How To Be A More Effective

Chemical Hygiene Officer

Developed by
RJG Associates

****

James Kaufman, Ph.D.
Russell Phifer, C.E.T.
George Wahl, Ph.D.

Presented by

Natick, Massachusetts
www.labsafety.org

DISCLAIMER / PREFACE

Please respect that LSI is a nonprofit educational institute that is largely funded by the sale of our training services and materials, so we appreciate your limited use of these materials and credit to us whenever you do reuse materials. You may not post these resources on the internet or distribute them electronically.

The course presenters are not associated with the National Registry of Certified Chemists (NRCC), the organization responsible for maintaining the Chemical Hygiene Officer certification program. While the course areas are designed to cover material presented in the certification exam, no warranty is presented regarding an individual's ability to obtain certification as a result of course attendance. Specific questions regarding the certification program and testing process should be referred to the NRCC.

The presenters have developed this course independent of any agency, employer, or formal organization. Government documents included are public record and may be reproduced without permission. All other documentation provided in the course material are the property of the course presenters and may not be duplicated without the expressed written permission of the presenters. For permission, please contact the Laboratory Safety Institute.

How to Become a More Effective CHO*

0. Introduction _____ 8:30 - 8:40
1. The Chemical Hygiene Officer _____ 8:40 - 9:15
2. OSHA/EPA Regulations in the Lab _____ 9:15 - 10:00

BREAK

3. The OSHA Laboratory Standard _____ 10:15-11:00
4. Chemical Hygiene Officer Responsibilities _____ 11:00-11:30

Discussion Period _____ 11:30-11:45

LUNCH BREAK (Dutch Treat) _____ 11:45-12:45

5. Lab Hazards and Control Methods _____ 12:45-1:30

BREAK

6. Chemical Hygiene Plan Development _____ 1:40-2:20
7. Chemical Plan Implementation _____ 2:20-2:35

BREAK

8. CHO Responsibilities
   Beyond the Laboratory Standard _____ 2:45-3:15
9. Resources for Chemical Hygiene Officers _____ 3:15-3:30

BREAK

10. Sample Test/Review _____ 3:30 - 4:30

* This course was developed by Russ Phifer, George Wahl, and Jim Kaufman (RJG Associates), the Workshop Committee of the American Chemical Society Division of Chemical Health and Safety. It is the prep course for taking the National Registry of Certified Chemists (NRCC) Certified Chemical Hygiene Officer exam.

ACTION IDEAS

Use this page for making notes on those simple, inexpensive things you can do now (tomorrow morning, Monday morning) to improve lab safety and your lab safety program.

Remember:

> *When nothing seems to help, I go and look at a stone cutter hammering away at his rock perhaps a hundred times without so much as a crack showing in it. Yet at the hundred and first blow it will split in two, and I know it was not that blow that did it – but all that had gone before.*
>
> *- Jacob Riis*

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____
16. _____
17. _____
18. _____
19. _____
20. _____
21. _____
22. _____

23. _____
24. _____
25. _____
26. _____
27. _____
28. _____
29. _____
30. _____
31. _____
32. _____
33. _____
34. _____
35. _____
36. _____
37. _____
38. _____
39. _____
40. _____
41. _____
42. _____
43. _____
44. _____
45. _____
46. _____
47. _____
48. _____
49. _____
50. _____
51. _____
52. _____
53. _____
54. _____
55. _____

How to be a More Effective Chemical Hygiene Officer

Christina Dillard
Jim Kaufman
Russ Phifer

See Reference Page 3, 4, 5

Introduction

DISCLAIMER

The course presenters are not employed by the National Registry of Certified Chemists (NRCC; http://www.nrcc6.org/), the organization responsible for maintaining the Chemical Hygiene Officer certification program. While the subject matter of the course is chosen to cover material likely to be found on the certification exam, no warranty is presented regarding any individual's ability to obtain certification as a result of course attendance. Specific questions regarding the certification program and testing process should be referred to the NRCC (rphifer@nrcc6.org).

RJG Associates has developed this course independent of any agency, employer, or formal organization. Government documents included are public record and may be reproduced without permission. All other documentation provided in the course manual is the property of RJG Associates and may not be duplicated without the expressed written permission of the authors (RJG Associates).

See Reference Page 2

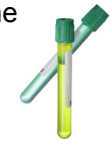
The Chemical Hygiene Officer

RJG Associates 2015

A Chemical Hygiene Officer should be

"an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan"

… 29 CFR 1910.1450(b)



RJG Associates 2015

2

"Qualified by training or experience"

- **Training** – could include formal safety training, a degree in a safety-related field, and/or attendance at professional training courses
- **Experience** – could include participation on a safety committee or, other safety-related responsibilities in the workplace

RJG Associates 2015

See Reference Page 7

2

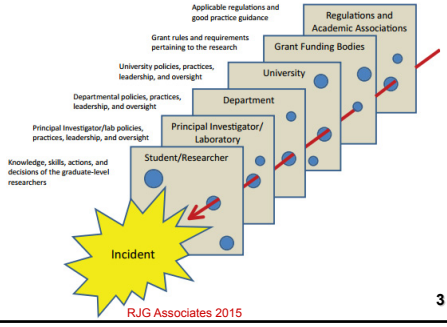
“Provide Technical Guidance”

- The Chemical Hygiene Officer *sets the tone* for a facility’s response to the requirements of the Laboratory Standard
- In order to provide the appropriate guidance on developing and implementing a CHP, the CHO must be familiar with the hazardous materials that may be encountered in the laboratory

despite everyone's best efforts, risk management of hazards fails on a frighteningly routine basis.

FIGURE 1

Examining a laboratory incident using James Reason’s Swiss Cheese Model of Accident Causation as the framework for analysis



Issues in the Selection of the CHO

- Qualifications
- Education
- Training
- Supervisory experience
- Specific laboratory expertise

Issues in CHO Selection
(continued)

- Communication skills
- Organizational support
- "*People skills*"
- Leadership
- Time to do a good job
- Compensation
- Liability

The Three Things a CHO Must Have

- **Time to do the job**
- **Authority to do the job**
- **Resources to do the job**

Laboratory Laws and Regulations

Laws and Environmental Controls

- Laws
- Regulations
- Clarifications
- Interpretations

Laws and Environmental Controls

- Laws - passed by Congress or a state legislature
- Regulations - prepared by federal or state agency, sometimes based on a specific law
- Clarifications - issued in the Federal Register to explain a regulation in more detail
- Interpretations - may be requested, usually online or by mail; can also be made by an inspector

Federal Laws

- Occupational Safety and Health Act – OSHA (29CFR)
- Resource Conservation and Recovery Act – EPA (40CFR)
- Community Right to Know Act – EPA (40CFR)
- Hazardous Materials Transportation Act – DOT (49CFR)

See Reference Page 9, 27-35

OSHA General Industry Standards
(that may apply to Laboratories)

- 1910.21-32 Walking and working surfaces
- 1910.35-40 Means of egress
- 1910.95 Noise
- 1910.101 Compressed gases
- 1910.106 Flammable/combustible liquids
- 1910.120 Emerg. Resp. (HAZWOPER)
- 1910.132-140 PPE
- 1910.141 Sanitation

More General Standards…

- 1910.145 Signs
- 1910.151 Medical and first aid
- 1910.155-165 Fire protection
- 1910.212-213 Machine guarding
- 1910.242-243 Hand/portable tools
- 1910.303-308 Electrical
- 1910.1020 Access to exposure/ medical records
- 1910.1030 Bloodborne pathogens
- 1910.1450 Occupational exposure to hazardous chemicals in laboratories

How does your facility define an "emergency"?

- Your Chemical Hygiene Plan should include a definition so employees know when to respond to a situation and when to notify and evacuate
- Training is required for all employees who respond to an emergency

Define Emergency

- Release which has the potential for harm to human health, property, or the environment
- Quantities need to be based on the hazards of the specific chemical or situation

Hazardous Waste Operations and Emergency Response

- First Responder – awareness level
- First Responder – operations level
- Hazardous Materials Technician (24 hr.)
- Hazardous Materials Specialist (24 hr.)
- On-scene Incident Commander (24 + 8 hr. supervisory training)

See Reference Page 11-16

Case Study: Texas Tech University

- Reported safety violations, Jan. 7 explosion
  - Outdated chemical inventory
  - No eye protection
  - No general training
  - No departmental safety coordinator
  - Unlabeled containers in lab
  - Workers unaware of safety guidelines
  - No written procedures for carcinogens
  - No proof of regular inspections
  - No formal explosive-material training
  - No departmental safety procedures

More violations…

- No standard operating procedure for hazardous materials
- No criteria to control employee exposure
- No special functioning requirements for fume hoods/safety equipment
- No provisions for employee training
- No departmental approval for procedures
- No provisions for medical consultations/examinations
- No appointed department chemical hygiene coordinator
- No established designated area
- Lab staff reported only minimal training
- No visible material safety data sheets

RCRA Regulations

40CFR 261-265, 270

- **Wastes can be hazardous due to either characteristics or listing, or both**
- **Hazardous characteristics**
  - **Ignitability** (liquid with flashpoint <140F; solid readily sustains combustion
  - **Corrosivity** (liquid with pH <2 or >12.5)
  - **Reactivity** (reacts violently with air or water or forms toxic gases when exposed to neutral conditions)
  - **TCLP Toxicity** (metals, solvents, pesticides)
- **Hazard lists** - F, K, P, U

See Reference Page 17-26

RCRA (continued)

- **Generator Status – CESQG, SQG, LQG**
  - <100 kg per month
  - 100 – 1000 kg/month
  - >1000 kg/month
- **Accumulation limits**
  - Satellite storage – storage at or near the point of generation, up to 55 gallons, indefinitely
- **On-site handling, storage, treatment**

Key RCRA Generator Requirements

- **Waste Determinations**
  - Evaluate all wastes and maintain records
- **Manage containers**
  - Properly label and store
- **Follow accumulation limits**
  - Based on generator level

Materials of Trade Exemption

- Applies to the transportation of small quantities of hazardous materials that are part of your business. Examples include:
- Facilities Maintenance Services (paints and solvents; gasoline & other fuels for groundskeepers),
- Researchers (preservatives for field samples)
- Educational Demonstrations (i.e. chemicals for public school outreach education programs)

Hazardous Material Transportation Regulations

- Shippers and receivers of hazardous materials
- Proper DOT shipping names, markings, labels, paperwork (Hazardous materials table – 49CFR 172.101) for sample shipments
- Liability for proper classification
- Training – http://hazmat.dot.gov/training.html
- NOTE: employees with ANY responsibility for offering hazmats for transportation, preparing shipments, labeling, or paperwork must be trained

Nuclear Regulatory Commission Regulations

- Radioactive sources (GC-EC)
- Radioactive licensing
- Radiation Safety Officer
- Radioactive and/or mixed wastes
- 10 CFR

The OSHA Lab Standard

(*Occupational exposure to hazardous chemicals in laboratories*)

Overview of 29CFR1910.1450

- **"a *performance-based* standard"**
- **Based on** "Prudent Practices"
- **Twelve sections – (a-l)**

See Reference Page 43

OSHA Laboratory Standard
(a) Scope and Application

- **Applies only to *laboratories* – "workplace where relatively small quantities of chemicals are used on a non-production basis"**
- **Supercedes, for laboratories, the requirements of 29CFR 1910 Subpart Z, but requires protection to *PEL limits* and prohibition of eye and skin contact as specified by other OSHA standards**

b. Definitions

- *Revised* **– March 26, 2012**; Incorporated HAZCOM changes
- **Chemical Hygiene Officer**
- **Chemical Hygiene Plan**
  - **Must include specific elements**
  - **Must be designed to protect employees from health hazards associated with hazardous chemicals in the specific laboratory**

c. Permissible Exposure Limits

- **The employer shall assure that laboratory employees' exposures to OSHA regulated substances do not exceed the permissible exposure limits set in 29CFR1910, Subpart Z**

d. Employee Exposure Determination

- Employer shall measure the employee's initial exposure to any substance regulated by a (OSHA) standard which requires monitoring <u>if there is reason to believe</u> that exposure levels for that substance routinely exceed action level (or in the absence of an action level, the PEL).

RJG Associates 2015
See Reference Page 45,69
12

"Reason to Believe"

- Employee shows signs/symptoms of exposure
- Known release of substance
- Some specific standards <u>require</u> initial monitoring
  - Formaldehyde, Vinyl chloride, Inorganic Arsenic, Lead, Cadmium, Benzene, 1,2-dibromo-3-chloropropane, Acrylonitrile, Ethylene oxide, Methylene chloride, Asbestos

RJG Associates 2015
12

Subpart Z Compounds with an OSHA Standard requiring monitoring

- Vinyl chloride
- Inorganic arsenic
- Lead
- Chromium (hexavalent)
- Cadmium
- Benzene
- 1,2 – Dibromo-3-chloropropane
- Acrylonitrile
- Ethylene oxide
- Formaldehyde
- Methylene Chloride
- Asbestos

RJG Associates 2015
See Reference Page 69
12

e. Chemical Hygiene Plan

- Written plan
- Easily accessible
- Designed to protect employees from health hazards associated with hazardous chemicals in their specific laboratory

RJG Associates 2015

See Reference Page 46

e. Chemical Hygiene Plan (the eight elements)

- Include procedures to:
  - Describe *Standard Operating Procedures*
  - Define criteria for implementation of control measures
  - Maintain proper functioning of chemical fume hoods / protective equipment
  - Provide employee information & training

RJG Associates 2015

See Reference Pag3 46-47

e. Chemical Hygiene Plan details

- Include procedures to:
  - Provide criteria for *Prior Approval*
  - Provide criteria for *Medical Consultation* and examination
  - Designate persons responsible for implementation
  - Provide employee protection from Particularly Hazardous Substances

RJG Associates 2015

Particularly Hazardous Substances

- These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity

Select Carcinogens

Any substance which meets one of the following criteria:

(1) It is regulated by Cal/OSHA as a carcinogen; or

(2) It is listed under the category, "known to be carcinogens," in the *Annual Report on Carcinogens* published by the National Toxicology Program (NTP) (1985 edition); or

(3) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer *Monographs* (IARC) (Volumes 1-48 and Supplements 1-8); or

(4) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

a. After inhalation exposure of 6-7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m3;

b. After repeated skin application of less than 300 mg/kg of body weight per week; or

c. After oral dosages of less than 50 mg/kg of body weight per day.

Carcinogenicity

CARCINOGENICITY

Signal Word		Danger		Warning
Pictogram				
Hazard Statement		May cause		Suspected of causing
Preface		*Known Human Carcinogen*	*Presumed Human Carcinogen*	*Suspected human carcinogen*
Category		Category 1A	Category 1B	Category 2
Definition		Based on human evidence	Based on demonstrated animal carcinogenicity	Limited evidence of human or animal carcinogenicity
Approximate Equivalency[1]	IARC	Group 1	Group 2A	Group 2B
	NTP *RoC*	Known	Reasonably Anticipated	Note 1
GHS H Code		H350		H351

Reproductive Toxins

- Chemicals which affect the reproductive capabilities including chromosomal damage (mutations), and effects on fetuses (teratogenesis), adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard .) shall be considered reproductive toxins for purposes of this section.

