Cadmium	Dichloroborane	Nickel*
Calcium	2-Furaldehyde	Phosphorous, Yellow*
Chromium*	Iron*	Tert-butyl Lithium
Cobalt*	Lead*	Zinc*

* Finely divided metals form a pyrophoric hazard.

6. LIGHT SENSITIVE CHEMICALS

- Avoid exposure to light.
- Store in amber bottles in a cool, dry place.

Bromine	Oleic Acid
Ethyl Ether	Potassium Ferricyanide
Ferric Ammonium Citrate	Silver Salts
Hydrobromic Acid	Sodium Iodide
Mercuric Salts	Mercurous Nitrate

7. CARCINOGENS

- Label all containers as Cancer Suspect Agents.
- Store according to hazardous nature of chemicals (e.g., flammable, corrosive).
- When necessary, store securely.

Antimony compounds	Acrylonitrile
Arsenic compounds	Benzene
Benzidine	Chloroform
Beryllium	Dimethyl Sulfate
Cadmium compounds	Dioxane
Chromates, salts of	Ethylene Dibromide
Formaldehyde	Hydrazine
Vinyl Chloride	Nickel Carbonyl

APPENDIX G

COMMON REACTIVE LABORATORY CHEMICALS

COMMON REACTIVE LABORATORY CHEMICALS

PEROXIDE FORMERS

To determine age:

- ***Look for dates when received and opened***
- ***Look at expiration date***
- ***Look for visible crystal formation***

Examples Include:

- Isopropyl Ether
- Ethyl Ether
- Tetrahydrofuran
- Dioxane

SHOCK SENSITIVE

Look for:

- ***Contamination***
- ***Age***
- ***Metal capped containers***
- ***Dry compounds***
- ***Discoloration***

Examples Include:

- Dipicrylamine
- Picric Acid (Trinitrophenol)
- Sodium Azide
- Other Poly-nitrated Compounds

COMPOUNDS NOT LIKELY TO DEGRADE:

WATER REACTIVES

Examples Include:

- Sodium Hydride
- Lithium Metal
- Sodium Metal
- Borohydrides

TEMPERATURE SENSITIVE

Examples Include:

- Azobis-Compounds
- Organic Peroxides (i.e., Benzoyl Peroxide)
- Cumene Hydroperoxide
- Methyl Ethyl Ketone Peroxide

AIR REACTIVE (PYROPHORICS)

Examples Include:

- Methyl Lithium
- Phosphorous Metal
- Metal Dusts
- Butyl Lithium

COMMON REACTIVE LABORATORY CHEMICALS SURVEY FORM

Department: _____ **Room #:** _____
Principal Investigator: _____ **Phone #:** _____
Laboratory contact at time of survey: _____ **Phone#:** _____

CHEMICAL NAME	WHAT TO LOOK FOR	Y/ N	COMMENTS
Peroxide Formers	**When/If Opened, Expiration Date, Visible Crystal Formation**		
Isopropyl Ether			
Ethyl Ether			
Tetrahydrofuran			
Dioxane			
Shock Sensitive	**Contamination, Age, Metal Cap, Dry, Discoloration**		
Dipicrylamine			
Picric Acid (Trinitrophenol)			
Sodium Amide			
Other Polynitrated compounds			
Water Reactives	**Not Likely To Degrade**		
Sodium Hydride			
Lithium Metal			
Sodium Metal			
Borohydrides			

Temperature Sensitive	**Not Likely To Degrade**		
Azobis-Compounds			
Organic Peroxides (i.e., Benzoyl Peroxide)			
Cumene Hydroperoxide			
Methyl Ethyl Ketone Peroxide			
Air Reactive (pyrophoric)	**Not Likely To Degrade**		
Phosphorous Metal			
Metal Dusts			
Butyl Lithium			
Methyl Lithium			

DATE OF SURVEY: _____ **SURVEYOR:**_____

APPENDIX H

CHEMICAL STORAGE GUIDELINES

CHEMICAL STORAGE GUIDELINES

The following information is designed to aid in proper chemical storage in the Ragon Institute laboratories. Chemicals are to be stored according to the following hazard classes. Storing all classes together alphabetically is prohibited. Chemicals may be organized alphabetically once they are segregated according to hazard class.

Oxidizers: Incompatible with **flammables** and organics.
Common Oxidizers—Ammonium persulfate, silver nitrate, silver nitrite, hydrogen peroxide, potassium permanganate, sodium dichromate.

Toxic: Poisons
Common Toxics—Arsenic compounds, cyanides, osmium tetroxide, formaldehyde, formalin, naphthalene, chloroform, acrylamide.

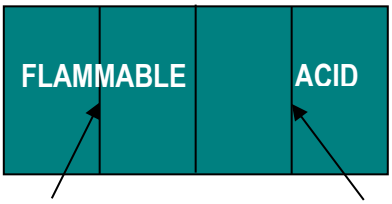
Flammables: Incompatible with **oxidizers**. Ignitable/flammable chemicals must be stored in a **flammable cabinet**. Flammable chemicals requiring refrigeration must be stored in a refrigerator rated for flammable storage.
Common Flammables—Ethanol, methanol, acetone, benzene, ethyl acetate, butanol, alcohols, furans, toluene, Sigmacote, TEMED, paraformaldehyde (flammable solid)

Corrosive: Three kinds of Corrosives: **Bases, Organic Acids, and Inorganic Acids.** All 3 of these corrosives have this pictogram; however, must be separated from each other.
Common Bases—sodium hydroxide, potassium hydroxide, developer.
Common Organic Acids—acetic acid, glacial acetic acid, phenol, formic acid.
Common Inorganic Acids—sulfuric acid, hydrochloric acid, perchloric acid, nitric acid, chromic acid.

Irritants: chemicals producing irritation. Often, the majority of chemicals in a dry chemical storage area in Ragon laboratories. Common Irritants—Sodium carbonate, sodium bicarbonate, Trizma, putrescine, antifoam.

Chemical Storage Shelving Example

Chemical Fume Hood Cabinet



Flammable Storage

Corrosive Storage – Segregate inorganic acids, organic acids, and bases.