UNIVERSITY OF RICHMOND

CHEMICAL HYGIENE PLAN

Prepared by:

University of Richmond, Safety Services & Risk Management (SSRM)
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(Reviewed July, 2011, without changes)
(Revised July, 2012)
FOREWORD

The University of Richmond (U of R) is committed to fostering and maintaining a safe and healthful environment for all persons associated with the institution; including faculty, staff, students, and visitors.

Implementation of the university’s Chemical Hygiene Plan (CHP) provides its employees with knowledge and information concerning potential health hazards associated with hazardous chemicals/substances in/near their respective occupations and workplaces. This Chemical Hygiene Plan establishes policies, procedures, and responsibilities designed to enlighten and promote employee awareness. The CHP is an essential tool of instruction for employees in applying appropriate, safe work practices – so that they (employees) can make knowledgeable decisions relating to personal risks of employment.

All employees will have access to current, pertinent safety information through their supervisor. Often times, due to familiarity, employees are best able to detect potential hazards and deficiencies in either the facility or work procedures. When these type and other safety concerns arise, employees are encouraged to promptly contact their supervisor. If additional assistance is needed, contact the University of Richmond, Safety Services & Risk Management (SSRM) office at (804) 289-8824.
Chemical Hygiene Plan (CHP) for the
University of Richmond

Purpose:

The University of Richmond has a commitment to create and maintain a safe and healthful environment for employees (students, faculty/staff), visitors, and all individuals associated with the university.

The purpose of this Chemical Hygiene Plan (CHP) for the University of Richmond is to:

- Provide/Establish guidelines, policies and procedures (general & specific) to protect employees from health hazards associated with hazardous chemicals in the laboratory


- Ensure compliance with the Occupational Safety and Health Administration (OSHA) "Occupational Exposures to Hazardous Chemicals in Laboratories" herein referred to as the OSHA Laboratory Safety Standard or LSS (29 CFR 1910.450)

The CHP will be available to all employees and personnel that utilize University of Richmond chemical/biological laboratories and facilities. A copy will be maintained in the University of Richmond Safety Services & Risk Management (SSRM) office. The CHP is available on-line at the following link:

http://safety.richmond.edu/laboratory/chemical-hygiene.html

Safety Services & Risk Management will review the CHP annually, and make necessary revisions.
I. Standard Operating Procedures (S.O.P.’s)

1. Laboratory Safety Rules of Conduct for U of R laboratories are attached to this CHP as “APPENDIX A.”

2. Laboratory Supervisors/Principal Investigators (PI’s)\(^1\) have the responsibility to maintain overall safe standard operating procedures and recommend revising the procedures as necessary. Additional, specific training for laboratory personnel is also a part of these duties and responsibilities.

3. U of R SSRM has the responsibility of conducting periodic laboratory inspections. Laboratory inspections will be conducted at varying frequencies and times, but at least once per calendar year.

4. The *Chemical Hygiene Officer (CHO)*\(^*\) shall ensure that the university’s overall Chemical Hygiene Plan is implemented and adhered to.

5. University of Richmond SSRM shall designate a Chemical Hygiene Officer. The CHO has primary responsibility for the implementation and maintenance of the CHP. The University of Richmond, Chemical Hygiene Officer is John Conover, Jr.

\(^1\)Lab Supervisor/PI is defined as an employee (staff/faculty member) who is responsible for a specific laboratory section.

II. Chemical Safety

1. *Inventory:* A chemical inventory should be performed for each laboratory. The inventory is to be updated when new chemicals are procured, consumed, or removed from the laboratory. The most current chemical inventory of Gottwald Center for the Sciences is available from the Stockroom Manager, Phil Joseph. A current report may be printed at individual laboratories’ request.

   Safety Services & Risk Management obtains an inventory of each department annually, and maintains a master file of Material Safety Data Sheets (MSDS’s).

2. *Procurement:* All chemical inventory for Gottwald Center for the Sciences must be received by the Stockroom Manager, Phil Joseph. Mr. Joseph ensures chemicals are properly inventoried and labeled before delivery to any laboratory.
3. **Distribution**: All chemical reagent requests must come through a Laboratory Manager or Director, or the Stockroom Manager.

4. **Chemical Transport within the Building**: When transporting chemicals within the building, use a cart or a chemical carrier when possible. Never transport an open container. Prevent contamination of common surfaces by observing the precautions outlined on Gottwald Center for the Sciences ‘Glove Policy’ posters.

5. **Shipping of samples and associated chemicals**: Any shipping of samples or associated chemicals (preservatives, reagents, fixatives) must be arranged through the Stockroom Manager, Phil Joseph. It is preferred to have necessary chemicals direct-shipped to the sampling location.

Hazardous wastes may not be transported from their point of generation. Consult with the Chemical Hygiene Office, John Conover, for proper waste-handling procedures.

6. **Laboratory Chemical Storage**

   a. No storage on floors and minimal storage on bench tops
   b. Limited storage in fume hoods
   c. Use of proper containers
   d. Use of less toxic chemicals where available
   e. Chemicals segregated according to hazard class & compatibility
   f. Stored chemicals are inspected periodically for deterioration, etc
   g. Amount of stored chemicals kept as small as possible
   h. Avoid chemicals contact with heat or direct sunlight
   i. Acutely toxic chemicals have secondary containment

III. **Environmental/Exposure Monitoring**

Periodic personal and area air sampling is conducted by the Chemical Hygiene Officer to determine airborne chemical concentrations.