ACUTE TOXICITY

	Signal Word	Danger			Warning		
	Pictogram						*Note: Only used in International GHS. Not adopted by OSHA.*
	Hazard Statement	Fatal		Toxic	Harmful		May be Harmful
	Preface	*Extremely*	*Highly*				
Route	**Acute Toxicity**	**Category 1**	**Category 2**	**Category 3**	**Category 4**		**Category 5**
Oral	**Oral** (mg/kg)	≤ 5	> 5 ≤ 50	> 50 ≤ 300	> 300 ≤ 2000		Criteria: • Anticipated oral LD_{50} between 2000 and 5000 mg/kg; • Indication of significant effect in humans;* • Any mortality at class 4;* • Significant clinical signs at class 4;* • Indications from other studies.* *If assignment to a more hazardous class is not warranted.
	H Code	H300		H301	H302	H303	
Dermal	**Dermal** (mg/kg)	≤ 50	> 50 ≤ 200	> 200 ≤ 1000	> 1000 ≤ 2000		
	H Code	H310		H311	H312	H313	
Inhalation	**Gases** (ppm)	≤ 100	> 100 ≤ 500	> 500 ≤ 2500	> 2500 ≤ 5000		
	Vapors (mg/l)	≤ 0.5	> 0.5 ≤ 2.0	> 2.0 ≤ 10	> 10 ≤ 20		
	Dusts & Mists (ng/l)	≤ 0.05	> 0.05 ≤ 0.5	> 0.5 ≤ 1.0	> 1.0 ≤ 5		
	H Code	H330		H331	H332	H333	

REPRODUCTIVE TOXICITY

Signal Word	Danger		Warning	
Pictogram				
Hazard Statement	May damage		Suspected of damaging	May cause harm to breast-fed children
Preface	*Known*	*Presumed*	*Suspected*	
Category	**Category 1A**	**Category 1B**	**Category 2**	**Additional Category**
Definition	Based on human evidence	Based on experimental animals	Human or animal evidence possibly with other information	Effects on or via lavation
GHS H Code	H360		H361	H362

f. Employee Information and Training

- At time of initial employment, when nature of hazards change, and as often as employer decides nec.
- Notify workers of hazards of chemicals in the workplace

RJG Associates 2015

See Reference Page 47-48

16

f. Employee Information, *more*

- Provisions of the Laboratory Standard, including Appendices
- Location and availability of the CHP
- PELs, TLVs and others
- Signs and symptoms of exposure
- Location and availability of reference material

RJG Associates 2015

See Reference Page 47-48

16

f. Employee Training, *more*

- Details of the CHP
- Procedures for the detection of presence or release of hazardous materials
- Physical and health hazards of chemicals in the workplace
- Protective measures including PPE, work practices, and emergency procedures

RJG Associates 2015

See Reference Page 47-48

16

g. Medical Consultation and Medical Examinations

- Provide opportunity for exam and/or consult when appropriate
- Provide needed information to physicians
- Obtain and keep physician's written opinion

RJG Associates 2015
See Reference Page 48
17

h. Hazard Identification

- Maintain labels without defacing
- Maintain and make available MSDSs received
- Chemicals developed in the laboratory
- Internal use – treat as "Particularly Hazardous Substances"
- External use – comply with federal Hazard Communication Standard

RJG Associates 2015
See Reference Page 49
17

i. Use of Respirators

- When needed, provide at no cost to employees
- Comply with *29CFR1910.134*

RJG Associates 2015
See Reference Page 50
17

j. Recordkeeping

- **Records of employee exposure monitoring, medical consultation, and examinations**
- ***29CFR 1910.1020*** **provides rules for maintenance, transfer and availability**

RJG Associates 2015
See Reference Page 50

18

k. Dates

- *Published* **– Jan 31, 1990**
- *Effective* **– May 1, 1990**
- **Develop and** *implement* **CHP by Jan 31, 1991**
- **Supercedes 1910 Subpart Z requirements when CHP is developed and implemented**
- *Revised* Mar 12, 2012: *reserved section k*

RJG Associates 2015
See Reference Page 50

18

l. Appendices

- Appendix A **– Non-mandatory Recommendations**
- *Revised* **– January 22, 2013**; New Appendix A;
- Effective 1/22/2014
- Appendix B **- References**

RJG Associates 2015
See Reference Page 50-66

18

January 2014 Amendments to the Laboratory Standard

- Significant changes to Appendix A in the following areas:
  - Personnel responsibilities
  - More emphasis on “program”
  - Risk assessment
  - Safety culture
  - Physical layout and equipment of laboratory
  - Topics in the CHP

CHO and Personnel Responsibilities

Revised recommended CHO responsibilities

- **(a) Establishes, maintains, and revises the chemical hygiene plan (CHP).**
- **(b) Creates and revises safety rules and regulations.**
- **(c) Monitors procurement, use, storage, and disposal of chemicals.**
- **(d) Conducts regular inspections of the laboratories, preparations rooms, and chemical storage rooms, and submits detailed laboratory inspection reports to administration.**
- **(e) Maintains inspection, personnel training, and inventory records.**
- **(f) Assists laboratory supervisors in developing and maintaining adequate facilities.**
- **(g) Seeks ways to improve the chemical hygiene program.**

See Reference Page 54

Establish & maintain the CHP

- Develop a CHP if one does not exist (new facility)
- Perform annual review
- Revise as necessary

RJG Associates 2015

20

Create and revise safety rules and regulations

- Review existing rules/policies/regulations
- Research and revise to include Best Practices

RJG Associates 2015

20

Monitor procurement, use and disposal…

- Inventory control – who has it?
- What are the routine processes, and what chemicals do they require?
- Are chemicals used efficiently?
- How are by-products handled (before they become wastes)?
- Is the waste management plan all it can be?

RJG Associates 2015

20

Conduct Regular Inspections

- Laboratories, store rooms and prep rooms
- Submit detailed inspection reports to administration

See Reference Page 33

Maintain Records

- Inspection
- Personnel training
- Inventory

Seek ways to improve the Chemical Hygiene Program

- Make it second nature…
- Looking at the "big picture" – full facility perspective
- Get the bench worker involved
- Follow up whenever there is a safety problem – and make appropriate changes

Know the legal requirements

Not described in Appendix A, but…..

- The Lab Standard, of course…
- Permissible exposure limits
- Training (and documentation)
- Hazardous waste disposal
- Sewer discharges
- "General duty clause"

RJG Associates 2015

22

Lab Hazards and Control Measures

RJG Associates 2015

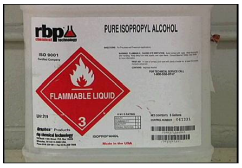
Life's Nine Hazards

- **Chemical**
- **Physical**
- **Biological**
- **Mechanical**
- **Radiation**
- **Hi/Low Pressure**
- **Noise**
- **Electrical**
- **Stress**

RJG Associates 2015

22

Chemical Hazards



- Flammability
- Corrosivity
- Reactivity
- Toxicity

RJG Associates 2015

23

Chemical Hazards - Toxicology

- Definitions / acronyms
- Dose-response relationship
- Routes of exposure
- Types of toxicity
- Chemical interactions

See Reference Page 68

RJG Associates 2015

23

Toxicology Terms

- *Toxicology* – **the study of the harmful interactions of chemicals on living organisms and biological systems**
- *PEL* – **permissible exposure limit, the allowable concentration for an 8 hour exposure**
- LD50 – **dose lethal to 50% of a given population**

RJG Associates 2015

See Reference Page 72

23

Toxicology terms (con't)…

- *Carcinogen* – substance capable of causing cancer
- *Mutagen* – substance that causes mutations (genetic damage)
- *Neurotoxin* – systemic poison whose target organ is the nervous system
- *Teratogen* – compound that causes birth defects in a developing fetus

RJG Associates 2015

24

More Toxicology terms…

- *Hepatoxin* – systemic poison whose target organ is the liver
- *Nephrotoxin* – systemic poison whose target organ is the kidney
- *Embryotoxin* – capable of harming the developing embryo
- *Mutation* – DNA damage resulting in genetic alterations (gene mutations or chromosome aberrations)

RJG Associates 2015

24

LABELING REQUIREMENTS

Every container (original and secondary) must be labeled with:

- Complete chemical name or trade name – no abbreviations
- Appropriate hazard warnings
- Name of manufacturer or responsible party

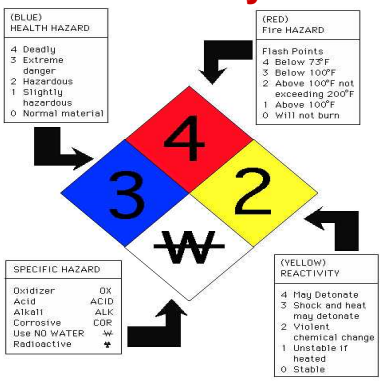
RJG Associates 2015

24

Labeling Systems

- NFPA - National Fire Protection Association
- HMIS - Hazardous Materials Identification System (NPCA - National Paint and Coatings Association)
- WHMIS - Workplace Hazardous Materials Identification (Canada)
- GHS - http://www.osha.gov/dsg/hazcom/ghs.html

NFPA System



About HMIS

- HMIS® stands for Hazardous Materials Identification System.
- It is a complete labeling program that helps employers comply with OSHA's 29 CFR 1910.1200 Hazard Communication Standard (HazCom).

About HMIS

- The program uses a numerical hazard rating system, labels with colored bars, and training materials to inform workers of chemical hazards in the workplace.
- It is NOT intended for emergency situations.

HMIS Health Hazards

- In the newest HMIS version, the blue health bar has two spaces- one for an asterisk and one for a numeric rating
- If present, the asterisk signifies a chronic health risk, meaning that long-term exposure is a health concern
- 4 Life-threatening, major or permanent damage may result from single or repeated overexposures.
- 3 Major injury likely unless prompt action is taken and medical treatment is given.
- 2 Temporary or minor injury may occur.
- 1 Irritation or minor reversible injury possible.
- 0 No significant risk to health.

HMIS Flammability

- Criteria in this section alone are identical to NFPA
- 4 Flammable liquids and gases with flash point below 73 °F and boiling point below 100 °F. Also includes materials that may ignite spontaneously in air (Class IA).
- 3 Materials capable of ignition under almost all normal temperature conditions. Includes flammable liquids with flash points below 73 degrees F and boiling points above 100 °F, as well as liquids with flash points between 73 °F and 100 °F. (Classes IB & IC).
- 2 Materials which must be moderately heated or exposed to high ambient temperatures before ignition will occur. Includes liquids having a flash point at or above 100 °F but below 200 °F. (Classes II & IIIA).
- 1 Materials that must be preheated before ignition will occur. Includes liquids, solids and semi-solids having a flashpoint above 200 °F(Class IIIB).
- 0 Materials that will not burn.

HMIS Physical Hazards

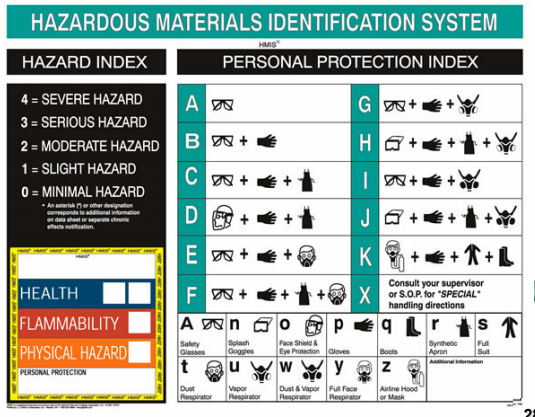
- Formerly this section was for reactive hazards; to has been changed to cover physical hazards
- Covers seven hazard classes:
  - Water reactives
  - Organic peroxides
  - Explosives
  - Compressed gases
  - Pyrophoric materials
  - Oxidizers
  - Unstable reactives
  - Cryogenic Liquids

HMIS Physical Hazards

- 4 Materials that are readily capable of explosive reaction with water, detonation or explosive decomposition, polymerization or self-reaction at STP.
- 3 Materials that may form explosive mixtures with water and are capable of detonation or explosive reaction in the presence of a strong initiating source. Materials that may rapidly change at STP with moderate risk of explosion.
- 2 Materials that are unstable and may undergo violent chemical changes at STP with low risk for explosion. Materials may react violently with water or form peroxides upon exposure to air.
- 1 Materials that are normally stable but can become unstable (self-react) at high temperatures and pressures. Materials may react non-violently with water or undergo hazardous polymerization in the absence of inhibitors.
- 0 Materials that are normally stable.

HMIS Personal Protection

- This section is the largest difference between HMIS and NFPA. NFPA uses for conveying special hazards; HMIS uses to indicate appropriate PPE
- Uses letter codes (see chart)



RJG Associates 2015

28

GHS

- Globally Harmonized System of Classification and Labelling of Chemicals
- OSHA revised the Hazard Communication Standard in 2012 vto reflect the implementation of GHS
  - Uses SDSs – very similar to MSDSs
  - 16 sections

RJG Associates 2015

28

OSHA Implementation of GHS

Effective Completion Date	Requirement(s)
December 1, 2013	All employees must be trained on the new label elements and SDS format
June 1, 2015	Compliance with all modified provisions of the final rule
December 1, 2015	The distributor shall not ship containers labeled by the chemical manufacturer or importer unless it is a GHS label
June 1, 2016	Facilities should update workplace labeling and hazard communication program as necessary, and provide additional employee training for newly identified hazards

RJG Associates 2015

28

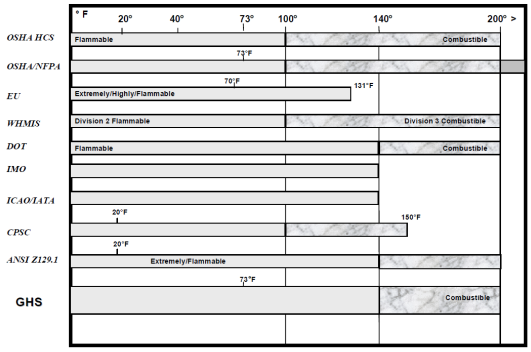
Safety Data Sheets

1. Identification of the substance or mixture and of the supplier
2. Hazards Identification
3. Composition/Information on ingredients
4. First aid measures
5. Fire protection measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/PPE
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. *Ecological information*
13. *Disposal considerations*
14. *Transport information*
15. *Regulatory information*
16. Other information including preparation & revision of SDS

Why align HCS (& Lab Standard) to GHS?

- Harmonized definitions applied globally
- Specific, consistent criteria for labels
- Identical formatting for SDS sheets

FLAMMABILITY



The numerical values on the hazard index scale in the table are not to scale.

Benefits of Adopting GHS

- **Reduce confusion / enhance comprehension of hazards**
- **Improve downstream risk management**
- **Facilitate training**
- **Help address literacy issues**
- **Benefit international trade of chemicals**

Hazard Classification

- Each physical or health hazard is a “hazard class”, i.e., carcinogenicity is a hazard class
- Classes may be subdivided based on the severity of the hazard
- Placement of a chemical into a hazard class or category is based on both hazard and severity

More on Classification

- **Manufacturers are still responsible for determining the hazard of the chemicals they produce or import**
- **Classification is based on all available information. Procedures for hazard classification are in Appendix A (health) and B (physical)**

Hazard Classification Comparison

HazCom1994

- Performance oriented
- Definitions in paragraph C and appendices A&B
- Appendix B – parameters for evaluating data
- "Floor" of chemicals considered hazardous
- "One Study" rule
- Standardized mixture cut-off rules

HazCom 2012

- Specific and detailed
- Concept of "classification vs. determination
- Each hazard class has detailed criteria to apply to data
- No floor; based on weight of evidence
- Mixture rules specific to hazard class

RJG Associates 2015

31

H2xx / H3xx

H2xx Physical Hazards				H3xx Health Hazards	
Unstable Explosive (Category wording)	1	1	1	1	1
A	A				Via Lactation (Adtl warning)

RJG Associates 2015

31

Health Hazards

Hazard Class	Hazard Category			
Acute Toxicity	1	2	3	4
Skin Corrosion/ Irritation	1A	1B	1C	2
Serious Eye Damage/ Eye Irritation	1	2A	2B	
Respiratory or Skin Sensitization	1			
Germ Cell Mutagenicity	1A	1B	2	
Carcinogenicity	1A	1B	2	
Reproductive Toxicity	1A	1B	2	Lactation
STOT – Single Exposure	1	2	3	
STOT – Repeated Exposure	1	2		
Aspiration	1			
Simple Asphyxiants	Single Category			

RJG Associates 2015

31

Flame	Flame over Circle	Exclamation Mark	Exploding Bomb
Flammables Pyrophorics Self Reactives Organic Peroxides Emits Flammable Gas Self-heating	Oxidizers	Acute Toxicity (harmful) Dermal Sensitizer Irritant	Explosives Self Reactives Organic Peroxides

Corrosive	Gas Cylinder	Health Hazard	Skull and Crossbones
Corrosive	Gases Under Pressure	Carcinogen Mutagenicity Reproductive Toxicity Specific Target Organ Toxicity Aspiration Toxicity Respiratory Sensitizer	Acute Toxicity (severe)

Example GHS Outer Container Label
(55 gallon/200 liter drum)

MyCompany, MyStreet, MyTown NJ 00000,
Tel: 444 999 9999

ToxiFlam

Danger! Toxic If Swallowed
Flammable Liquid and Vapor

Flammable liquids, toxic, n.o.s.

(contains XYZ)
UN 1992

Do not eat, drink or use tobacco when using this product. Wash hands thoroughly after handling. Keep container tightly closed. Keep away from heat/sparks/open flame. - No smoking. Wear protective gloves and eye/face protection. Ground container and receiving equipment. Use explosion-proof electrical equipment. Take precautionary measures against static discharge. Use only non-sparking tools. Store in cool/well-ventilated place

IF SWALLOWED: Immediately call a POISON CONTROL CENTER or doctor/physician. Rinse mouth.

In case of fire, use water fog, dry chemical, CO_2, or "alcohol" foam.

See Material Safety Data Sheet for further details regarding safe use of this product.

Protect from chemical hazards by…

- **Provide engineering controls**
- **Provide administrative controls by changing processes or procedures**
- **Provide personal protective equipment, as appropriate, including eye protection, gloves, respiratory protection**
- **Properly label all chemicals!**

Physical Hazards

- Lifting
- Ergonomics
- Lighting
- Slips, trips and falls
- Sharps

Physical Hazards

Hazard Class	Hazard Category						
Explosives	Unstable Explosives	Div 1.1	Div 1.2	Div 1.3	Div 1.4	Div 1.5	Div 1.6
Flammable Gases	1	2					
Flammable Aerosols	1	2					
Oxidizing Gases	1						
Gases under Pressure Compressed Gases Liquefied Gases Refrigerated Liquefied Gases Dissolved Gases	1						
Flammable Liquids	1	2	3	4			
Flammable Solids	1	2					
Self-Reactive Chemicals	Type A	Type B	Type C	Type D	Type E	Type F	Type G
Pyrophoric Liquids	1						
Pyrophoric Solid	1						
Pyrophoric Gases	Single category						
Self-heating Chemicals	1	2					
Chemicals, which in contact with water, emit flammable gases	1	2	3				
Oxidizing Liquids	1	2	3				
Oxidizing Solids	1	2	3				
Organic Peroxides	Type A	Type B	Type C	Type D	Type E	Type F	Type G
Corrosive to Metals	1						
Combustible Dusts	Single category						

Control physical hazards through…

- Engineering controls
- Administrative controls
- Improved housekeeping
- Employee training
- Use of appropriate protective equipment

Mechanical Hazards

- Pinch points
- Pulleys/ belts
- Gears
- Clutches / brakes
- Slide counterbalances

Eliminate mechanical hazards by…

- Machine guarding
- Use of appropriate protective equipment

Radiation Hazards

- Ionizing radiation
  - enough energy to remove tightly bound electrons from atoms, thus creating ions (UV, X-ray, gamma rays)
- Non-Ionizing radiation
  - has enough energy to move atoms in a molecule around or cause them to vibrate, but not enough to remove electrons (sound waves, visible light, microwaves)

Radiation Hazards

- Alpha emitters
  - radium, radon, thorium, and uranium
- Beta emitters
  - hydrogen-3 (tritium), carbon-14,phosphorus-32, phosphorus-33, and sulfur-35
- Gamma emitters
  - cobalt-60, zinc-65, cesium-137, and radium-226

Eliminate radiation hazards by…

- Shielding
- Time
- Distances
- Monitoring

Biological Hazards

- Bloodborne Pathogens
- Infectious Agents
- Plants
- Animals

Biohazardous Agent Definition

Infectious agents or other hazardous biologic materials that present a risk or potential risk to the health of humans, animals, or the environment:

- Bacteria
- Fungi
- Viruses
- Rickettsia
- Toxins

The NIH classifies agents into 4 risk groups on the basis of hazard. They correlate with but do not equate to the 4 biosafety levels.

Types of Biological Hazards

- Infection
- Animal bites
- "Any sharps"
- Aerosol generation
- Virulence/pathogenicity/infectious dose
- Environmental stability
- Route of spread, communicability
- Quantity/concentration/volume used
- Vaccine/Treatment availability
- Allergenicity
- Zoonotic exposures (ex., Lyme Disease, Rabies)

Eliminate biological hazards through…

- Proper design of facilities
- Engineering controls (Biological Safety Cabinets)
- Administrative controls (SOPS for decontamination and disposal, universal precautions)
- Providing appropriate protective equipment (gloves, eye protection, masks, lab coats)

Noise Hazards

- Noise levels at or above 85 db on an 8 hour time weighted average
- Higher levels for shorter periods

Examples of Noise Levels

- 150 dB = rock music peak
- 140 dB = firearms, air raid siren, jet engine
- 130 dB = jackhammer
- 120 dB = jet plane take-off, amplified rock music at 4-6 ft.
- 110 dB = rock music, model airplane
- 106 dB = timpani and bass drum rolls
- 100 dB = snowmobile, chain saw, pneumatic drill
- 90 dB = lawnmower, shop tools, truck traffic, subway
- 80 dB = alarm clock, busy street
- 70 dB = busy traffic, vacuum cleaner
- 60 dB = conversation, dishwasher
- 50 dB = moderate rainfall
- 40 dB = quiet room
- 30 dB = whisper, quiet library

Eliminate noise hazards by…

- Engineering controls
- Instituting a hearing conservation program
- Personal Protective Equipment

High and low pressure hazards

- Working at or below atmospheric pressure
- Compressed liquids and gases in cylinders and piping

Cylinder Markings

- A shoulder label indicates the product's shipping name and ID#
  - *Cylinder Specification:*
  - DOT—Department of Transportation specification
  - Specification of the cylinder type of material of construction (e.g., 3AA).
  - Service/working pressure in pounds per square inch (e.g., 2,265 psig).
  - *Date of Manufacture: Th*is date also indicates the original hydrostatic test.
  - *Retest Markings:*
  The + symbol (Plus Rating) indicates that the cylinder qualifies for 10% overfill.• The H symbol (Star Stamp) indicates that the cylinder meets the requirements for 10-year retest, instead of a 5-year retest.

Eliminate pressure hazards by…

- Shielding devices
- Personal Protective Equipment
- Hydrostatic testing

Stress Hazards

- Psychological
- Physical

Reduce stress hazards by…

- Providing a safe workplace
- Providing necessary protective equipment
- Reviewing procedures as necessary

Electrical Hazards

- Improper wiring
- Extension cords
- Non-polarized plugs
- Fatigued Receptacles

Control electrical hazards by…

- Testing devices
- Ground fault interrupters
- Routine inspections

RJG Associates 2015

40

Chemical Hygiene Plan Development and Improvement

RJG Associates 2015

Chemical Hygiene Plan Development & Improvement

- Start from scratch, or…
- Use a model as a starting point
- Modify existing safety plan structure as necessary
- Inventory chemicals
- Audit of laboratory operation
- Consensus of affected personnel

RJG Associates 2015

40

Chemical Hygiene Plan – Standard Operating Procedures

- Review procedures utilized on a routine basis
- Review non-routine procedures
- Apply general safety rules from existing or new sources

Chemical Hygiene Plan – Criteria for control measures

- Apply administrative /engineering controls (chemical hoods, protective shields, etc.)
- Apply personal protective equipment requirements when controls (administrative/engineering) do not adequately control specific hazards

Chemical Hygiene Plan – verify equipment is operating properly

- Routine inspection of chemical hoods
- Regular testing of flow rates and air direction
- Preventive and routine maintenance programs

Chemical Hygiene Plan – Employee information and Training

- Initial (and annual?) training program based on the site-specific CHP whenever chemicals or operations change significantly
- Available resources – MSDSs, chemical reference materials, labels, other employees' knowledge

Chemical Hygiene Plan – Circumstances Requiring Prior Approval

- Particularly hazardous substances
  - Carcinogens, mutagens, teratogens, radioactives
  - Extremely reactive materials
  - Extremely toxic materials based on LD50 or PEL

Chemical Hygiene Plan – Prior Approval

- Introduction of new equipment
- Working alone
- Locked out / tagged out equipment

Chemical Hygiene Plan – Responsible Personnel

- **Designates those responsible for the CHP**
- **Includes assignment of the Chemical Hygiene Officer ("CHO")**
- **Establishment of Chemical Hygiene Committee, if appropriate**

Chief Executive Officer / President of University / Board of Regents

- Promote a strong safety and health culture
- Assure balance of safety and health is incorporated into laboratory practices
- Encourage involvement and buy-in of all members of the workforce
- Establish mutual, meaningful, and measurable safety and health improvement goals; and policies and procedures that serve as reference tools, rather than obscure rules

Department Chair or Director Responsibilities

a) Assumes responsibility for personnel engaged in the laboratory use of hazardous chemicals.
b) Provides the chemical hygiene officer (CHO) with the support necessary to implement and maintain the CHP.
c) After receipt of laboratory inspection report from the CHO, meets with laboratory supervisors to discuss… violations, timely actions…ensures Department compliance with applicable codes and regulations
d) Provides budgetary arrangements to ensure safety of everyone entering the laboratory (including students)

Laboratory Supervisor or Principal Investigator

- Overall responsibility for chemical hygiene in the laboratory
- (the original lab standard did not assign any responsibilities to Supervisors or PIs)

Lab Supervisor / PIs

- (a) Ensure that laboratory personnel comply with the departmental CHP and do not operate equipment or handle hazardous chemicals without proper training and authorization.
- (b) Always wear personal protective equipment (PPE) that is compatible to the degree of hazard of the chemical.
- (c) Follow all pertinent safety rules when working in the laboratory to set an example.
- (d) Review laboratory procedures for potential safety problems before assigning to other laboratory personnel.

Assist Laboratory Supervisors

- Be safely productive
- Develop and maintain adequate facilities
- Separate the routine from the non-routine

Lab Workers

- Obey rules and follow policies
- Read labels and SDSs
- Report all accidents, injuries, close calls and near misses
- Look out for each other
- Exercise good judgment

Department Safety Committee

- Reviews accident reports and makes appropriate recommendations to the department chairperson regarding proposed changes in the laboratory procedures.

Chemical Hygiene Plan - Provisions for use of Particularly Hazardous Substances

- **Determine which chemicals require additional safety measures**
- **Engineering Controls; or, Appropriate PPE**
- **Include notification process**
- **"Designated Area" delineated**

Chemical Hygiene Plan Implementation

Implementation of the Chemical Hygiene Plan

- Getting management commitment
  - Responsibilities of the CEO
  - Resources, authority and time
  - Liability issues

Implementation of the Chemical Hygiene Plan

- Getting employee commitment
  - Appeal of a safe workplace
  - Address any concerns over possible exposures
  - Encourage employee input
  - Provide incentives as appropriate

Implementation, cont'd…

- Review and evaluate the Chemical Hygiene Plan
  - At least annually
  - Update as necessary, especially after an incident

CHO Responsibilities Beyond the Laboratory Standard

Chemical Hygiene Officer - Responsibilities beyond the CHP

- Non-chemical lab safety issues
- Chemical safety issues outside the lab
- Non-chemical safety issues outside the lab

Non-chemical laboratory safety issues

- Life's 9 hazards…
- Can (or should) these responsibilities be separated from the CHO's responsibilities?

Chemical safety issues outside the lab

- Waste accumulation areas / storage areas
- Fire protection / bulk storage of chemicals
- Shipping/ receiving of chemicals
- Transfer of chemicals thru the facility
- Dealing with contractors / contractor oversight
- Graphic arts
- Maintenance areas
- Laboratory emissions

Non-chemical safety issues outside the lab

- Maintenance areas
- Material handling
- Dealing with contractors
- Housekeeping
- Office ergonomics
- Fire safety
- Structural safety

Resources for Chemical Hygiene Officers

RJG Associates 2015

Resources and References

- Fellow attendees?
- Instructors
  - Russ Phifer – rphifer@wcenvironmental.com
  - Jim Kaufman – jim@labsafetyinstitute.org
  - Christina Dillard – cdillard@labsafetyinstitute.org
- https://www.osha.gov/SLTC/laboratories/
- Books and other resources

  Prudent Practices, Handbook of Laboratory Safety, NIOSH, SACL, and other reference materials

RJG Associates 2015

See Reference Page 74-85

49

Thank you!

- The sample test for the NRCC certification exam is optional….

RJG Associates 2015

See Reference Page 95

49

HOW TO BE A MORE EFFECTIVE CHEMICAL HYGIENE OFFICER

Table of Contents

DISCLAIMER / PREFACE

The course presenters are not associated with the National Registry of Certified Chemists (NRCC), the organization responsible for maintaining the Chemical Hygiene Officer certification program. While the course areas are designed to cover material presented in the certification exam, no warranty is presented regarding an individual's ability to obtain certification as a result of course attendance. Specific questions regarding the certification program and testing process should be referred to the NRCC.

The presenters have developed this course independent of any agency, employer, or formal organization. Government documents included are public record and may be reproduced without permission. All other documentation provided in the course material are the property of the course presenters and may not be duplicated without the expressed written permission of the presenters.

Workshop Presenters

RUSSELL W. PHIFER
WC Environmental, LLC
PO Box 1718
West Chester, PA 19380
(610) 696-9220
rphifer@wcenvironmental.com

Mr. Phifer has been active in the hazardous materials management field for over 25 years. As a former Chair of the ACS Task Force on Laboratory Environment, Health & Safety, he has been actively involved in developing EH&S policies on behalf of the Society's 162,000 members worldwide. He has served the Division of Chemical Health & Safety in various capacities, including Councilor, Alternate councilor, Secretary, Workshops Committee Chair and as Chair in 2005. He was elected a CHAS Fellow in 2002.

He has presented over 75 technical papers, workshops and symposium at regional and national meetings since 1982. Other ACS activities have included service on the Committee on Chemical Safety and the Committee on Environmental Improvement. He has been an active member of the Chester County Occupational Education Advisory Board since 1989 and served as Chair of the Environmental Education Advisory Council for the Chester County Intermediate Unit. He wrote the approved PA state curriculum for Environmental Technology. He has also served as Vice-Chair of the Chester County Local Emergency Planning Committee since 1987.

Mr. Phifer is Principal/ Project Manager for WC Environmental, LLC in West Chester, Pennsylvania. He has served as Project Manager and Health & Safety officer on two Superfund cleanup sites. He routinely develops and presents training programs to meet OSHA, RCRA and DOT requirements, and has received professional certification from the National Environmental Training Association, Academy of Hazardous Materials Managers, the Environmental Assessment Association and the World Safety Organization. He is also an authorized OSHA Outreach Trainer.

James Kaufman, Ph.D.
Laboratory Safety Institute
192 Worcester Street
Natick, MA 01760
(508) 647-1900
jim@labsafetyorg

Dr. James Kaufman is President of The Laboratory Safety Institute, President of Kaufman & Associates and former Professor of Chemistry at Curry College. He received his bachelors degree in chemistry from Tufts University and his doctorate in organic chemistry from WPI.

After two years as a post-doctoral fellow in the WPI Chemical Engineering Department converting garbage into fuel oil, Dr. Kaufman joined the Dow Chemical Company's New England Research Laboratory as a Process Research Chemist. During his four years with Dow, he became increasingly involved in laboratory safety related activities. He authored "Laboratory Safety Guidelines". Originally distributed by Dow, now over two million copies of the widely requested and reprinted brochure are in circulation.

Dr. Kaufman is the founder and president/ceo of The Laboratory Safety Institute (LSI) - a national, non-profit center for safety in science and science education (www.labsafety.org). LSI's lectures and training programs, AV-lending library, Mini-Grants, Internet discussion list, other services and publications help academic institutions throughout the world. LSI is supported by grants from individuals, foundations, companies and professional societies.

The Laboratory Safety Institute conducts seminars, short courses, audits and inspections for schools, colleges, government agencies, and companies. They also provide advice on regulatory compliance, safety program development, facilities design and editorial commentary on laboratory texts. Learn more at www.labsafety.org/forms/2007.Brochure.pdf

Dr. Kaufman is a former, ten-year member of the American Chemical Society's (ACS) Council Committee on Chemical Safety and is past-chairman of the 2,500-member ACS Division of Chemical Health and Safety. He is the author-narrator of the ACS Audio Course on Laboratory Safety and editor of "Waste Disposal at Academic Institutions" from Lewis Publishers. He recorded and edited the "One-Day Laboratory Safety Audio Seminar" and "Two-Day Lab Safety Video Course." Most recently, he co-authored “Safety Is Elementary: the new standard for safety in the elementary science classroom”

Special Thanks to:

GEORGE H. WAHL, JR. Ph.D.
(919) 787-8916
ghw917@gmail.com

Dr. Wahl, a native of New York City, is a graduate of Fordham College and New York University. After a year as a National Institutes of Health Post Doctoral Fellow at Cornell University, he joined the faculty of North Carolina State University at Raleigh, where he currently is Professor of Chemistry. During 1997-1999 he also served as the first popularly elected Chair of the University Faculty. In 2002 he was awarded the Holladay Medal for Excellence, the university's highest faculty award.

At NC State, Dr. Wahl has served on a number of committees including Chair of the University Safety Council, and Chair of the University Teaching Effectiveness and Evaluation Committee. He spent ten years as Chair of the University Hazardous Materials Committee during which time he led the development of the University Safety Plan program which resulted in over five hundred lab customized Chemical Hygiene Plans for the numerous facilities throughout this Research I, Land Grant University, the largest in the state.

Dr. Wahl's varied professional positions include Research Chemist at Columbia-Southern Chemical Co., Barberton, OH; on-site consultant at Aberdeen Proving Grounds; and at the US Environmental Protection Agency; and a year as Guest Professor at the Swiss Federal Institute of Technology (ETH) in Zurich.

Dr. Wahl is a frequent safety and health consultant to academia, government and industry. He offers customized health, safety and regulatory training programs for a variety of audiences. He is Editor of "Minimizing Hazardous Waste from High School Chemistry Laboratories"; a co-author of the American Chemical Society's "Developing a Chemical Hygiene Plan"; technical advisor to the ACS Safety Video production group; author of the award winning ACS video on Chemical Storage; a founding member of the Board of Editors of "Chemical Health and Safety"; a former member of the ACS Council Committee on Chemical Safety; past Chair and Program Chair, and current Councilor of the ACS Division of Chemical Health and Safety; winner of the 1997 Tillmans-Skolnick Award of the Division of Chemical Health and Safety; and a member of the first class of CHAS Fellows. He is also a member of the ACS College Chemistry Consultants Service, and with DivCHAS, is currently developing a series of on-line lessons to assist college and university students learn safety.