If there is reason to suspect that a worker’s exposure levels to any regulated hazardous chemical exceed the regulatory limits of that chemical – exposures shall be monitored.

See “APPENDIX C” for Table Z-2 “Toxic and Hazardous Substances” (29 CFR 1910.1000) – In addition, Appendix B contains lists of some common “LISTED CARCINOGENS”; “SPECIFIC CARCINOGENS”; and “SPECIFIC AIR CONTAMINANTS”
IV. **Housekeeping, Maintenance and Inspections**

Waste should be deposited in appropriate receptacles. Custodial services will not collect waste containing improperly packaged waste glass. *In addition*, custodial services shall not handle, package, or remove hazardous chemicals/wastes, radioactive materials, or pathological/pathological waste materials. **NOTE:** Sanitary sewer/Drain/Sink disposal is prohibited.

Passageways (i.e. stairways, hallways, aisles, etc.) should not be used as storage areas. Access to exits, emergency equipment (eyewashes/showers, fire extinguishers) and utility/mechanical controls should never be blocked. Floors should be cleaned regularly and kept free of obstructions.

Equipment and chemicals should be stored properly; clutter should be minimized.

**Spills:** Small spills should be cleaned up immediately by laboratory personnel. Spills which **cannot** be cleaned up safely by laboratory personnel should be reported according to the university’s *Emergency Procedures* (available on-line at U of R SSRM website).

**Inspections:** It is recommended that PI/lab supervisors perform lab safety/housekeeping inspections at least quarterly. Lab safety inspections will be performed by the U of R SSRM on a continual basis.

V. **Medical Program**

Medical consultations and surveillance which may be required under the Laboratory Safety Standard will be coordinated through University of Richmond, Safety Services & Risk Management (804) 289-8824.

*Some instances where medical services may be required include:*

1. Worker develops signs/symptoms associated with over-exposure to a hazardous chemical.
2. Exposure monitoring indicates exposure levels routinely above regulated levels.
3. A spill, leak, or explosion in a work area results in the likelihood of exposure.
VI. Personal Protective Equipment and Apparel (PPE)

PPE will be provided by the university (employer) to the employee at no cost to the employee; *with the exception* of prescription eyewear and footwear.

PPE should be compatible with the required degree of protection for substances being handled. Chemical Resistance Guides for proper glove selection should be posted in each lab.

*Forms of PPE include:* Safety glasses, face shields, gloves, lab coats/aprons, shoe protectors/coverings; *and can include* respirators*, emergency eyewashes/showers, and fume hoods, etc.*

*29 CFR 1910.134 – Respiratory Protection*

VII. Records/Recordkeeping

The Chemical Hygiene Plan must be reviewed and evaluated *at least* annually – and updated as required by SSRM. The CHP is available to all employees via website at the following:

http://safety.richmond.edu/laboratory/chemical-hygiene.html

Laboratory Managers maintain records of employee attendance at health and safety training(s) given by SSRM. Copies of these records are available to departments on request. Laboratories should maintain records of all internal, additional health and safety training. These records should be available for the employee to review.

Employee accident reports are retained by SSRM in accordance with the requirements of state and federal regulations.

VIII. Signage and Labeling

**Signage:** Signs/markings identifying emergency equipment, i.e. eyewashes/showers and first aid equipment, etc. should be posted.

Laboratory Door Signs should placed at entrance(s) to laboratory: These signs contain information about laboratory hazards, warnings, and point(s) of contact. Laboratory Door Signs are reviewed periodically by the Chemical Hygiene Officer and the appropriate Lab Manager. An example of the *Laboratory Door Sign* (below):
Labeling: All secondary containers will be labeled with sufficient wording and markings identifying its contents and hazard warning; No chemical formulas or abbreviations. (See “XI. Waste Disposal” section of this CHP for label information)

IX. Spills, Accidents, and Emergency Procedures

Spills maybe cleaned up if IT CAN BE DONE SAFELY!! – AND you have:

1. Less than 1 gallon
2. Familiarity with the hazards & properties of the spilled material
3. Sufficient supplies for clean-up & containerization – To include PROPER personal protective equipment (PPE)
4. Adequate ventilation

It is important that chemical & hazardous wastes/materials spills are cleaned up appropriately by trained personnel.

For all emergencies: Large, hazardous spills, accidents, toxic releases and/or fires/explosions – Please call Campus Police at 911
X. **Training and Information**

1. Laboratory personnel will be informed by PI/supervisor of the Laboratory Safety Standard and Chemical Hygiene Plan.

2. All other laboratory-specific training and laboratory/operation-specific Standard Operating Procedures (SOP’s) will be the PI/supervisor’s responsibility.

3. U of R SSRM will facilitate state/federal-mandated health/safety training and maintain records of attendance

**Material Safety Data Sheets (MSDS’s):** MSDS’s are documents provided by manufacturers describing the physical and health hazards of chemicals and trade-name products.