Questions Asked by Chemical Hygiene Officers

Where can I find the responsibilities of a CHO in a clear, concise outline format?

Why are fire extinguishers required when we teach everyone to get out the lab and leave the fire fighting to professionals? They seem like a great unnecessary expense.

As a CHO for one week, I would like information on my basic responsibilities. How do I interface effectively with OSHA personnel?

What are the legal responsibilities of a CHO?

Why should a laboratory have a CHO?

How do I implement a CHP in a high school chemistry laboratory?

What are some proven strategies to use in getting everyone involved in a Chemical Hygiene Plan?

What types of situations might require emergency power in a lab?

What are the separation distances for hazardous/ reactive chemicals in storage rooms and on laboratory shelves?

How should training be documented, new and refresher training?

What is necessary for hazard communication as a part of a CHP?

How do you design a CHP for small companies with R&D labs?

What are the general roles and responsibilities of a Safety Committee?

How is a Hazard Assessment conducted?

How should unknown chemical waste be handled?

(From a talk given by George Wahl to the NC State Office of Personnel, 3/97)

NRCC CHO – Areas of Training

OSHA Lab Standard

- Performance based –
- CHO/CHP Designated areas
- Medical consultation
- Select carcinogens
- Prior approval

Hazard Communication (Right to Know)

- Labels
- Material Safety Data Sheets
- NFPA & HMIS hazard rating systems
- Hazard Communication
- Standard Toxicity

Hazardous Materials

- Corrosives
- Flammable & combustible
- Microbiological materials
- Oxidizer
- Poison
- Reactive

Personal Protective Equipment

- Eye protection
- Gloves & clothing
- Hearing conservation
- Job hazard analysis
- Other protective equipment
- Respirators

Emergency Response

- HAZWOPER
- Classification of hazardous & reactive
- materials Fire safety
- Levels of emergency
- response Labeling
- Packaging
- Shipping papers

Other Safety Materials

- Chemical fume hoods
- Laboratory inspections, chemical inventories, recordkeeping
- Monitoring
- Basic Toxicology

Robert J. Alaimo and Kenneth P. Fivizzani, “Qualifications and Training of Chemical Hygiene Officers”, Chemical Health and Safety, 3(60), 10-13 (1996).

STATE PLAN STATES

The Occupational Safety and Health Act (29 CFR 1910) provides for individual states to adopt and enforce their own regulations as long as they are at least as stringent as the Federal standard and the coverage is extended to public employees. The list below indicates whether or not states have adopted such plans.

Alabama	no	Maine*	no	Oregon	yes
Alaska	yes	Maryland	yes	Pennsylvania	no
Arizona	yes	Massachusetts**	no	Puerto Rico	yes
Arkansas	no	Michigan	yes	Rhode Island *	no
California	yes	Minnesota	yes	South Carolina	yes
Colorado	no	Mississippi	no	South Dakota	no
Connecticut***	yes	Missouri	no	Tennessee	yes
Delaware	no	Montana	no	Texas*	no
Florida *	no	Nebraska*	no	Utah	yes
Georgia	no	Nevada	yes	Vermont	yes
Hawaii	yes	New Hampshire	no	Virginia	yes
Idaho	no	New Jersey***	yes	Virgin Islands***	yes
Illinois***	yes	New Mexico	yes	Washington	yes
Indiana	yes	New York***	yes	West Virginia*	no
Iowa	yes	North Carolina	yes	Wisconsin *	no
Kansas	no	North Dakota *	no	Wyoming	yes
Kentucky	yes	Ohio *	no		
Louisiana	no	Oklahoma *	no		

Note: * Indicates states with other regulations requiring public sector compliance
** Strongly recommended by MA Department of Safety and required for vocational schools.
*** Applies only to the public sector.

States with other Regulations

Ohio: Chapter 4167: Public Employee's Risk Reduction Program
http://codes.ohio.gov/orc/4167

Standard Interpretations
(Example from OSHA Files)

09/07/1990 - Incorporation of the Chemical Hygiene Plan (CHP) into current Hazard Communication and/or other related manuals

---

Standard Interpretations - Table of Contents

ÅStandard Number: 1910.1450

September 7, 1990

Mr. William E. Clark
Supervisor of Safety and Health
Williams Pipe Line Company
Post Office Box 3448
Tulsa, Oklahoma 74101

Dear Mr. Clark:

This is in response to your letter of July 2, regarding the Chemical Hygiene Plan (CHP) under the Occupational Safety and Health Administration's (OSHA) Laboratory Standard, 29 CFR 1910.1450. Your letter proposed to incorporate the CHP into your current Hazard Communication and/or other related manuals.

As Mr. Brown of OSHA's Oklahoma City area office indicated to you, this situation would be sufficient as long as ALL information in 29 CFR 1910.1450 is covered, easily identified and readily accessible. Please note the requirement for a Chemical Hygiene Officer or a Committee to implement the CHP.

We are sending copies of this interpretation to all of our Regional Offices. Among the states you mentioned in your letter, Iowa and Minnesota are not within Federal OSHA's jurisdiction but are state-plan states which handle their own health and safety programs. Their standards are at least as effective as Federal OSHA's but can be stricter. We suggest that you contact them for their interpretation on the subject. Their addresses and phone numbers are as follows:

Iowa Division of Labor Services	Minnesota Department of Labor and Industry
1000 E. Grand Avenue	443 Lafayette Road
Des Moines, Iowa 50319	St. Paul, Minnesota 55155
[(515) 281-6432]	[(651) 296-2342]

If you need further assistance, please do not hesitate to contact us.

Sincerely,

Patricia K. Clark
Director Designate
Directorate of Compliance Programs

July 17, 1990

MEMORANDUM FOR: PATRICIA CLARK
Director Directorate of Compliance Programs

THROUGH: LEO CAREY Director
Office of Field Programs

SUBJECT: Request for Interpretation - Williams Pipe Line Company

The attached request for interpretation is forwarded for your response because it pertains to state plan locations and federal jurisdiction in states outside Region VI (Regions V, VII and VIII). The request is dated July 2, 1990, and was directed to our Oklahoma City Area Office by Mr. William Clark of Williams Pipe Line Company.

Please respond directly to Mr. Clark and furnish a copy of your response to Mr. White of the Oklahoma City Area Office and Jerry Bailey, Assistant Regional Administrator for Technical Support.

Your assistance in this matter is appreciated.

GILBERT J. SAULTER
Regional Administrator

U.S. DEPARTMENT OF LABOR
Occupational Safety
and Health Administration

HAZWOPER Frequently Asked Questions:

Who is covered by OSHA's HAZWOPER standard?

The Hazardous Waste Operations and Emergency Response Standard (HAZWOPER) applies to five distinct groups of employers and their employees.

This includes any employees who are exposed or potentially exposed to hazardous substances -- including hazardous waste -- and who are engaged in one of the following operations as specified by 1910.120(a)(1)(i-v) and 1926.65(a)(1)(i-v):

clean-up operations -- required by a governmental body, whether federal, state, local, or other involving hazardous substances -- that are conducted at uncontrolled hazardous waste sites;

corrective actions involving clean-up operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 U.S.C. 6901 et seq.);

voluntary clean-up operations at sites recognized by federal, state, local, or other governmental body as uncontrolled hazardous waste sites;

operations involving hazardous wastes that are conducted at treatment, storage, and disposal facilities regulated by Title 40 Code of Federal Regulations Parts 264 and 265 pursuant to RCRA, or by agencies under agreement with U.S. Environmental Protection Agency to implement RCRA regulations; and

emergency response operations for releases of, or substantial threats of releases of, hazardous substances regardless of the location of the hazard.

Reference Interpretation and Compliance Letters:
Hazwoper applications. [11/19/91]
Clarification of HAZWOPER to a cleanup operation at a solid waste management unit. [07/14/92]

Fires involving spills or releases of hazardous substances. [06/17/91] Interpretation on the application of 1910.120 to clean-up of water-borne releases of hazardous substances. [10/09/89]

Is computer-based training acceptable for refresher training?

Computer-based training may meet some refresher training requirements, provided that it covers topics relevant to workers' assigned duties. It must be supplemented by the opportunity to ask questions of a qualified trainer and by an assessment of hands-on performance of work tasks.

Reference Interpretation and Compliance Letters:

The use of computer-based training to satisfy OSHA training requirements. [11/22/94]

The acceptability of a computer based, self-paced training program for use in meeting the refresher training requirements of the standard. [10/11/94]

For emergency response in an unknown or potentially IDLH atmosphere, what is the minimum number of people required?

At a minimum, four (4) people are required: two working as a team inside the unknown or potentially IDLH atmosphere, and two working outside this atmosphere for assistance or rescue.

Reference Interpretation and Compliance Letters:
The interpretation of the OSHA standards 1910.134 and 1910.156 which address the requirements for workers who are actively conducting operations in atmospheres that are IDLH. [11/01/95] (See the Attached 5/1/95 Memo from James W. Stanley.)

See Also: OSHA Instruction CPL 2-2.59A, Inspection Procedures for the Hazardous Waste Operations and Emergency Response Standard, 29 CFR 1910.120 and 1926.65, Paragraph (q): Emergency Response to Hazardous Substance Releases, Appendix A, Paragraph IV.A. and Appendix C, Paragraph II.E.-F. [04/24/98]

Can refresher training be given in segments?

Refresher training may be given in segments so long as the required 8 hours have been completed by the employee's anniversary date.

Reference Interpretation and Compliance Letters:
Refresher training and HAZWOPER. [07/21/92]

What if refresher training isn't received in 12 months?

If the date for refresher training has lapsed, the need to repeat initial training must be determined based on the employee's familiarity with safety and health procedures used on site. The employee should take the next available refresher training course. "There should be a record in the employee's file indicating why the training has been delayed and when the training will be completed."

Reference Interpretation and Compliance Letters:
Hazardous waste operations and emergency response lapsed refresher training requirements. [03/12/93]

What are the training or certification requirements for HAZWOPER trainers?

The "Hazardous Waste Operations and Emergency Response" standard (HAZWOPER), 29 CFR 1910.120, states in paragraph (e)(5) that "Trainers shall be qualified to instruct employees about the subject matter that is being presented in training". In addition, 29 CFR 1910.120(e)(5) explains that the qualifications of the

instructors may be shown by academic degrees, completed training courses and/or work experience.

At this time, OSHA does not have any specific requirements to certify an instructor. The subjects that trainers should be able to convey to employees at hazardous waste operations who need training are summarized in paragraphs (e), (p) and (q) of the HAZWOPER standard.

Reference Interpretation and Compliance Letters:
OSHA does not certify instructors in HAZWOPER. [2/12/92]

Training requirements for employees in food storage facility where ammonia is used solely as a refrigerant. [5/10/91]

See Also: OSHA Regulations 29 CFR 1910.120 Appendix E or
29 CFR 1926.65 Appendix E, Training Curriculum Guidelines - (Non-mandatory)

What are the HAZWOPER training requirements for hospital staff?

OSHA's Hazardous Waste and Emergency Response standard (HAZWOPER) requires that workers be trained to perform their anticipated job duties without endangering themselves or others. To determine the level and type of training your workers need, you must consider the hazards in your community and what capabilities your personnel need to respond to those hazards.

You should make your determination based on worst-case scenarios. If your personnel are expected to provide limited decontamination services in order to attend to medical problems, they must be trained to the first responder operations level with emphasis on the use of PPE and decontamination procedures. This level of emergency response training is described in 29 CFR 1910.120(q)(6)(ii); additional guidance about the content of this training is available in HAZWOPER's Appendix E. Hospitals may develop in-house training or they may send personnel to a standard first responder operations level course, then provide additional training in decontamination and PPE as needed. HAZWOPER requires the employer to certify that workers have the training and competencies listed in (q)(6)(ii). The standard also requires annual refresher training or demonstration of competency, as described in (q)(8).

Reference Interpretation and Compliance Letters:
Emergency response training necessary for hospital physicians/nurses that may treat contaminated patients. [3/10/99]

Emergency response training requirements for hospital staff. [4/25/97]
Medical personnel exposed to patients contaminated with hazardous waste. [3/31/92]

See Also: OSHA 3152, Hospitals and Community Emergency Response - What you need to know. [1997]

What is the difference between an incidental and an emergency spill?

An incidental release is a release of a hazardous substance which does not pose a significant safety or health hazard to employees in the immediate vicinity or to the employee cleaning it up, nor does it have the potential to become an emergency within a short time frame. Incidental releases are limited in quantity, exposure potential, or toxicity and present minor safety or health hazards to employees in the immediate work area or those assigned to clean them up. An incidental spill may be safely cleaned up by employees who are familiar with the hazards of the chemicals with which they are working.

The properties of hazardous substances, such as toxicity, volatility, flammability, explosiveness, corrosiveness, etc., as well as the particular circumstances of the release itself, such as quantity, confined space considerations, ventilation, etc., will have an impact on what employees can handle safely and what procedures should be followed. Additionally, there are other factors that may mitigate the hazards associated with a release and its remediation, such as the knowledge of the employee in the immediate work area, the response and personal protective equipment (PPE) at hand, and the pre-established standard operating procedures for responding to releases of hazardous substances. There are some engineering control measures that will mitigate the release that employees can activate to assist them in controlling and stopping the release.

These considerations (properties of the hazardous substance, the circumstances of the release, and the mitigating factors in the work area) combine to define the distinction between incidental releases and releases that require an emergency response. The distinction is facility-specific and is a function of the emergency response plan.

Reference Interpretation and Compliance Letters:
Emergency situations that fall under Hazwoper. [11/8/91]

Considerations for "incidental" spills cleaned up by maintenance personnel to satisfy the definition of "emergency response." [7/31/90]

See Also: OSHA Instruction CPL 2-2.59A, Appendix E, Inspection Procedures for the Hazardous Waste Operations and Emergency Response Standard, 29 CFR 1910.120 and 1926.65, Paragraph (q): Emergency Response to Hazardous Substance Releases [04/24/98]

What are the HAZWOPER training requirements for on-site workers who are not directly involved in cleanup activities?

Workers, such as utility workers, who must perform duties at a hazardous waste site that has not yet been characterized but where contamination is expected, do fall under the scope of 29 CFR 1910.120. These workers must work under the direction of an on-site supervisor and a site-specific safety and health plan, and must be fully trained and protected pursuant to the HAZWOPER standard. When additional information becomes available through site characterization which verifies that there is minimal or no risk of

employee exposure to hazardous substances, a lesser degree of PPE and worker training may be acceptable.

When site characterization shows that the area to be serviced by workers is free of potential exposure, or the proposed work assignments would not expose any of the work crew to hazardous substances, the activity can be carried out as a normal maintenance or construction operation.

... The utility contractor is bound to provide at least the minimum number of training hours specified. On a hazardous waste site that has many site specific peculiarities the employer may need to train employees beyond the 40 or 24 hour minimum set by the standard. Employees must be provided training that prepares them for their job functions and responsibilities, as stated in the general requirements in 29 CFR 1910.120(e).

Reference Interpretation and Compliance Letters:
Employees at a hazardous waste site not necessarily related to clean-up. [9/8/92]

Hazwoper applications. [11/19/91]

1910.120 Application to Petroleum Product Spills or Releases Subject to State Codes. [7/17/91]

What is the applicability of HAZWOPER to small quantity generators?

Employers who are not required to have a permit or interim status because they are conditionally exempt small quantity generators under 40 CFR 261.5 or are generators who qualify under 40 CFR 262.34 for exemptions from regulation under 40 CFR 262.34 for exemptions from regulation under 40 CFR parts 264, 265, and 270 ("excepted employers") are not covered by paragraphs (p)(1) through (p)(7) of this section [1910.120 or 1926.65]. Excepted employers who are required by the EPA or state agency to have their employees engage in emergency response or who direct their employees to engage in emergency response are covered by paragraph (p)(8) of this section [1910.120 or 1926.65], and cannot be exempted by (p)(8)(i) of this section [1910.120 or 1926.65].

Reference Interpretation and Compliance Letters:
Manufacturing facilities with potential for exposure to hazardous waste. [9/22/92]

Actively involved; generators; CERCLA 101(33) substances. [8/6/91]

Training required for clean-up of hazardous waste and hazardous substances. [6/10/91]

What is the application of HAZWOPER to TSD facilities that store hazardous materials for 90 days or less?

Conditionally-exempt small quantity generators and generators who store hazardous wastes for less than 90 days are exempt from compliance with sections (p)(1) through

(p)(7), and are thus covered only by section (p)(8), the emergency response program. Employers who have hazardous waste storage areas in their facilities have the option of meeting the emergency response requirements of HAZWOPER by complying with either paragraph (p)(8) or paragraph (q) for those areas. The employer must meet the requirements of paragraph (q) for other areas of their facility which have potential for emergency releases of hazardous substances or hazardous raw materials.

... [Regarding the] exemption from employee training requirements under paragraph (p)(8) if the employer intends to evacuate employees in the event of an emergency. Paragraph (p)(8)(i), like paragraph (q)(1), provides an exemption from the emergency response requirements if the employer intends to evacuate all employees and provides an emergency action plan (i.e., an evacuation plan) in accordance with 29 CFR 1910.38(a).

However, the HAZWOPER standard states in paragraph (a)(2)(iii)(B) that "employers who are required by the EPA or state agency to have their employees engage in emergency response... are covered by paragraph (p)(8) of this section, and cannot be exempted by (p)(8)(i) of this section."

Reference Interpretation and Compliance Letters:
Manufacturing facilities with potential for exposure to hazardous waste. [9/22/92]

Application of 1910.120 to general industry with potential for hazardous substance emergencies. [12/21/90]

ENVIRONMENTAL LAWS AND REGULATIONS

I. Overview

Environmental legislation and regulation in the U.S. was initially enacted to control industrial effluents, such as air and wastewater, whose negative impacts on the environment were the easiest to observe. Later regulation of industrial chemicals and wastes arose after highly publicized incidents such as Love Canal and noted impact of certain pesticides on wildlife. More recently, legislation and regulations have focused on worker and community right to know, pollution prevention, and expansion and refinement of earlier programs. Most environmental laws are enacted for set periods of time, such as five years, and must be periodically re-authorized. Changes are often enacted at the time of re-authorization.

The U.S. Environmental Protection Agency (EPA) was established to oversee the federal environmental programs created by Congress. The EPA has many responsibilities, including supporting research into a wide variety of environmental impact, monitoring and control issues, developing and promulgating regulations to carry out legislative mandates, and enforcement of environmental laws and regulations. IN the early years of each environmental initiative (e.g. air pollution control, water pollution control, waste management, etc.) The EPA usually had sole responsibility for promulgating and enforcing regulations. Later, as individual states enacted similar environmental laws and regulations, the EPA began sharing enforcement (and permitting) responsibility, with stringent oversight. Today, most federal environmental legislation is constructed such that the EPA establishes baseline regulatory criteria for each environmental program. States that then pass laws and regulations at least as stringent as the federal standards are delegated the authority to run those programs within their borders.

Environmental regulation in the U.S. has profoundly affected the way hazardous substances are managed and business is conducted. Some of the most significant changes have occurred in the area of liability. Environmental legislation created liability schemes, repeatedly uphed by the Supreme Court, which were previously unknown in this country. Generators of hazardous waste are liable for those wastes, and any resulting contamination associated with releases, from “cradle to grave”. This liability remains with the generator even if someone else, such as a transporter or disposal site, mishandles the material and causes contamination. Persons that currently, or ever owned, a contaminated site are liable for the cleanup of that site simply through the act of their ownership (known as status liability and liability without fault or causation), even if they did not cause the contamination.

All parties responsible for contamination at a site are jointly liable for the cleanup, and any one party can be held individually (severally) responsible for the entire cleanup if the other responsible parties cannot be located or if those parties do not have the resources to contribute their fair share towards the cleanup.

The potentially massive costs of environmental resource and harm to human health, environmental cleanup, effluent management, regulatory reporting, lawsuits for damages, and other environmental compliance activities have significantly changed

American manufacturing and chemical management practices. Some products, such as PCBs and chlorinated pesticides, have disappeared completely. Other, such as chlorinated solvents (used as degreasers), aromatic hydrocarbons, and Freons® are produced and currently used in much lower quantities than before. Manufacting processes and chemicals have been changed to reduce the need for costly emission controls or waste disposal. These changes also have been encouraged by the public availability of mandatory annual Toxic Release Inventories documenting the volumes of hazardous substances used and discharged by manufacturing facilities across the U.S.

Based on the potential costs of cleaning up contaminated sites, liability is a major issue in all transfers of commercial and industrial property. Environmental assessment prior to accepting ownership of a site often determines whether or not a sale is completed. In addition, ownership is a major issue at abandoned or financially unstable disposal sites. This has resulted in much greater care in how and where hazardous wastes are disposed of, with far greater emphasis placed on recycling and thermal destruction. These handling methods result in a loss of a waste's identity more readily than other techniques such as stabilization and landfilling.

The nature of environmental controls

Environmental laws passed by the US Congress generally require the US Environmental Protection Agency to develop and promulgate regulations. There are six steps in this process:

1. Research into appropriate and fair regulatory structures and limits
2. Publish notice of proposed rulemaking
3. Review comments from the regulated community and interested parties
4. Publish proposed rules
5. Receive and review public comments
6. Promulgate final rules

Federal environmental laws have generally allowed states to promulgate regulations and issue appropriate permits. A nearly universal thread among environmental laws and controls is the shift of regulation from the federal government to individual states. This has been accomplished without creating nightmares of consistency through a provision common to nearly all federal environmental laws - the requirement that a state's regulations be "at least as strict as" the federal model. Specific requirements of the federal laws cannot be compromised by state programs, though many states, due to specific regional circumstances, have chosen to tighten regulations well beyond federal law. Examples include stricter air controls to address California's severe air pollution problems, restrictive water management requirements in Florida, with it's shallow water table, and additional chemical waste listings in New Jersey, with its large volume of chemical businesses.

The general political awareness of a state's citizens also has a bearing on how environmental controls are implemented and enforced. The issue of jurisdiction is not always clear; in some cases, for instance, EPA regional offices may take enforcement responsibilities in addition to or instead of state environmental agencies. Clarifications (written addendums to regulatory language in response to specific questions from the regulated community) can also change enforcement policies. Interpretations, either by

an individual regulator (inspector), an agency, or the facility being regulated, may differ considerably; there is, for instance, no guarantee that today's inspector will interpret a regulation the same as one that inspects the same facility tomorrow. Despite these difficulties, however, the prudent facility manager or responsible party will take a common sense approach to each issue, and request a written clarification when it appears that there are significant differences of opinion.

Regulating agencies / authority

The US Environmental Protection Agency is responsible for issuing and enforcing regulations on the environment at the federal level. Other agencies, however, may be involved when issues cross over into their jurisdiction. The US Department of Transportation, for instance, has nearly total control over the packaging, labeling, marking, placarding, transportation and paperwork associated with the movement of hazardous materials and wastes. The Occupational Safety and Health Administration (OSHA) has jurisdiction over all worker protection issues. These include hazard communication (the employee's right to know about hazardous materials in the workplace), workplace exposures to air contaminants and other hazardous materials, and worker training in environmental areas such as waste management and response to chemical emergencies. Ironically enough, academic students are not protected under these laws and regulations, since they are not considered employees.

In the majority of states, a state agency has been designated to issue regulations and enforce state laws. A list of these agencies is included at the end of this chapter. Some states have multiple agencies to address different issues, such as air or water quality. Most states also have an OSHA equivalent agency.

National Environmental Policy Act

Federal facilities have traditionally been exempt from most environmental laws. Without the hammer of regulations to force funding, environmental programs at facilities such as military testing and defense research operations were given little attention. This resulted in some of the most polluted sites in the US being located at defense facilities. To address this problem, Congress passed the National Environmental Policy Act, which essentially requires federal facilities to comply with public laws and regulations, and further directs all federal agencies to consider the environmental impact of any decision making early in the process. An environmental impact statement (EIS) is required for any project that may have a significant effect on the environment or that may be controversial due to environmental concerns.

II. Air Controls

Clean Air Act and amendments

The Clean Air Act is the basis for nearly all regulation of air emissions involving hazardous pollutants. Of primary concern are such contaminants as volatile organic compounds, nitric oxides, and particulates. The law regulates both mobile and stationary sources; permits are required for significant emissions (generally, activities

resulting in emissions of less than ten tons per year do not require permitting). The Act puts an onus on states to meet certain attainment levels (national ambient air quality standards) and to protect areas that already meet these levels. Other controls include ozone protection (CFCs), limits on vehicle emissions and fuel additives, and measures designed to reduce acid rain. The EPA sets minimum standards which individual states must meet, and then works with state agencies on such issues as procedures, permitting, monitoring, and recordkeeping. The Clean Air Act's amendments allow for tighter controls than currently in place, but only if a health benefit can be shown.

Indoor air quality / personnel exposure

Ironically, there is no single federal agency with control over air quality issues. OSHA essentially regulates indoor air quality, while the EPA regulates outdoor air quality. An additional irony is that only workers are normally protected by OSHA regulation. For instance, in an academic setting, faculty, staff, and maintenance workers are provided with rights under the Hazard Communication Standard; students are not covered. OSHA regulates indoor air quality by setting personnel exposure limits to various air contaminants such as formaldehyde, glutaraldehyde, carbon monoxide, cadmium, lead, and volatile organic compounds. There are also training requirements associated with procedures and personal protective equipment designed to prevent exposures.

III. Water Controls

Clean Water Act

The Clean Water Act is the principal authority for federal water pollution control regulations and policies. Designed essentially to eliminate the discharge of hazardous substances to streams, rivers, and other bodies of water, the Act mandates the permitting program that controls these discharges - the National Pollution Discharge Elimination System (NPDES). The Act also sets pre-treatment standards for wastewater treatment operations, and includes grants for construction and improvements to these such facilities.

In addition to surface discharges, the Clean Water Act is designed to protect groundwater supplies. This effectively means that discharges to the ground which have the potential to migrate and affect groundwater quality are also regulated. This interpretation explains the application of the permitting program to industrial stormwater discharges. With few exceptions, facilities that store hazardous materials where they might be contacted by stormwater runoff are required to obtain a permit and perform stormwater monitoring.

One major limitation of the Clean Water Act is its neglible impact on agricultural discharges, which account for significant water quality problems. Of particular concern is the high nitrogen content of stormwater runoff from livestock grazing areas.

National Pollution Discharge Elimination System (NPDES)

This permitting program, mandated by the Clean Water Act, is designed to eliminate the discharge of industrial wastes to bodies of water. The basic means of meeting goals for

improving water quality is through the setting of effluent limits on a variety of toxic pollutants. All industrial discharges require a permit, though both general and individual permits are allowed. State programs also have significant leeway in the setting of monitoring requirements, and many states have set up streamlined requirements for general permitting.

Safe Drinking Water Act

The basis for the Safe Drinking Water Act (SDWA) is the fact that much of the US obtains its drinking water from groundwater supplies. An additional concern was the aging condition of many of the public water systems; treatment technologies were also inadequate or poorly designed. There was also concern over the level of training of operational personnel and the resulting substandard monitoring of water quality. The Act sets primary and secondary standards for various contaminants, sets treatment standards, and provides mechanisms for programs designed to protect water sources. Under the Act, states must submit compliance plans to the EPA that meet or exceed federal standards for drinking water quality. The Act also placed controls on underground injection of hazardous materials.

IV. Waste controls

Resource Conservation & Recovery Act of 1976

The Resource Conservation & Recovery Act (RCRA), which was last reauthorized in 1984, mandates “cradle to grave” management of hazardous wastes. It regulates both materials that are specifically listed and those that meet certain characteristics. The “U” and “P” list refer to specific chemical compounds that are hazardous when discarded as off-spec or surplus. The “K” list refers to byproducts of specific industrial processes, and the “F” list refers to wastes generated by non-specific processes such as cleaning or degreasing. The four characteristics, which cover the largest range of waste material, are ignitability, corrosivity, reactivity, and toxicity.

RCRA, and its resulting regulations at the state and federal level, place requirements on generators to properly label, store, and document the accumulation of hazardous wastes. Other requirements include training of employees, recordkeeping, and documentation of all shipments. While recycling and reclamation of hazardous wastes is encouraged, on-site treatment and/or disposal of wastes typically requires extensive permitting. As a result, most small companies and educational institutions accumulate wastes on site, and arrange for off-site handling of wastes. There are significant restrictions on the amount of time that wastes can be accumulated on-site without a storage permit. Large generators, those who produce over 1000 kilograms of hazardous waste per month, are allowed to accumulate for only 90 days before wastes must be shipped off site. Smaller generators, those that generate between 100 and 1000 kilograms per month, may store for up to 180 days, or under some circumstances, for up to 270 days. Generators that produce less than 100 kilograms of hazardous waste per month are exempt from accumulation time limits, but are restricted as to the total volume that may be stored on site. Generating acutely toxic wastes in quantities greater than 1 kilogram per month will result in classification as a large generator.

RCRA provides significant civil and criminal penalties for improper management of wastes, and the Environmental Protection Agency (EPA) continues to actively enforce the provisions of the Act. The total amount of penalties against individuals and companies in 1996 was $173 million; of this total, $76.6 million was for criminal fines, the highest total ever recorded. [1] It should be noted that individuals within a company may have criminal and civil liability for willful acts that result in environmental impairment. Such cases may also result in state violations and fines.

Comprehensive Environmental Response, Compensation & Liability Act Few other environmental laws have had the financial impact of the Comprehensive Environmental Response, Compensation & Liability Act (CERCLA). CERCLA, frequently referred to as Superfund, allows the EPA to determine cleanup costs for abandoned and closed waste sites, and to then assign financial liability to those it deems to be responsible parties. Many generators have had to pay twice for the disposal of the same hazardous wastes as the result of CERCLA actions. The Act establishes a grading process for the severity of pollution and resulted in the development of a National Priority List (NPL) of contaminated sites. Funding is provided for sites where no responsible parties can be located, and the program also provides for oversight by the EPA for private-party cleanups outside the realm of Superfund. CERCLA also defines hazardous substances (through a hazardous substance list), and regulates responses to, and reporting of, spills or releases of such substances.

The legal issue of joint and several liability raised by CERCLA has raged in federal courts almost since the Act was first passed by Congress. Many questions concerning CERCLA liability still need to be addressed; most efforts to amend the Act have been aimed at making the assignment of financial liability more equitable. The EPA also has the right “to act when there is a release or *threat of a release* of a pollutant from a site which may endanger public health”. The decision of when a threat of a release exists is left up to the EPA, which has broadly interpreted this clause in many instances.

Toxic Substances Control Act

The Toxic Substances Control Act (TSCA) primarily addresses the manufacture of toxic substances that might present a future unreasonable risk. The most significant provision of the Act was giving EPA the right to prohibit the manufacture, sale, use, or disposal of a new or existing chemical. Each new chemical must undergo toxicity testing to determine its impact on public health, and existing compounds are selected each year for testing as well.

Of particular interest within the Act are the specific controls on the use and disposal of polychlorinated biphenyls (PCBs), since their disposal is controlled not by RCRA, but specifically by TSCA. This was apparently due to the immediacy (at the time of TSCA passage) of public concerns over their toxicity. Their manufacture was discontinued in the 1970's, and while the cleanup of PCB contaminated sites continues, most PCB transformers and capacitors have been either disposed of or retrofilled with safer heat

---

[1] Chemical & Engineering News, American Chemical Society, March 3, 1997.

transfer fluids. TSCA also regulates responses to PCB spills and remediation of PCB contamination.

The Act also addresses public concerns over asbestos through amendments in 1986 (the Asbestos Hazard Emergency Response Act, or AHERA). This amendment precipitated the inspection for, and removal of, asbestos in all public schools and thousands of other public buildings.

Superfund Amendments and Reauthorization Act (SARA)

While the name of this Act implies a primary objective of reauthorizing CERCLA, its more sweeping impact is the result of Title III of the Act, known as the Emergency Planning and Community Right to Know Act. SARA Title III has arguably had more impact on the reduction of hazardous chemical emissions and releases than any other single piece of legislation. This has been accomplished by requiring industry to report all emissions of a substantial list of chemicals.

A major impact of SARA is the public availability of emission figures. Those companies with the highest emission figures are encouraged by public pressure to make reductions. Ironically, most government efforts to require reductions have been through voluntary programs. Specific reductions are not required by the Act.

The Act has also had a significant impact on the handling of chemical emergencies, largely through the development of a hierarchy of local and state emergency response planning committees. State Emergency Response Commissions (SERCs) and Local Emergency Planning Committees (LEPCs) are charged with developing plans for handling emergencies that threaten human health or the environment, and they must develop local emergency response (Haz Mat) teams to deal with hazardous material emergencies. Industries that store chemicals above threshold planning quantities must report to state and local agencies, and pay fees based on the number of reportable chemicals at their facilities. The presence of Extremely Hazardous Substances, as defined by the Act, require the development of written response plans to be implemented in the event of a release with possible impact on the surrounding community and/or the environment. The Act also requires specific notifications in the event of a release.

SARA has also had a significant impact on a less obvious factor in emergency management - training. OSHA regulations require significant training of those personnel involved in responses to hazardous chemical emergencies at SARA sites.