MSDS’s must be accessible to employees at all times. For new, incoming hazardous chemicals and manufacturer’s modification to current chemicals/products – MSDS files should be updated.

Material Safety Data Sheets are maintained in the SSRM office.

MSDS links are available on-line at the following address:

http://safety.richmond.edu/hazard/msds.html

XI. **Waste Disposal**

1. Satellite Accumulation Areas (SAA’s)

   a. **Satellite Accumulation Area:** An area where a waste generator may accumulate wastes in containers at or near the point of generation. Specifically, this means within the control, sight, and within the area (i.e. laboratory) of the generator.

   b. **Satellite Accumulation Area Checklist** (below): Available on-line at:

   http://safety.richmond.edu/common/PDF/SAA%20Checklist%20for%20laboratories.pdf
**Satellite Accumulation Area (SAA) Checklist:**

- An SAA has been designated
- *SAA Checklist* & generator contact information are posted at SAA

**WASTE CONTAINERS:**

- Are in good condition: **Inspected at least once every 7 days (1 week)**
- Are compatible with material being stored in them
- Are closed or sealed except when adding material
- Are labeled with the words “Hazardous Waste” – **NOTE:** Contents of container can be recorded on appropriate “waste label” and affixed to container or separate sheet(s) maintained near the container. In either case the generator’s name and department should be on the container.
- Are properly stored according to waste properties
- Are removed within 3 days of becoming full

**WASTE LABELING:** Waste labels should include the information checked below:

- Words: “Hazardous Waste”
- Generator’s contact information: *name, department, location, & phone number*
- Full, proper chemical name(s) of contents. **No** formulas or abbreviations
- Percent volume of each waste in container *(if applicable)*

Please go to our website link to access and print labels – just fill in your information:

[http://safety.richmond.edu/waste/hazardous.html](http://safety.richmond.edu/waste/hazardous.html)
APPENDICES

A. Laboratory Safety Rules of Conduct

B. Procedures for Minimizing Hazards of Specific Chemicals

C. Toxic & Hazardous Substances (Table) and Carcinogen/Air Contaminants lists

D. Chemical Safety Information Guide

E. Other References
APPENDIX A – Laboratory Safety Rules of Conduct

1. Eating/Drinking, smoking, “horseplay”, and bare feet are prohibited in the laboratory at all times

2. “BE ALERT! STAY ALERT!”

3. Before initiating a process or experiment: Ensure that you have adequate information about the materials and potential hazards

4. Always use proper personal protective equipment (PPE), such as; eye protection, skin protection, gloves, etc. – and any other apparel that a process or experiment may warrant

5. Before exiting the laboratory: Ensure that all electrical equipment and alarms are shut off

6. Do not mouth suction with pipettes or use laboratory equipment and utensils for personal use

7. Be familiar with location of emergency equipment and phone numbers, such as; fire extinguishers/pull-stations, emergency eyewashes/showers, first-aid supplies, and emergency services (Campus Police)

8. ALWAYS report injuries, spills and accidents to supervisor, IMMEDIATELY!

9. Use good housekeeping practices to eliminate clutter, hazards, and/or cross-contamination

10. Keep countertops clean

11. Keep aisles and walkways free from storage, electrical cords, and other trip hazards

12. Laboratory shall be supervised at all times and locked when unattended – Enact “Buddy System” when working in laboratory after hours: Working alone is not advised

13. Ensure that chemicals are stored properly according to their hazard classes and compatibility

14. Ensure that chemicals and containers are in condition and not
polymerizing or degrading

15. Keep flammable chemical storage in the laboratory to a minimum

16. Sanitary sewer/Drain/Sink disposal of chemicals is prohibited

17. **Do not** allow evaporation of chemicals in the fume hood

18. Ensure that compressed gas cylinders are secured to a permanent, stationary object and valves, hoses, etc. are in good condition

19. Know how to access Material Safety Data Sheet (MSDS) information

20. Follow appropriate university waste procedures from generation, storage, and disposal
Appendix B: Procedures for Minimizing Hazards of Specific Chemicals

Part 1 – Mercury Hazard Reduction Program

Part 2 – Chemical Inventory Reduction and Redistribution Program

Part 3 – Use of Extremely Hazardous Non-Carcinogens
Appendix B: Procedures for Minimizing Hazards of Specific Chemicals - Part 1

Mercury Hazard Reduction Program

In an effort to reduce hazards posed by mercury and its compounds, the University of Richmond Gottwald Center for the Sciences has instituted the following actions:

Mercury Article replacement:
Mercury Articles for which there is a suitable replacement, will be replaced with cost-effective alternatives. Replacement examples include alcohol-containing thermometers, thermocouples, and digital manometers. Departments will evaluate their Mercury Article stock, investigate scientifically equivalent cost-effective replacements, and prioritize replacements for current or later purchase.

For those Mercury Articles where no scientifically equivalent cost-effective replacement exists, the device shall be protected from breakage by one or more of the following methods, in order of preference:
1. Sequestration of mercury-containing thermometers in the Stockroom when not in use,
2. Shielding for manometers and barometers,
3. Protective storage within the laboratory for non-thermometer devices, and
4. Teflon coating and protective storage of existing mercury thermometers to be stored in laboratories.

Fate of replaced Mercury Articles:
The goal of the Mercury Hazard Reduction Plan is both hazard reduction and environmental protection. Therefore, all Mercury Articles which have been suitably replaced shall be eliminated from the inventory by one of the following methods, in order of preference:
1. Transfer to chemical re-distribution vendor,
2. Reclamation of elemental mercury by vendor using EPA-approved methods,
3. Disposal through hazardous waste contractor.

Mercury Spills

Students, including student employees, are not permitted to clean up mercury spills. Students are to leave the lab, close the door, and immediately notify their assigned Faculty member, a Laboratory Manager, or the Chemical Hygiene Officer. Entry should not be permitted until the spill has been properly cleaned up by Faculty or Staff members. Clean-up procedures are found in the Chemical Hygiene Plan.

Laboratory Managers maintain mercury spill kits in each stockroom associated with teaching laboratories. Additionally, some laboratories have their own, which is recommended until Mercury Articles can be replaced.
Mercury-containing Compound Reduction
Faculty members should investigate substitution of mercury-containing compounds (including organo-mercury compounds and mercury salts) with non-mercury chemicals, in an effort to reduce or eliminate the use of mercury-containing compounds. This statement does not imply that any mercury-containing compound will be eliminated from stock, unless the material is no longer in use.
Appendix B: Procedures for Minimizing Hazards of Specific Chemicals Part 2 - Chemical Inventory Reduction and Redistribution Program

The American Chemical Society estimates that unused chemicals can constitute up to 40% of the wastes generated by a lab. Therefore, purchasing and inventory functions are vital to reducing hazardous wastes.

**Purchasing**

Prior to purchasing new chemicals, the Stockroom Manager reviews the inventory to determine if the department has an existing supply of the chemical in the Stockroom. While bulk purchasing may seem less expensive per gram of material, studies have shown that eventual disposal costs drive the price much higher when excess chemicals are purchased. Therefore, when chemical purchases are made, the Stockroom Manager purchases only the quantity required for the research project or instructional experiment.

**Inventory Management**

The Stockroom Manager maintains an accurate electronic inventory of all chemicals in the Gottwald Center for the Sciences. Each chemical is assigned a unique inventory number. A bar coded label is placed on each chemical, with the inventory number and chemical’s date of receipt. Chemical stock is rotated on a first in / first out basis to minimize aging.

**Laboratory Unit Inventory Review**

All Faculty and Staff are encouraged to perform an annual inventory review to determine if:

- All chemicals listed on the inventory are present
- All bar-coded chemicals in the lab are listed on the inventory
- Chemicals have not deteriorated or aged beyond usefulness
- Peroxide-forming chemicals are in good condition, and are tested for peroxides
- All chemicals have a foreseeable use, or are returned to the Stockroom (see below)

**Return to Stock Program**

Many chemical reagents can be used by other laboratories. Even those chemicals deemed too old for research use may be useful in teaching laboratories, where a high level purity is not required. All chemicals which have no foreseeable use in the laboratory unit should be returned to the Stockroom for potential redistribution within the department(s). Those chemicals which are no longer usable will be evaluated for redistribution by a vendor (chemical recycling company), or declared a waste and properly disposed through the hazardous waste contractor.
Appendix B: Procedures for Minimizing Hazards of Specific Chemicals  Part 3 – Use of Extremely Hazardous Non-Carcinogens

Certain chemicals pose hazards which require specialized training and SOP’s, even though they are not known carcinogens. These chemicals include:

1. Hydrofluoric Acid (HF)
2. Osmium Tetroxide
3. Sodium Azide
4. Pyrophoric Chemicals

Hydrofluoric Acid (HF)
All use of hydrofluoric acid (HF) requires extensive training and preparation. Users and Buddies must receive training from the Chemical Hygiene Officer before planning their use. Prior to beginning work, the PI must complete the SOP for HF use, and submit it to the Chemical Hygiene Officer for review. HF never leaves the Stockroom. Use is strictly limited to trained faculty or staff member, and all work must be performed at the fume hood in the Stockroom. The Chemical Hygiene Officer is responsible for maintaining the HF Emergency Kit, and the supplies must be verified immediately prior to any use of HF. HF hazards, use, PPE, and first aid procedures will be reviewed with all participants prior to each use of HF.

Osmium Tetroxide (OsO₄)
All use of osmium tetroxide is limited to the Electron Microscopy Suit. Each user must be trained by the Director of Biological Imaging prior to their first use, and annually thereafter. Training shall include: MSDS review, hazards, signs and symptoms of exposure, emergencies, PPE, proper use/decontamination/disposal of equipment, and waste handling. Osmium tetroxide must always be used in a fume hood. Only the Director of Biological Imaging is permitted to make stock solutions from pure osmium tetroxide crystals.

Sodium Azide (NaN₃)
Due to the reactive and extremely toxic nature of sodium azide, this reagent is securely stored in the Stockroom. The Stockroom Manager issues sodium azide to PI’s on an ‘as-needed’ basis to minimize potential hazards. As with other chemicals used in research laboratories, the PI is responsible for training student researchers and employees on the safety issues of sodium azide.