Environmental laws and regulations will continue to have a significant impact on industry, both the U.S. and abroad. While political conditions dictate the extent and direction of changes in standards, environmental controls and liabilities are here to stay. It is largely through industry recognition of the benefits of maintaining effective environmental management programs that pollution prevention efforts remain strong. As long as there are serious liabilities associated with non-compliance, however, environmental laws and regulations will continue to have a major impact.

THE OSHA GENERAL DUTY CLAUSE

The General Duty Clause, found in the Occupational Safety and Health Act of 1970, has become increasingly important to employers in the last few years as OSHA has begun to utilize the clause in more and more of its penalty and enforcement actions. The discussion below describes the General Duty Clause and how it is being used by OSHA to ensure a safe work environment.

Section 5(a)(1) of the Occupational Safety and Health Act of 1970 requires that every working man and woman must be provided with a safe and healthful workplace. The section, more commonly known as the General Duty Clause, specifically states:

"Each employer shall furnish to each of his employees employment and a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees."

In simple terms, this statement means that you, as an employer, may be obligated to protect your employees from recognized hazards in the workplace even if there is not an OSHA standard which applies to the situation or if hazards still exist after compliance with a standard. In effect, the General Duty Clause obligates employers to take additional steps toward safety if the well-being of employees is in jeopardy.

How Does OSHA Use the General Duty Clause?

The General Duty Clause extends OSHA's authority beyond the specific requirements of the OSHA standards when a recognized workplace hazard exists or potentially exists. In 1990-1991 alone, the General Duty Clause was used as the basis for over 2,232 OSHA citations. Over $500,000 in penalties were collected as a result of these citations. Only nine other sections of the OSHA standards (Parts 1910 and 1926) are cited more frequently as the basis for OSHA violations than Section 5(a)(1).

The General Duty Clause is often used by OSHA when there is no specific standard which applies to a recognized hazard in the workplace. OSHA may also use the General Duty Clause when a standard exists, but it is clear that the hazards involved warrant additional precautions beyond what the current safety standards require.

OSHA's recent action on ergonomic hazards in the workplace is a good example of the application of the General Duty Clause in situations where a standard does not currently exist. There are no standards governing job or work station design to reduce or prevent cumulative trauma disorders or other injuries. However, OSHA has widely applied the General Duty Clause to address ergonomic hazards in the workplace. Typically in these situations, OSHA will discover ergonomic-related problems while reviewing a company's accident and injury records. The highly publicized citations issued to several meatpacking plants for cumulative trauma disorders are an example of the use of the General Duty Clause to correct ergonomic hazards. The action in this area eventually led to the issuance of ergonomic guidelines for the meatpacking industry and consideration of a standard for the general industry.

OSHA has also issued General Duty Clause citations on other issues where no apparent safety standard exists. Citations have been issued for lack of training, failure to have additional safety or alarm equipment to detect or warn of chemical leaks, and failure to provide safe locations or safe access to valves or other instruments necessary to an employee's job.

What about situations where a safety standard currently exists on a particular subject? Are you doing enough if you are in compliance with OSHA's safety standard? The answer, unfortunately, is maybe not. OSHA has also used the General Duty Clause to cite employers who knew that an OSHA standard was inadequate to protect their employees from harm.

At least one Circuit Court decision (International Union UAW v. General Dynamics, 815 F.2d 1570, D.C. Cir. 1987) has validated OSHA's use of the General Duty Clause in this manner. In this situation, after several injuries and eventually a death involving the use of Freon in confined spaces, OSHA cited General Dynamics under the General Duty Clause for not having a confined space procedure in situations where an employee could be asphyxiated or chemically poisoned by the cleaning compound (Freon) being used. General Dynamics appealed the citation to the Occupational Safety and Health Review Commission which ruled in favor of the company noting that since there was a specific OSHA exposure standard for Freon (eight-hour time-weighted average), OSHA could not cite the company under the General Duty Clause. The Commission's decision was then reviewed by the Circuit Court of the District of Columbia which decided in favor of OSHA. The court stated that

:. . .if (as alleged in this case) an employer knows a particular safety standard is inadequate to protect his workers against the specific hazard it is intended to address, or that the conditions in his place of employment are such that the safety standards will not adequately deal with the hazards to which his employees are exposed, he has a duty under Section 5(a)(1) to take whatever measures may be required by the Act, over and above those mandated by the safety standard, to safeguard his workers.

Conclusion

Section 5(a)(1) of the Occupational Safety and Health Act of 1970 places additional responsibilities on the employer and the safety manager to ensure that a safe work environment is provided to all employees. The General Duty Clause is being increasingly applied to a wide variety of situations, many of which have not been addressed by a specific OSHA standard. What may be even more disconcerting, however, is that general duty citations can also be issued if OSHA feels that additional safety equipment or procedures are necessary beyond what is required in an OSHA standard. Thus, the General Duty Clause is making it increasingly difficult for companies to fully comply with OSHA's requirements.

One way to deal with the increasing threat of general duty violations is to make good faith efforts to correct existing workplace hazards and to identify and address new hazards as they appear. Some steps you can take to accomplish this goal include:

Regularly review your accident and injury records to identify injury patterns or areas for concern;

- Investigate every accident or injury in the workplace to determine the specific cause and to determine whether any action needs to be taken to prevent the accident or injury from recurring;
- Conduct job hazard analyses on a regular basis in order to identify the specific hazards associated with every job and to identify new job hazards;
- Document your training efforts and conduct periodic retraining as necessary; o

Consider establishing an employee safety committee in the workplace; and

- When you have met the "letter of the law," step back, and critically assess whether the process might still be unsafe.

(Courtesy www.jjkelleronline.com, 2006)

Training Requirements from the OSHA General Industry Standards

Employee Emergency Plans and Fire Prevention Plans (1910.38)
(a.5.i) Designate and train a sufficient number of people to assist in the emergency evacuation of employees.
(a.5.ii) Review the plan with covered employees: (A) when the plan is developed; (B) whenever the employee's responsibilities change; and (C) whenever the plan is changed.
(a.5.iii) Review with employees, upon initial assignment, parts of the plan they must know in the event of an emergency. The written plan must be kept at the workplace and made available to employees. Employers with 10 or fewer employees may communicate the plan orally.
(b.4.i) Apprise employees of the fire hazards to which they are exposed.
(b.4.ii) See (a.5.iii).

Powered Platforms for Building Maintenance (1910.66)
(i.1.i) Only those proficient in the operation of a particular platform can operate a working one.
(i.1.ii.) Employees operating working platforms must be trained in recognizing and preventing safety hazards and knowing emergency action plans, work procedures and how to take care of personal fall arrest systems.
(i.1.iii) A competent person must perform the training.
(i.1.iv) Provide written work procedures for employee training.
(i.1.v) Certify employee training.

Occupational Noise Exposure (1910.95)
(i.4) Provide training in the use and care of all hearing protectors.
(k.1) Institute a training program for all employees exposed to noise at or above an eight-hour time-weighted average (TWA) of 85 decibels (dB), and ensure that every employee participates.
(k.2) Repeat the training program annually for employees included in the hearing conservation program. Update information in the program to keep it current and consistent with standards.
(k.3) Ensure employees are informed of: (i) the effects of noise on hearing; (ii) the purpose of hearing protectors, the advantages, disadvantages and attenuation of various types, and instruction on selection, fitting, use and care; and (iii) the purpose of audiometric testing and an explanation of the test procedures.

Flammable and Combustible Liquids (1910.106)
(b.5.vi.V.2) Post detailed flood emergency instructions.
(b.5.vi.V.3) Inform station operators who carry out flood instructions of the location of valves and other pertinent equipment.

Storage and Handling of Liquified Petroleum Gases (1910.110)

(b.16) Train personnel performing installation, removal, operation and maintenance work.
(k.5) Retraining must be administered annually, and when: (i) changes in the workplace or the type of respirator used render previous training obsolete; (ii) inadequacies in the employee's knowledge or use of the respirator indicate that the requisite understanding or skill has not been retained; or (iii) any other situation arises in which retraining appears necessary to ensure safe respirator usage.

Storage and Handling of Anhydrous Ammonia (1910.111)
(b.13.ii) Instruct personnel unloading tank cars.
Process Safety Management of Highly Hazardous Chemicals (1910.119)
(g.1) Initially train all employees involved in a process and newly assigned to a process as specified in (f).
(g.2) Provide refresher training at least every three years and more often, if necessary, for all employees operating a process.
(g.3) Document training and include the identity of the employee, the date of training and the means used to verify that the employee understood the training.
(h.3.i) Contract employers must assure employees are trained in safe work practices.
(h.3.ii) Contract employers must instruct employees about potential hazards of their jobs and ensure they know the emergency action plan.
(h.3.iii) Contract employers must document training and prepare a record identifying the employee, the date of training and the means used to verify the training was understood.
(j.3) Employees involved in maintaining the on-going integrity of process equipment must be trained in an overview of the process and its hazards and the procedures necessary to perform the job safely.

Hazardous Waste Operations and Emergency Response (1910.120)
(e.1.i) Train employees exposed to any hazardous situations before they engage in them.
(e.2) Training must cover the following: (i) names of personnel and alternates responsible for site safety and health; (ii) safety and health hazards present on the site; (iii) use of personal protective equipment; (iv) work practices that minimize risks; (v) safe use of engineering controls and equipment; (vi) medical surveillance requirements; and (vii) contents of (g-j) of the plan set forth in (b.4.ii).
(e.3.i) General site workers engaging in any hazardous activity must receive 40 hours of off-site instruction and a minimum of three days supervised field experience.
(e.3.ii) Workers on-site occasionally must receive 24 hours of off-site instruction and one day of supervised field experience.
(e.3.iii) Workers who work in nonhazardous areas must receive 24 hours of off-site instruction and one day of supervised field experience.
(e.3.iv) Workers in (e.3.ii) and (e.3.iii) must receive 16 additional training hours when they become general site workers or are required to wear respirators.
(e.4) Supervisors responsible for employees engaging in hazardous operations must receive 40 hours of initial training.
(e.5) Trainers must complete a training program.
(e.6) All trained employees and supervisors must be given a written training certificate.

(e.7) Train emergency response employees in how to respond to expected emergencies.
(e.8) Employees specified in (e.1) and (e.4) must receive eight hours of refresher training annually.
(e.9) Employers who can document that an employee's work experience equals the training required in (e.1-4) do not have to provide initial training requirements.
(o.1) Develop and implement procedures for the introduction of effective new technologies and equipment used to protect employees working with hazardous waste cleanup operations.
(p.7.i) Develop a training program with 24 hours of refresher training and eight hours annual training for employees exposed to health hazards. Issue a written certificate upon completion.
(p.7.iii) Trainers must complete a training course or have academic credentials.
(q.4) Temporary skilled support personnel do not need training.
(q.5) Specialist employees must prove their competency in their specialization annually.
(q.6) Train emergency response employees in the following: (i) first responder awareness level; (ii) first responder operations level; (iii) hazardous materials technician; (iv) hazardous material specialist; and (v) on-scene incident commander.
(q.7) Refer to (p.7.iii).
(q.8) Employees trained in (q.6) must receive annual refresher training.

General Requirements of Personal Protective Equipment (1910.132)
(f.1) Train employees using PPE in the following: (i-ii) when and what PPE is necessary for the workplace; (iii) how to put on, remove, adjust and wear the PPE; and (iv-i) the limitations, proper care, maintenance, life expectancy and disposal of the PPE.
(f.2) Employees must demonstrate that they understood their training prior to performing work.
(f.3) Retrain employees when: (i and ii) changes occur in the workplace or types of PPE; and (iii) inadequacies exist in the employee's knowledge of PPE.
(f.4) Verify employee training with a certificate.

Respiratory Protection (1910.134)
(c.3) A program administrator qualified by appropriate training or experience must be designated to administer the written respiratory protection program.
(c.4) The employer must provide training at no cost to employees.
(d) Respirator users must receive fit testing according to the exact type of respirator they will be using.
(k) Training and information. (1) Employers must ensure that each employee can demonstrate knowledge of at least the following: (i) the reasons why a respirator is necessary and how improper fit, usage or maintenance can compromise its protective effect; (ii) respirator limitations and capabilities; (iii) how to use a respirator effectively in emergency situations, including situations in which the respirator malfunctions; (iv) how to inspect, put on, remove, use and check respirator seals;
(v) procedures for respirator maintenance and storage; (vi) how to recognize medical signs and symptoms that may limit or prevent the effective use of respirators; and
(vii) the general requirements of this section.
(k.2) The training must be conducted in a manner that is understandable to the employee.

(k.3) Employers must provide the training prior to requiring the employee to use a respirator in the workplace.
(k.4) Employers who can demonstrate that a new employee has received training within the last 12 months that addresses the elements specified in (k.1.i-vii) is not required to repeat the training, provided that, as required by (k.1), the employee can demonstrate knowledge of those element(s).
Previous training not repeated initially by the employer must be provided no later than 12 months from the date of the previous training.
(k.5) Retraining must be administered annually, and when: (i) changes in the workplace or the type of respirator used render previous training obsolete; (ii) inadequacies in the employee's knowledge or use of the respirator indicate that the requisite understanding or skill has not been retained; or (iii) any other situation arises in which retraining appears necessary to ensure safe respirator usage.
(k.6) The basic advisory information on respirators, as presented in Appendix D of this section, must be provided by employers in any written or oral format to employees who wear respirators when such use is not required by this section or the employer.

Accident Prevention Signs and Tags (1910.145)
(c.1.ii) Employees must be instructed that danger signs indicate immediate danger.
(c.2.ii) Employees must be instructed that caution signs indicate a possible hazard.

Permit-Required Confined Spaces (1910.146)
(g.1) Train employees on the knowledge and skills necessary for safe performance in this area.
(g.2) Training must be given to affected employees: (i) before their first assigned duties; (ii) before there is a change in assigned duties; (iii) whenever a change in permit space operations causes a hazard that an employee has not previously been trained on; and (iv) whenever the employer believes there are deviations from the procedures in (d.3) or inadequacies in employee knowledge.
(g.3) Training must establish employee proficiency and introduce new or revised procedures when necessary.
(g.4) Certify employee training.

The Control of Hazardous Energy (Lockout/Tagout) (1910.147)
(a.3.ii) When other standards in this part require lockout/tagout, they must be used and supplemented by procedural and training requirements.
(c.6.i.C) Periodic inspection of tagout used for energy control must include a review between the inspector and authorized employees.
(c.7.i) Training must include: (A) recognizing and controlling applicable hazardous energy sources;
(B) the purpose and use of energy control procedures; and (C) instruction to employees not affected.
(c.7.ii) Employees must know the following about tags: (A) that they are warning devices without physical restraint; (B) that they must not be removed without authorization; (C) that they must be legible and understandable; (D) that they must withstand environmental conditions; (E) that they may evoke a false sense of security; and (F) that they must be securely attached to energy isolating devices.

(c.7.iii) Retrain employees when: (A) a change in job assignments, machines, equipment or processes occurs; (B) periodic inspections reveal inadequacies; and (C) there is a need to reestablish employee proficiency. (c.7.iv) Certify employee training.

(c.8) Lockout/tagout must be performed only by authorized employees.

Medical Services and First Aid (1910.151)
(b) When medical aid is not nearby, a person or persons must be trained to give first aid.

Fire Brigades 1910.156
(c.1) Provide training and education for brigade members before they perform emergency activities.
Training instructors and fire brigade leaders must receive more comprehensive training. (c.2) Train brigade members at least annually, and train members expected to perform interior structural fire fighting duties quarterly.
(c.3) The training and education program should be similar to programs conducted by fire training schools.
(c.4) Inform fire brigade members about special hazards to which they may be exposed, as well as changes to specific hazards during emergencies. Employers must provide written procedures.

Portable Fire Extinguisher (1910.157)
(g.1) When portable fire extinguishers are provided for employees, also provide an education program on how to use them.
(g.2) This education must be given upon initial employment and annually thereafter.
(g.3) Train designated employees in the use of appropriate fire fighting equipment.
(g.4) This training must take place upon initial assignment and annually thereafter.

Fixed Extinguishing Systems, General (1910.160)
(b.10) Train personnel designated to inspect, operate or repair these systems and annually review their training.

Powered Industrial Trucks (1910.178)
(l) Operator training. (1) Safe operation. (i) Employers must ensure that each powered industrial truck operator is competent to operate a powered industrial truck safely, as demonstrated by the successful completion of the training and evaluation specified in this paragraph.
(l.1.ii) Prior to permitting an employee to operate a powered industrial truck (except for training purposes), employers must ensure that each operator has successfully completed the training required by this paragraph (l), except as permitted by (l.5).