Pyrophoric chemicals
Due to the hazard presented by any pyrophoric chemical, PI’s must train all users in proper handling, inerting, and quenching techniques, along with all other routine safety training for specific chemicals. As with other chemicals used in research laboratories, the PI is responsible for training student researchers and employees on the safety issues of pyrophoric chemicals. Several video training resources are available on the internet to augment this training. The Chemical Hygiene Officer sends periodic reminders to all PI’s who maintain stocks of pyrophoric chemicals, to inspect the condition of these reagent containers.
### APPENDIX C – Toxic and Hazardous Substances & Carcinogen/Air Contaminants Lists

**TABLE Z-2 (Toxic and Hazardous Substances)**

<table>
<thead>
<tr>
<th>Substance</th>
<th>8-hour time weighted average</th>
<th>Acceptable ceiling concentration</th>
<th>Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzene(^{(a)}) (Z37.40-1969)</td>
<td>10 ppm</td>
<td>25 ppm</td>
<td>50 ppm 10 minutes.</td>
</tr>
<tr>
<td>Beryllium and beryllium compounds (Z37.29-1970)</td>
<td>2 ug/m(3)</td>
<td>5 ug/m(3)</td>
<td>25 ug/m(3) 30 minutes.</td>
</tr>
<tr>
<td>Cadmium fume(^{(b)}) (Z37.5-1970)</td>
<td>0.1 mg/m(3)</td>
<td>0.3 mg/m(3)</td>
<td>20 ppm 5 minutes.</td>
</tr>
<tr>
<td>Cadmium dust(^{(b)}) (Z37.5-1970)</td>
<td>0.2 mg/m(3)</td>
<td>0.6 mg/m(3)</td>
<td>50 ppm 5 minutes.</td>
</tr>
<tr>
<td>Carbon disulfide (Z37.3-1968)</td>
<td>20 ppm</td>
<td>30 ppm</td>
<td>100 ppm 30 minutes.</td>
</tr>
<tr>
<td>Carbon tetrachloride (Z37.17-1967)</td>
<td>10 ppm</td>
<td>25 ppm</td>
<td>200 ppm 5 min. in any 3 hrs.</td>
</tr>
<tr>
<td>Chromic acid and chromates (Z37-7-1971)</td>
<td></td>
<td>1 mg/10 m(3)</td>
<td>10 mins. once only if no other meas. exp. occurs.</td>
</tr>
<tr>
<td>Ethylene dibromide (Z37.31-1970)</td>
<td>20 ppm</td>
<td>30 ppm</td>
<td>50 ppm 5 minutes.</td>
</tr>
<tr>
<td>Ethylene dichloride (Z37.21-1969)</td>
<td>50 ppm</td>
<td>100 ppm</td>
<td>200 ppm 5 min. in any 3 hrs.</td>
</tr>
<tr>
<td>Fluoride as dust (Z37.28-1969)</td>
<td>2.5 mg/m(3)</td>
<td>1 mg/10 m(3)</td>
<td>10 mins. once only if no other meas. exp. occurs.</td>
</tr>
<tr>
<td>Formaldehyde: see 1910.1048</td>
<td></td>
<td>1 mg/10 m(3)</td>
<td>10 mins. once only if no other meas. exp. occurs.</td>
</tr>
<tr>
<td>Hydrogen fluoride (Z37.28-1969)</td>
<td>3 ppm</td>
<td>1 mg/10 m(3)</td>
<td>10 mins. once only if no other meas. exp. occurs.</td>
</tr>
<tr>
<td>Hydrogen sulfide (Z37.2-1966)</td>
<td></td>
<td>20 ppm</td>
<td>50 ppm 10 mins. once only if no other meas. exp. occurs.</td>
</tr>
<tr>
<td>Mercury (Z37.8-1971)</td>
<td></td>
<td>1 mg/10 m(3)</td>
<td>10 mins. once only if no other meas. exp. occurs.</td>
</tr>
<tr>
<td>Methyl chloride (Z37.18-1969)</td>
<td>100 ppm</td>
<td>200 ppm</td>
<td>300 ppm 5 mins. in any 3 hrs.</td>
</tr>
<tr>
<td>Methylene Chloride: see 1910.1052</td>
<td></td>
<td></td>
<td>5 mins. in any 3 hrs.</td>
</tr>
<tr>
<td>Organo (alkyl) mercury (Z37.30-</td>
<td></td>
<td>0.01mg/m(3)</td>
<td>0.04 mg/m(3)</td>
</tr>
<tr>
<td>Compound (Z37.15-1969)</td>
<td>100 ppm</td>
<td>200 ppm</td>
<td>600 ppm</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>100 ppm</td>
<td>200 ppm</td>
<td>300 ppm</td>
</tr>
<tr>
<td>Toluene (Z37.12-1967)</td>
<td>200 ppm</td>
<td>300 ppm</td>
<td>500 ppm</td>
</tr>
<tr>
<td>Trichloroethylene (Z37.19-1967)</td>
<td>100 ppm</td>
<td>200 ppm</td>
<td>300 ppm</td>
</tr>
</tbody>
</table>

Footnote (a) This standard applies to the industry segments exempt from the 1 ppm 8-hour TWA and 5 ppm STEL of the benzene standard at 1910.1028.

Footnote (b) This standard applies to any operations or sectors for which the Cadmium standard, 1910.1027, is stayed or otherwise not in effect.
APPENDIX C – Toxic and Hazardous Substances & Carcinogen/Air Contaminants Lists

(…continued)

LISTED CARCINOGENS:

4-Nitrobiphenyl
Alpha-Napthylamine
4,4’-Methylene bis (2-chloroaniline)
Methyl Chloromethyl Ether
3,3’-Dichlorobenzidine (and its salts)
Bis-Chloromethyl ether
Beta-Naphthylamine

SPECIFIC CARCINOGENS:

Acrylonitrile
Cadmium
Ethylene Oxide
Methylene Chloride

SPECIFIC AIR CONTAMINANTS:

Asbestos
Formaldehyde
Methylenedianiline

Benzidine
4-Aminodiphenyl
Ethyleneimine
Beta-Propiolactone
Acetylaminofluorene
4-Dimethylaminoazobenzene
N-Nitrosodimethylamine
Butadiene
1,2-Dibromo-3 chloropropane
Inorganic arsenic
Vinyl Chloride
Benzene
Lead
Thiram
APPENDIX D – *Chemical Safety Information Guide*

Part 1 – Chemical Incompatibility Storage Chart

Part 2 – Peroxidizable Chemicals

Part 3 – Shock-sensitive Chemicals
## CHEMICAL INCOMPATIBILITY STORAGE CHART

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Is Incompatible With</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>Chronic acid, nitric acid, hydroxyl compounds, ethylene glycol, perchloric acid, peroxides, permanganates</td>
</tr>
<tr>
<td>Acetylene</td>
<td>Chlorine, bromine, copper, fluorine, silver, mercury</td>
</tr>
<tr>
<td>Acids; mineral, nonoxidizing (hydrochloric, hydrobromic, phosphoric, sulfuric)</td>
<td>Water, bases, ethylene, strong oxidizers</td>
</tr>
<tr>
<td>Acids; mineral, oxidizing [nitric, perchloric, chromic (Chromium trioxide)]</td>
<td>(STORE IN GLASS OR OTHER INERT BOTTLES) (DO NOT USE CORKS OR RUBBER STOPPERS)</td>
</tr>
<tr>
<td>Acids; organic (Acetic, benzoic, caprylic, chloracetic, formic, fumaric, maleic, oxalic, phthalic, propionic)</td>
<td>Sulfuric acid, nitric acid, peroxides, chromic acid, acetaldehyde, ethylenediamine, hydroxides, water, permanganates, hypochlorites</td>
</tr>
<tr>
<td>Alkali and Alkaline Earth metals (such as powdered aluminum or magnesium, calcium, lithium, sodium, potassium)</td>
<td>Water, oxidizers, carbon tetrachloride or other chlorinated hydrocarbons, carbon dioxide, halogens</td>
</tr>
<tr>
<td>Alcohols, Glycols (Allyl alcohol, methanol, ethanol, butanol, pentanol, 2-chloroethanol, benzyl alcohol, ethylene glycol, propylene glycol)</td>
<td>Strong acids, strong bases, strong oxidizers, phenols, urea</td>
</tr>
<tr>
<td>Aldehydes (Formaldehyde, glutaraldehyde)</td>
<td>Mercury (in manometers, for example), chlorine, calcium, hypochlorite, iodine, bromine, hydrofluoric acid, oxidizers</td>
</tr>
<tr>
<td>Ammonia, anhydrous</td>
<td>Acids, metal powders, flammable liquids, chlorates, nitrates, sulfur, finely divided organic or combustible materials, reducing agents</td>
</tr>
<tr>
<td>Ammonia nitrate</td>
<td>Strong oxidizers, halogenated compounds, esp. CCl₄</td>
</tr>
<tr>
<td>Amides (Formamidine, dimethylaminobenzaldehyde)</td>
<td>Acetic acid, acetic anhydride, chlorosulfonic acid, nitric acid, hydrochloric acid, sulfuric acid, acrolein, acrylonitrile, hydrofluoric acid, vinyl acetate, oxidizers in general</td>
</tr>
<tr>
<td>Amines (Pyridine, benzylamine, naphthylamine, aniline)</td>
<td>Nitric acid, hydrogen peroxide, other oxidizers</td>
</tr>
<tr>
<td>Aninline (Azo compounds, Diazoo compounds, and Hydrazine (Hydrazine, diazomethane, diazoaminobenzene, azobenzene)</td>
<td>Hydrogen peroxide, nitric acid, porous materials, oxidizers, strong acids, metal oxides</td>
</tr>
<tr>
<td>Bromine</td>
<td>Same as for chlorine</td>
</tr>
<tr>
<td>Carbon, activated</td>
<td>Calcium hypochlorite, all oxidizing agents</td>
</tr>
<tr>
<td>Caustics (Sodium hydroxide, potassium hydroxide, ammonium hydroxide, ammonia, barium oxide, calcium oxide, lithium hydroxide, sodium)</td>
<td>Acid, water, acetic anhydride, acetaldehyde, acrolein, acrylonitrile, propane, tetrahydrofuran, trichloroethylene, organic halogens, tin, nitro compounds</td>
</tr>
</tbody>
</table>
carbonate)