(I.2) Training program implementation. (i) Trainees may operate a powered industrial truck only: (A) Under the direct supervision of those who have the knowledge, training and experience to train operators and evaluate their competence; and (B) where such operation does not endanger the trainee or other employees.
(I.2.ii) Training must consist of a combination of formal instruction (e.g., lecture, discussion, interactive computer learning, video tape, written material), practical training (demonstrations performed by the trainer and practical exercises performed by the trainee) and evaluation of the operator's performance in the workplace.
(I.2.iii) All operator training and evaluation must be conducted by those who have the knowledge, training and experience to train powered industrial truck operators and evaluate their competence.
(I.3) Training program content. Powered industrial truck operators must receive initial training in the following topics, except when the employer can demonstrate they are not applicable to safe operations in the employer's workplace.
(I.3.i) Truck-related topics include: (A) operating instructions, warnings and precautions for the types of trucks the operator will be authorized to operate; (B) differences between the truck and the automobile; (C) truck controls and instrumentation such as where they are located, what they do and how they work; (D) engine or motor operation; (E) steering and maneuvering; (F) visibility (including restrictions due to loading); (G) fork and attachment adaptation, operation and use limitations; (H) vehicle capacity; (I) vehicle stability; (J) any vehicle inspection and maintenance the operator will be required to perform; (K) refueling and/or charging and recharging of batteries; (L) operating limitations; and (M) any other operating instructions, warnings or precautions listed in the operator's manual for the types of vehicles the employee is being trained to operate.
(I.3.ii) Workplace-related topics include: (A) surface conditions where the vehicle will be operated;
(B) composition of loads to be carried and load stability; (C) load manipulation, stacking and unstacking; (D) pedestrian traffic in areas where the vehicle will be operated; (E) narrow aisles and other restricted places where the vehicle will be operated; (F) hazardous (classified) locations where the vehicle will be operated; (G) ramps and other sloped surfaces that could affect the vehicle's stability; (H) closed environments and other areas where insufficient ventilation or poor vehicle maintenance could cause a buildup of carbon monoxide or diesel exhaust; and (I) other unique or potentially hazardous environmental conditions in the workplace that could affect safe operation.
(I.3.iii) The requirements of this section.(I.4) Refresher training and evaluation. (i) Refresher training, including an evaluation of the effectiveness of that training, must be conducted as required by (I.4.ii) to ensure that the operator has the knowledge and skills needed to operate the powered industrial truck safely.
(I.4.ii) Refresher training in relevant topics must be provided to the operator when: (A) the operator has been observed operating the vehicle in an unsafe manner; (B) the operator has been involved in an accident or near-miss incident; (C) the operator has received an evaluation that reveals the truck is not being operated safely; (D) the operator is assigned to drive a different type of truck; or (E) a condition in the workplace changes in a manner that could affect the safe operation of the truck.
(I.4.iii) An evaluation of each powered industrial truck operator's performance must be conducted at least once every three years.

(l.5) Avoidance of duplicative training. If an operator has previously received training in a topic specified in (l.3) and such training is appropriate to the truck and working conditions encountered, additional training is not required if the operator has been evaluated and found to be competent to operate the truck safely.
(l.6) Certification. Employers must certify that each operator has been trained and evaluated as required. The certification must include the name of the operator, the date of the training, the date of the evaluation and the identity of the person(s) performing the training or evaluation.
(l.7) Dates. Employers must ensure operators are trained, as appropriate, by the following dates:
employees hired before December 1, 1999 by December 1, 1999; employees hired after December 1, 1999 before assignment.
(l.8) Appendix A provides nonmandatory guidance to assist employers in implementing this paragraph (l). Please consult a complete copy of the standard for more information.

Overhead and Gantry Cranes (1910.179)
(n.3.ix) When two or more cranes are used, a qualified person must be in charge of the operation.
(o.3) Familiarize operators with the care and use of the fire extinguisher provided.

Crawler Locomotive and Truck Cranes (1910.180)
(i.5.ii) Operating and maintenance personnel must be made familiar with the use and care of the fire extinguisher provided.

Mechanical Power Presses (1910.217)
(e.3) Train maintenance personnel.
(f.2) Train operators in safe methods of work.
(h.13.i) Operator training in (f.2) must include instruction for presses in the presence sensing device initiation (PSDI) mode. Instructions include: (A) manufacturer's test procedures for checking operations; (B) safety distance; (C) operation, function and performance of the PSDI mode; (D) requirements for hand tools; and (E) severe consequences resulting from by-passing any safeguards.
(h.13.ii) Certify employee training.

Forging Machines (1910.218)
(a.2.iii) Train personnel on the inspection and maintenance procedures of this equipment.

Oxygen-Fuel Gas Welding and Cutting (1910.253)
(a.4) Deem employees in charge competent to do their work before leaving them in control.

Arc Welding and Cutting (1910.254)
(a.3) Instruct and qualify workers.

Resistance Welding (1910.255)
(a.3) Instruct workers and deem them competent.

Electrical Safety-Related Work Practices (1910.332)
(b.1) Train employees in the safe work practices required by 1910.331-335 that pertain to their respective job assignments.

Bloodborne Pathogens (1910.1030)
Requires annual training of employees who may be exposed to bloodborne pathogens such as Hepatitis C or HIV. Also requires development and implementation of an Exposure Control Plan.

Air Contaminants

Use of the following air contaminants in the workplace requires employee training (see specific standard for requirements)

Carcinogens (1910.1003-1910.1016)
Vinyl Chloride (1910.1017)
Inorganic Arsenic (1910.1018)
Hexavalent Chromium (1910.1026)
Cadmium (1910.1027)
Benzene (1910.1028)
Coke Oven Emissions (1910.1029)
Cotton Dust (1910.1043)
1,2-Dibromo-3-Chloropropane (DBCP) (1910.1044)
Acrylonitrile (1910.1045)
Ethylene Oxide (1910.1047)
Formaldehyde (1910.1048)
Methylenedianiline (1910.1050)
1,3-Butadiene (1910.1051)
Methylene Chloride (1910.1052)

Ionizing Radiation (1910.1096)
(f.3.viii) Employees in an area covered by an emergency signal must be made familiar with its sound.
(i.2) Inform employees in radiation areas of radioactive materials. Instruct them in safety problems and protective provisions, and advise them of radiation exposure reports.

Hazard Communication (1910.1200)
(h.1) Train employees about hazardous chemicals in their work area.
(h.2) Inform employees of: (i) the requirements of this section; (ii) operations where hazardous chemicals are present; and (iii) the location of the written hazard communication program and the material safety data sheets.

(h.3) Employee training must include: (i) methods used in detecting the presence of hazardous
chemicals; (ii) hazards of chemicals in the workplace; (iii) protective measures; and (iv) details of the hazard communication program.

Occupational Exposures to Hazardous Chemicals in Laboratories (1910.1450)
(f.4.i) Employee training must include: (A) methods used to detect the presence of a hazardous chemical; (B) hazards of the chemicals in the work area; and (C) measures employees can take to protect themselves.

SAMPLE OSHA SAFETY CHECK SHEET

Date _____ Location _____

1. Safety and Health Protection on the Job Poster displayed. (1904.1). _____

2. Log of occupational injuries or illnesses maintained. (1904.2) _____

3. Record of occupational injuries posted for required time period. (1904.4) _____

4. Summary of occupational injuries and illnesses posted. (1904.5) _____

5. Compliance records for organization maintained current by office and separate records maintained in each location. (1904.6) _____

6. Permanent passageways and aisles appropriately marked. (1910.22) _____

7. Passageways, store rooms, service rooms, and work areas clean and aisles clear. (1910.22) _____

8. All floors clean and dry. (1910.22) _____

9. Floors free of protruding nails, splinters, holes, and loose boards. (1910.22) _____

10. Where storage is on a second floor, balcony, or other overhead areas-load limits are marked. (1910.22) _____

11. Floor openings of any kind have standard railing or floor hole cover constructed as required. (1910.23). _____

12. Temporary floor openings have standard railings or are constantly attended by someone. _____

13. Every opening, floor or platform, 4 feet or more above ground level has a standard rail and toe boards guarding. (1910.23) _____

14. All stairs with four or more risers have standard hand rails. (1910.23) _____

15. Portable step ladders in good condition. (1910.25 and 1910.26)_____

16. Portable rung ladders have safety feet securely bolted or fastened. 1910.25)_____

17. Wood ladders are stored in shelter or out of elements. (1910.25) _____

18. Metal ladders are equipped with nonslip material on rungs. (1910.26)_____

19. Metal ladders not used in areas where exposed to electric circuits. 1910.26)_____

20. Exits are visible and clearly marked (1910.36). _____

21. Work areas have at least two exits. (1910.36) _____

22. Where exits are not clearly visible from work areas, signs pointing to exits are posted. (1910.37) _____

23. Doors or openings which are not a means of egress are marked "Not an Exit". (1910.37) _____

24. Permissible noise exposure levels have been checked with in areas where necessary and personal protective equipment provided as needed. (1910.95)_____

25. Approved containers for flammable materials are available. (1910.106) _____

26. Closed containers are provided for oily-rag disposal. (1910.106) _____

27. Hard hats are provided and used in areas where impact or falling object hazards exist. (1910.132) _____

28. Employee handling heavy objects are provided and use protective footwear. (1910.132) _____

29. Separate toilet facilities provided for each sex; facilities clean. (1910.141)_____

30. Toilet facilities are adequate for number of employees. (1910.141) _____

31. Toilet room doors have self-closing device. (1910.141) _____

32. Individual towels or drying equipment for employees in wash room are provided. (1910.141)_____

33. Drinking water is within 200 feet of all employee stations. (1910.141) _____

34. Where disposable drinking cups are provided, a container is provided for disposal of used cups. (1910.141) _____

35. Lunch room adequate for number of employees who may use it. (1910.141)_____

36. Covered receptacles are provided in lunch room and are emptied not less than once daily. (1910.141) _____

37. A positive "Lockout System" is provided to render those machine operated by electric motors inoperative while repairs or adjustments are being made. (1910.145)_____

38. "No Smoking" signs are posted in areas where conditions require them. (1910.145) _____

39. Physician-approved first aid kit accessible. (1910.151) _____

40. Personal protective equipment for eyes, face, head, and extremities, protective clothing, respiratory devices, protective shields and barriers are provided, used, and maintained by employer wherever necessary. (1910.151)_____

41. Fire extinguisher for necessary classes of fire visibly mounted. (1910.157)_____

42. Extinguisher tops are not more than 5 feet from floor.

43. Extinguishers over 40 pounds are not elevated more than 3.5' from the ground.(1910.157) _____

44. Fire extinguishers for Class A fires are within 75 feet from any point in the work area and extinguishers for Class B fires are within 50 feet. _____

45. Access to extinguisher is not hindered in any way. (1910.157) _____

46. Cylinders, tanks, and air receivers have been checked for: dents, cuts, or gouges in cylinders, corrosion or pitting, hairline cracks in necks. Storage safety: dry, clean area; drain pipe or valve at low point of air receivers. (1910.166) _____

47. All materials are piled, racked, or stored in a safe manner. (1910.176) _____

48. High-lift trucks have overhead guards and working horn. (1910.178)_____

49. Where lift trucks are used, all aisles are clear of obstruction. (1910.178) _____

50. Lift trucks have load limit posted visible to operator. (1910.178) _____

51. Operators of lift trucks have been instructed and trained as to use; training should be documented. (1910.178) _____

52. Machines, presses, grinders, saws, etc., are properly guarded to protect employees from hazards created by: (1910.219) _____

a. Point of operation
b. Nip points
c. Rotating parts
d. Flying chips and sparks

53. All mechanically powered transmission apparatus 7 feet or less above floor or work platform is guarded. (1910.219) _____
These include:

a. V-belts, shafts, pulleys
b. Chain and sprocket drives
c. Flywheels

54. Compressed air cleaning equipment has been limited to less than 30 psi and is chip-guarded. (1910.242) _____

55. Portable power wood-working tools or equipment have deadman guards or switches and are so placed as to prevent accidental operation when not in use. (1910.243)_____

56. Welding equipment inspected for hazards. (1910.252) _____

57. Oxygen and acetylene tanks stored separately. (1910.252) _____

58. Unused or abandoned electric receptacles are plate-covered. (1910.309) _____

59. Drop cords, trouble lights, and extension cords are three-wire, rubber coated, and three prong type. (1910.309) _____

60. Circuit breaker switches identify what circuits they control. (1910.309) _____

61. Access to electrical panels is unobstructed. (1910.309) _____

62. Employee safety meetings scheduled and held at regular intervals. (Safety check only)_____

63. Adequate lighting in work areas for work or job being performed. (Safety check only)_____

64. Safety rules posted and distributed. (Safety check only) _____

Prepared by Russ Phifer, WC Environmental, LLC 2005.
Note: while this checklist covers many OSHA requirements, it is not intended to be inclusive of all OSHA regulatory requirements.

Chemical Hygiene Officer Duties

1. Provide Training
2. Assist Departments and Researchers with Implementation
3. Manage Hazardous Waste Program
4. Update CHP/Review
5. Conduct Inspections/ Audits
6. MSDS Maintenance
7. Maintain Hazardous Materials Chemical Inventory
8. Write Chemical Hygiene Plan
9. Check Performance of Fume Hoods
10. Respond to Safety Related Inquiries
11. Recommend Safety And Health Practices for Proposed Response
12. Serve as Regular Agency Contact
13. Advise and Counsel on Storage and Handling
14. Conduct or Arrange Sampling
15. Assist Director of Environmental Health & Safety to Determine Research Proposals; Satisfy CHP and Other Regulations
16. Review MSDSs
17. Manage Hazardous Communications Program
18. Purchasing, Installing, Maintaining Safety Supplies
19. Maintain PPE Inventory
20. Keep Health Safety & Environmental Records
21. Develop Specific Chemical Standard Operating Procedures
22. Seek Ways to Improve the CHP and Safety Programs
23. Develop and Maintain the CHP Safety Committee
24. Verify & Improve OSHA Compliance
25. Monitor Use & Procurement of Chemicals
26. Shower/ Eyewash Maintenance
27. Teach Lab Safety / Hazardous Waste Courses
28. Provide Regulatory Information Updates
29. Keep Training Records
30. Provide Chemical Safety Reference Materials
31. Plan Community RTK/ Emergency Response
32. Enforce CHP Rules
33. MSDS Preparation
34. Shipment Labeling

35. Check/ Maintain Egress Lighting
36. Compressed Gases
37. Maintain Lock-Out Tag-Out Equipment
38. Maintain OSHA/EPA Regulatory Understanding
39. Conduct Incident Investigations
40. Development of CHP Measurements
41. Supervise Work Study Students
42. Participate in Division/ Department Staff Meetings
43. Prepare Audit Materials
44. Maintain Prior Approval Program
45. Lab Design Review
46. Review Lab Accidents
47. Conduct Training For Non-Lab Workers
48. Maintain Spill Records
49. Report Chemical Hazards and Recommend Corrective Actions
50. Become Familiar with Labs/Campus Facilities and Chemical Use
51. Coordinate Environmental Health and Safety Newsletter Production
52. Participate in Developing a WebPage

CHO Duties: Beyond the Job Description

1. Respond to other Safety & Health Concerns
2. Hazard Communication
3. Indoor Air Quality
4. Respiratory Protocol
5. Hearing Conservation
6. Confined Space Entry
7. Radiation
8. Biosafety Issues
9. Asbestos Management
10. Ventilation
11. General Environmental Health & Safety Resource
12. Ergonomics
13. Lab Design Review
14. Underground Storage Tanks
15. Soil Contamination
16. Industrial Hygiene
17. Toxicology
18. Environmental Compliance
19. Environmental Health & Safety
20. Computer Support
21. Laboratory Technical Duties: Set-up/ Take Down Experimental Apparatus

The OSHA Laboratory Standard

1910.1450(a)
Scope and application.

1910.1450(a)(1)
This section shall apply to all employers engaged in the laboratory use of hazardous chemicals as defined below.

1910.1450(a)(2)
Where this section applies, it shall supersede, for laboratories, the requirements of all other OSHA health standards in 29 CFR part 1910, subpart Z, except as follows:

1910.1450(a)(2)(i)
For any OSHA health standard, only the requirement to limit employee exposure to the specific permissible exposure limit shall apply for laboratories, unless that particular standard states otherwise or unless the conditions of paragraph (a)(2)(iii) of this section apply.

1910.1450(a)(2)(ii)
Prohibition of eye and skin contact where specified by any OSHA health standard shall be observed.

1910.1450(a)(2)(iii)
Where the action level (or in the absence of an action level, the permissible exposure limit) is routinely exceeded for an OSHA regulated substance with exposure monitoring and medical surveillance requirements paragraphs (d) and (g)(1)(ii) of this section shall apply.

1910.1450(a)(3)
This section shall not apply to:

1910.1450(a)(3)(i)
Uses of hazardous chemicals which do not meet the definition of laboratory use, and in such cases, the employer shall comply with the relevant standard in 29 CFR part 1910, subpart Z, even if such use occurs in a laboratory.

1910.1450(a)(3)(ii)
Laboratory uses of hazardous chemicals which provide no potential for employee exposure. Examples of such conditions might include:

1910.1450(a)(3)(ii)(A)
Procedures using chemically-impregnated test media such as Dip-and-Read tests where a reagent strip is dipped into the specimen to be tested and the results are interpreted by comparing the color reaction to a color chart supplied by the manufacturer of the test strip; and

1910.1450(a)(3)(ii)(B)
Commercially prepared kits such as those used in performing pregnancy tests in which all of the reagents needed to conduct the test are contained in the kit.