Chlorates Ammonium salts, acids, powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid Acetic acid, naphthalene, camphor, glycerin, turpentine, alcohol, flammable liquids
Chlorine Ammonia, acetylene, butadiene, butane, methane, propane, (or other petroleum gases), hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine dioxide Ammonia, methane, phosphine, hydrogen peroxide, nitric acid, sodium peroxide, the halogens
Copper Acetylene, hydrogen peroxide
Cumene hydroperoxide Acids, organic or inorganic, reducing agents
Cyanides Acids and acid salts, nitrates, chlorates, other oxidizers
(Sodium, potassium, hydrogen)
Esters Oxidizing materials, nitrate, strong acids, strong bases, peroxides
(Dibutyl phthalate, ethyl acetate, methyl methacrylate)
Ethers Strong acids, liquid oxygen or air, oxidizers
(Isopropyl ether, 1,4-dioxane, tetrahydrofuran)
Flammable liquids Ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, the halogens Acids; best to isolate
Fluorides Ammonia, aqueous or anhydrous
(Potassium fluoride, sodium fluoride, hydrofluoric acid)
Fluorine Isolate from everything
Hydrocarbons Fluorine, chlorine, bromine, chromic acid, sodium peroxide, other oxidizers
(Butane, propane, benzene, gasoline, turpentine, etc.)
Hydrocyanic acid Nitric acid, alkali
Hydrofluoric acid, anhydrous Ammonia, aqueous or anhydrous
Hydrogen peroxide Copper, chromium, iron, most metals or their salts, alcohols, acetone, organic materials, aniline, nitromethane, flammable liquids, combustible materials
Hydrogen sulfide Fuming nitric acid, oxidizing gases
Iodine Acetylene, ammonia (aqueous or anhydrous), hydrogen
Isocyanates (STORE UNDER NITROGEN OR DRY AIR)
(Methyl isocyanate, toluene diisocyanate) WATER, alkali, amines, iron, copper, tin, strong oxidizers
Ketones Strong oxidizers, nitric acid, hypochlorites, nitric acid-hydrogen peroxide mixture
(Acetone, diethyl ketone, butanone, methyl ethyl ketone)
Mercaptans and organic sulfides Oxidizing agents, chlorine, azides, ethylenediamine, fluorine, permanganates, potassium, zinc, calcium hypochlorite, and organic amines
(Methyl isocyanate, toluene diisocyanate)
Mercury Acetylene, fulminic acid, ammonia
Nitric acid, concentrated Acetic acid, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases
Oxalic acid Silver, mercury
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Reactants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perchloric acid</td>
<td>Acetic anhydride, bismuth and its alloys, alcohol, paper, wood</td>
</tr>
<tr>
<td></td>
<td>STORE SEPARATELY. USE IN A SEPARATE AREA SPECIFICALLY DESIGNED FOR PERCHLORIC USE. (including fume hood with washdown system)</td>
</tr>
<tr>
<td>Potassium</td>
<td>Carbon tetrachloride, carbon dioxide, water, oxidizers</td>
</tr>
<tr>
<td>Potassium chlorate</td>
<td>Sulfuric and other acids, other oxidizers</td>
</tr>
<tr>
<td>Potassium perchlorate</td>
<td>Sulfuric and other acids, other oxidizers</td>
</tr>
<tr>
<td></td>
<td>(See also Chlorates)</td>
</tr>
<tr>
<td>Potassium permanganate</td>
<td>Glycerin, ethylene glycol, benzaldehyde, sulfuric acid, reducing agents</td>
</tr>
<tr>
<td></td>
<td>such as organic liquids, etc.</td>
</tr>
<tr>
<td>Silver</td>
<td>Acetylene, oxalic acid, tartaric acid, ammonium compounds</td>
</tr>
<tr>
<td>Sodium</td>
<td>Carbon tetrachloride, carbon dioxide, water, oxidizers</td>
</tr>
<tr>
<td>Sodium peroxide</td>
<td>Ethyl or methyl alcohol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerin, ethylene glycol, ethyl acetate, methyl acetate, furfural, other reducing agents</td>
</tr>
<tr>
<td>Sulfuric acid</td>
<td>Potassium chlorate, potassium perchlorate, potassium permanganate (or compounds with similar light metals, such as sodium, lithium)</td>
</tr>
</tbody>
</table>
### Peroxidizable Chemicals

<table>
<thead>
<tr>
<th><strong>Ethers</strong> - Straight-chain and cyclic ethers readily for peroxides.</th>
</tr>
</thead>
<tbody>
<tr>
<td>• isopropyl ether</td>
</tr>
<tr>
<td>• ethyl ether</td>
</tr>
<tr>
<td>• furan</td>
</tr>
<tr>
<td>• tetrahydrofuran</td>
</tr>
<tr>
<td>• p-dioxane</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Unsaturated Compounds</strong> - Relatively low molecular weight compounds containing carbon-carbon double and triple bonds often have a propensity to form explosive peroxides. These include:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• cyclopentene</td>
</tr>
<tr>
<td>• cyclohexene</td>
</tr>
<tr>
<td>• dicyclopentadiene</td>
</tr>
<tr>
<td>• divinyl acetylene</td>
</tr>
</tbody>
</table>

Note: Some halogenated-substituted alkenes will form peroxides. Some, such as trichloroethylene, pose no significant danger. Others produce an extreme peroxide hazard, such as:

| • 1,1-dichloroethylene |

Note: Styrene, acrylates, and methacrylates form peroxides which do not pose an explosive hazard, but may initiate rapid and violent polymerization of the chemical.

<table>
<thead>
<tr>
<th><strong>Other Organic Compounds</strong> - Several organic compounds form explosive peroxides. Among these are:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• decahydronaphthalene</td>
</tr>
<tr>
<td>• tetrahydronaphthalene</td>
</tr>
<tr>
<td>• methylcyclohexane</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Inorganic Compounds</strong> - The following metals will form dangerous peroxides and/or superoxides over time:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• metallic potassium</td>
</tr>
<tr>
<td>• metallic rubidium</td>
</tr>
<tr>
<td>• metallic cesium</td>
</tr>
<tr>
<td>• potassium amide</td>
</tr>
<tr>
<td>• sodium amide</td>
</tr>
<tr>
<td>• metal amides</td>
</tr>
<tr>
<td>• metal alkoxides</td>
</tr>
</tbody>
</table>
### SHOCK-SENSITIVE COMPOUNDS

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetylenic Compounds</td>
<td>especially polyacetylenes, haloacetylenes, and heavy metal salts of acetylenes (copper, silver, and mercury salts are particularly sensitive).</td>
</tr>
<tr>
<td>Acyl nitrates</td>
<td></td>
</tr>
<tr>
<td>Alkyl Nitrates</td>
<td>particularly polyl nitrates such as nitrocellulose and nitroglycerine.</td>
</tr>
<tr>
<td>Alkyl and Acyl Nitrites</td>
<td></td>
</tr>
<tr>
<td>Alkyl Perchlorates</td>
<td></td>
</tr>
<tr>
<td>Ammine metal oxosalts</td>
<td>metal compounds with coordinated ammonia, hydrazine, or similar nitrogenous donors and ionic perchlorate, nitrate, permanganate, or other oxidizing group.</td>
</tr>
<tr>
<td>Azides</td>
<td>including metal, nonmetal, and organic azides.</td>
</tr>
<tr>
<td>Chlorite salts of metals</td>
<td>such as AgClO2 and Hg (ClO2)2.</td>
</tr>
<tr>
<td>Diazonium salts</td>
<td>diazides.</td>
</tr>
<tr>
<td>Diazonium salts</td>
<td>when dry.</td>
</tr>
<tr>
<td>Fulminates</td>
<td>(silver fulminate, AgCNO, can form in the reaction mixture from Tollens’ test for aldehydes if it is allowed to stand for some time; this can be prevented by adding dilute nitric acid to the test mixture as soon as the test has been completed).</td>
</tr>
<tr>
<td>Hydrogen peroxide</td>
<td>becomes increasingly treacherous as the concentration rises above 30%, forming explosive mixtures with organic materials and decomposing violently in the presence of traces of transition metals.</td>
</tr>
<tr>
<td>N-Halogen compounds</td>
<td>such as difluoroamino compounds and halogen azides.</td>
</tr>
<tr>
<td>N-Nitro compounds</td>
<td>such as N-nitromethylamine, nitrourea, nitroguanidine, and nitric amide.</td>
</tr>
<tr>
<td>Oxo salts of nitrogenous bases</td>
<td>perchlorates, dichromates, nitrates, iodates, chlorites, chlorates, and permanganates of ammonia, amines, hydroxylamine, guanidine, etc.</td>
</tr>
<tr>
<td>Perchlorate salts</td>
<td>Most metal, nonmetal, and amine perchlorates can be detonated and may undergo violent reaction in contact with combustible materials.</td>
</tr>
<tr>
<td>Peroxides and hydroperoxides</td>
<td>organic.</td>
</tr>
<tr>
<td>Peroxides (solid)</td>
<td>that crystallize from or are left from evaporation of Peroxidizable solvents.</td>
</tr>
<tr>
<td>Peroxides, transition-metal salts</td>
<td></td>
</tr>
<tr>
<td>Picrates</td>
<td>especially salts of transition and heavy metals, such as Ni, Pb, Hg, Cu, and Zn; picric acid is explosive but is less sensitive to shock or friction than its metal salts and is relatively safe as a water-wet paste.</td>
</tr>
<tr>
<td>Polynitroalkyl compounds</td>
<td>such as tetranitromethane and dinitroacetonitrile.</td>
</tr>
<tr>
<td>Polynitroaromatic compounds</td>
<td>especially polynitro hydrocarbons, phenols, and amines.</td>
</tr>
</tbody>
</table>
APPENDIX E – OTHER REFERENCES

(1) American Conference of Governmental Industrial Hygienists, *Threshold Limit Values for Chemical Substances and Physical Agents & Biological Indices*, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634, [2003].


i [http://membership.acs.org/c/ccs/pubs/less_is_better.pdf](http://membership.acs.org/c/ccs/pubs/less_is_better.pdf)

ii [http://membership.acs.org/c/ccs/pubs/less_is_better.pdf](http://membership.acs.org/c/ccs/pubs/less_is_better.pdf)