1910.1450(b)
Definitions —

Action level means a concentration designated in 29 CFR part 1910 for a specific substance, calculated as an eight (8)- hour time-weighted average, which initiates certain required activities such as exposure monitoring and medical surveillance.

Assistant Secretary means the Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, or designee.

Carcinogen (see *select carcinogen*).

Chemical Hygiene Officer means an employee who is designated by the employer, and who is qualified by training or experience, to provide technical guidance in the development and implementation of the provisions of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer's organizational structure.

Chemical Hygiene Plan means a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that (i) are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace and (ii) meets the requirements of paragraph (e) of this section.

Emergency means any occurrence such as, but not limited to, equipment failure, rupture of containers or failure of control equipment which results in an uncontrolled release of a hazardous chemical into the workplace.

Employee means an individual employed in a laboratory workplace who may be exposed to hazardous chemicals in the course of his or her assignments.

Hazardous chemical means any chemical which is classified as health hazard or simple asphyxiant in accordance with the Hazard Communication Standard (§1910.1200).

Health hazard means a chemical that is classified as posing one of the following hazardous effects: Acute toxicity (any route of exposure); skin corrosion or irritation; serious eye damage or eye irritation; respiratory or skin sensitization; germ cell mutagenicity; carcinogenity; reproductive toxicity; specific target organ toxicity (single or repeated exposure); aspiration hazard. The criteria for determining whether a chemical is classified as a health hazard are detailed in appendix A of the Hazard Communication Standard (§1910.1200) and §1910.1200(c) (definition of "simple asphyxiant").

Laboratory means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.

Laboratory scale means work with substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

Laboratory-type hood means a device located in a laboratory, enclosure on five sides with a moveable sash or fixed partial enclosed on the remaining side; constructed and maintained to draw air from the laboratory and to prevent or minimize the escape of air contaminants into the laboratory; and allows chemical manipulations to be conducted in the enclosure without insertion of any portion of the employee's body other than hands and arms.

Walk-in hoods with adjustable sashes meet the above definition provided that the sashes are adjusted during use so that the airflow and the exhaust of air contaminants are not compromised and employees do not work inside the enclosure during the release of airborne hazardous chemicals.

Laboratory use of hazardous chemicals means handling or use of such chemicals in which all of the following conditions are met:

(i) Chemical manipulations are carried out on a "laboratory scale;"

(ii) Multiple chemical procedures or chemicals are used;

(iii) The procedures involved are not part of a production process, nor in any way simulate a production process; and

(iv) "Protective laboratory practices and equipment" are available and in common use to minimize the potential for employee exposure to hazardous chemicals.

Medical consultation means a consultation which takes place between an employee and a licensed physician for the purpose of determining what medical examinations or procedures, if any, are appropriate in cases where a significant exposure to a hazardous chemical may have taken place.

Mutagen means chemicals that cause permanent changes in the amount or structure of the genetic material in a cell. Chemicals classified as mutagens in accordance with the Hazard Communication

Standard (§1910.1200) shall be considered mutagens for purposes of this section.

Physical hazard means a chemical that is classified as posing one of the following hazardous effects: Explosive; flammable (gases, aerosols, liquids, or solids); oxidizer (liquid, solid, or gas); self reactive; pyrophoric (gas, liquid or solid); self-heating; organic peroxide; corrosive to metal; gas under pressure; in contact with water emits flammable gas; or combustible dust. The criteria for determining whether a chemical is classified as a physical hazard are in appendix B of the Hazard Communication Standard (§1910.1200) and §1910.1200(c) (definitions of "combustible dust" and "pyrophoric gas").

Protective laboratory practices and equipment means those laboratory procedures, practices and equipment accepted by laboratory health and safety experts as effective, or that the employer can show to be effective, in minimizing the potential for employee exposure to hazardous chemicals.

Reproductive toxins mean chemicals that affect the reproductive capabilities including adverse effects on sexual function and fertility in adult males and females, as well as adverse effects on the development of the offspring. Chemicals classified as reproductive toxins in accordance with the Hazard Communication Standard (§1910.1200) shall be considered reproductive toxins for purposes of this section.

Select carcinogen means any substance which meets one of the following criteria:

(i) It is regulated by OSHA as a carcinogen; or

(ii) It is listed under the category, "known to be carcinogens," in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or

(iii) It is listed under Group 1 ("carcinogenic to humans") by the International Agency for Research on Cancer Monographs (IARC) (latest editions); or

(iv) It is listed in either Group 2A or 2B by IARC or under the category, "reasonably anticipated to be carcinogens" by NTP, and causes statistically significant tumor incidence in experimental animals in accordance with any of the following criteria:

(A) After inhalation exposure of 6–7 hours per day, 5 days per week, for a significant portion of a lifetime to dosages of less than 10 mg/m^3;
(B) After repeated skin application of less than 300 (mg/kg of body weight) per week; or
(C) After oral dosages of less than 50 mg/kg of body weight per day.

1910.1450(c)
Permissible exposure limits.
For laboratory uses of OSHA regulated substances, the employer shall assure that laboratory employees' exposures to such substances do not exceed the permissible exposure limits specified in 29 CFR part 1910, subpart Z.

1910.1450(d)
Employee exposure determination --

1910.1450(d)(1)
Initial monitoring. The employer shall measure the employee's exposure to any substance regulated by a standard which requires monitoring if there is reason to believe that exposure levels for that substance routinely exceed the action level (or in the absence of an action level, the PEL).

1910.1450(d)(2)
Periodic monitoring. If the initial monitoring prescribed by paragraph (d)(1) of this section discloses employee exposure over the action level (or in the absence of an action level, the PEL), the employer shall immediately comply with the exposure monitoring provisions of the relevant standard.

1910.1450(d)(3)

Termination of monitoring. Monitoring may be terminated in accordance with the relevant standard.

1910.1450(d)(4)

***Employee notification of monitoring results*.** The employer shall, within 15 working days after the receipt of any monitoring results, notify the employee of these results in writing either individually or by posting results in an appropriate location that is accessible to employees.

1910.1450(e)

Chemical hygiene plan –

General. (Appendix A of this section is non-mandatory but provides guidance to assist employers in the development of the Chemical Hygiene Plan).

1910.1450(e)(1)

Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan which is:

1910.1450(e)(1)(i)

Capable of protecting employees from health hazards associated with hazardous chemicals in that laboratory and

1910.1450(e)(1)(ii)

Capable of keeping exposures below the limits specified in paragraph (c) of this section.

1910.1450(e)(2)

The Chemical Hygiene Plan shall be readily available to employees, employee representatives and, upon request, to the Assistant Secretary.

1910.1450(e)(3)

The Chemical Hygiene Plan shall include each of the following elements and shall indicate specific measures that the employer will take to ensure laboratory employee protection;

1910.1450(e)(3)(i)

Standard operating procedures relevant to safety and health considerations to be followed when laboratory work involves the use of hazardous chemicals;

1910.1450(e)(3)(ii)

Criteria that the employer will use to determine and implement control measures to reduce employee exposure to hazardous chemicals including engineering controls, the use of personal protective equipment and hygiene practices; particular attention shall be given to the selection of control measures for chemicals that are known to be extremely hazardous;

1910.1450(e)(3)(iii)

A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment;

1910.1450(e)(3)(iv)

Provisions for employee information and training as prescribed in paragraph (f) of this section;

1910.1450(e)(3)(v)

The circumstances under which a particular laboratory operation, procedure or activity shall require prior approval from the employer or the employer's designee before implementation;

1910.1450(e)(3)(vi)

Provisions for medical consultation and medical examinations in accordance with paragraph (g) of this section;

1910.1450(e)(3)(vii)
Designation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer, and, if appropriate, establishment of a Chemical Hygiene Committee; and

1910.1450(e)(3)(viii)
Provisions for additional employee protection for work with particularly hazardous substances. These include "select carcinogens," reproductive toxins and substances which have a high degree of acute toxicity. Specific consideration shall be given to the following provisions which shall be included where appropriate:

1910.1450(e)(3)(viii)(A)
Establishment of a designated area;

1910.1450(e)(3)(viii)(B)
Use of containment devices such as fume hoods or glove boxes;

1910.1450(e)(3)(viii)(C)
Procedures for safe removal of contaminated waste; and

1910.1450(e)(3)(viii)(D)
Decontamination procedures.

1910.1450(e)(4)
The employer shall review and evaluate the effectiveness of the Chemical Hygiene Plan at least annually and update it as necessary.

1910.1450(f)
***Employee information and training*.**

1910.1450(f)(1)
The employer shall provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area.
1910.1450(f)(2)
Such information shall be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training shall be determined by the employer.
1910.1450(f)(3)
Information. Employees shall be informed of:

1910.1450(f)(3)(i)
The contents of this standard and its appendices which shall be made available to employees;

1910.1450(f)(3)(ii)
The location and availability of the employer's Chemical Hygiene Plan;

1910.1450(f)(3)(iii)
The permissible exposure limits for OSHA regulated substances or recommended exposure limits for other hazardous chemicals where there is no applicable OSHA standard;

1910.1450(f)(3)(iv)
Signs and symptoms associated with exposures to hazardous chemicals used in the laboratory; and

1910.1450(f)(3)(v)
The location and availability of known reference material on the hazards, safe handling, storage and disposal of hazardous chemicals found in the laboratory including, but not limited to, safety data sheets received from the chemical supplier.

1910.1450(f)(4)
Training.

1910.1450(f)(4)(i)
Employee training shall include:

1910.1450(f)(4)(i)(A)
Methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

1910.1450(f)(4)(i)(B)
The physical and health hazards of chemicals in the work area
and **1910.1450(f)(4)(i)(C)**
The measures employees can take to protect themselves from these hazards, including specific procedures the employer has implemented to protect employees from exposure to hazardous chemicals, such as appropriate work practices, emergency procedures, and personal protective equipment to be used.

1910.1450(f)(4)(ii)
The employee shall be trained on the applicable details of the employer's written Chemical Hygiene Plan.

1910.1450(g)
***Medical consultation and medical examinations*.**

1910.1450(g)(1)
The employer shall provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations which the examining physician determines to be necessary, under the following circumstances:

1910.1450(g)(1)(i)
Whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory, the employee shall be provided an opportunity to receive an appropriate medical examination.

1910.1450(g)(1)(ii)
Where exposure monitoring reveals an exposure level routinely above the action level (or in the absence of an action level, the PEL) for an OSHA regulated substance for which there are exposure monitoring and medical surveillance requirements, medical surveillance shall be established for the affected employee as prescribed by the particular standard.

1910.1450(g)(1)(iii)
Whenever an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee shall be provided an opportunity for a medical consultation. Such consultation shall be for the purpose of determining the need for a medical examination.

1910.1450(g)(2)
All medical examinations and consultations shall be performed by or under the direct supervision of a licensed physician and shall be provided without cost to the employee, without loss of pay and at a reasonable time and place.

1910.1450(g)(3)
Information provided to the physician. The employer shall provide the following information to the physician:

1910.1450(g)(3)(i)
The identity of the hazardous chemical(s) to which the employee may have been exposed;

1910.1450(g)(3)(ii)
A description of the conditions under which the exposure occurred including quantitative exposure data, if available; and

1910.1450(g)(3)(iii)
A description of the signs and symptoms of exposure that the employee is experiencing, if any.

1910.1450(g)(4)
Physician's written opinion.

1910.1450(g)(4)(i)
For examination or consultation required under this standard, the employer shall obtain a written opinion from the examining physician which shall include the following:

1910.1450(g)(4)(i)(A)
Any recommendation for further medical follow-up;

1910.1450(g)(4)(i)(B)
The results of the medical examination and any associated tests;

1910.1450(g)(4)(i)(C)
Any medical condition which may be revealed in the course of the examination which may place the employee at increased risk as a result of exposure to a hazardous workplace; and

1910.1450(g)(4)(i)(D)
A statement that the employee has been informed by the physician of the results of the consultation or medical examination and any medical condition that may require further examination or treatment.

1910.1450(g)(4)(ii)
The written opinion shall not reveal specific findings of diagnoses unrelated to occupational exposure.

1910.1450(h)
***Hazard identification*.**

1910.1450(h)(1)
With respect to labels and safety data sheets:

1910.1450(h)(1)(i)
Employers shall ensure that labels on incoming containers of hazardous chemicals are not removed or defaced.

1910.1450(h)(1)(ii)
Employers shall maintain any safety data sheets that are received with incoming shipments of hazardous chemicals, and ensure that they are readily accessible to laboratory employees.

1910.1450(h)(2)
The following provisions shall apply to chemical substances developed in the laboratory:

1910.1450(h)(2)(i)
If the composition of the chemical substance which is produced exclusively for the laboratory's use is known, the employer shall determine if it is a hazardous chemical as defined in paragraph (b) of this section. If the chemical is determined to be hazardous, the employer shall provide appropriate training as required under paragraph (f) of this section.

1910.1450(h)(2)(ii)
If the chemical produced is a byproduct whose composition is not known, the employer shall assume that the substance is hazardous and shall implement paragraph (e) of this section.

1910.1450(h)(2)(iii)

If the chemical substance is produced for another user outside of the laboratory, the employer shall comply with the Hazard Communication Standard (29 CFR 1910.1200) including the requirements for preparation of safety data sheets and labeling.

1910.1450(i)

Use of respirators. Where the use of respirators is necessary to maintain exposure below permissible exposure limits, the employer shall provide, at no cost to the employee, the proper respiratory equipment. Respirators shall be selected and used in accordance with the requirements of 29 CFR 1910.134.

1910.1450(j)

Recordkeeping.

1910.1450(j)(1)

The employer shall establish and maintain for each employee an accurate record of any measurements taken to monitor employee exposures and any medical consultation and examinations including tests or written opinions required by this standard.

1910.1450(j)(2)

The employer shall assure that such records are kept, transferred, and made available in accordance with 29 CFR 1910.1020.

1910.1450(k)

[Reserved]

1910.1450(l)

***Appendices*.** The information contained in the appendices is not intended, by itself, to create any additional obligations not otherwise imposed or to detract from any existing obligation.

[55 FR 3327, Jan. 31, 1990; 55 FR 7967, March, 6, 1990; 55 FR 12777, March 30, 1990; 61 FR 5507, Feb. 13, 1996; 71 FR 16674, April 3, 2006; 77 FR 17887, March 26, 2012]

Appendix A
National Research Council Recommendations Concerning Chemical Hygiene in Laboratories (Non-Mandatory)

To assist employers in developing an appropriate laboratory Chemical Hygiene Plan (CHP), the following non-mandatory recommendations were based on the National Research Council's (NRC) 2011 edition of "Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards." This reference, henceforth referred to as "Prudent Practices," is available from the National Academies Press, 500 Fifth Street NW., Washington DC 20001 (www.nap.edu). "Prudent Practices" is cited because of its wide distribution and acceptance and because of its preparation by recognized authorities in the laboratory community through the sponsorship of the NRC. However, these recommendations do not modify any requirements of the OSHA Laboratory standard. This appendix presents pertinent recommendations from "Prudent Practices," organized into a form convenient for quick reference during operation of a laboratory and during development and application of a CHP. For a detailed explanation and justification for each recommendation, consult "Prudent Practices."

"Prudent Practices" deals with both general laboratory safety and many types of chemical hazards, while the Laboratory standard is concerned primarily with chemical health hazards as a result of chemical exposures. The recommendations from "Prudent Practices" have been paraphrased, combined, or otherwise reorganized in order to adapt them for this purpose. However, their sense has not been changed.

Section F contains information from the U.S. Chemical Safety Board's (CSB) Fiscal Year 2011 Annual Performance and Accountability report and Section F contains recommendations extracted from the CSB's 2011 case study, "Texas Tech University Laboratory Explosion," available from: http://www.csb.gov/.

Culture of Safety

With the promulgation of the Occupational Safety and Health Administration (OSHA) Laboratory standard (29 CFR 1910.1450), a culture of safety consciousness, accountability, organization, and education has developed in industrial, governmental, and academic laboratories. Safety and training programs have been implemented to promote the safe handling of chemicals from ordering to disposal, and to train laboratory personnel in safe practices. Laboratory personnel must realize that the welfare and safety of each individual depends on clearly defined attitudes of teamwork and personal responsibility. Learning to participate in this culture of habitual risk assessment, experiment planning, and consideration of worst-case possibilities—for oneself and one's fellow workers—is as much part of a scientific education as learning the theoretical background of experiments or the step-by-step protocols for doing them in a professional manner. A crucial component of chemical education for all personnel is to nurture basic attitudes and habits of prudent behavior so that safety is a valued and inseparable part of all laboratory activities throughout their career.

Over the years, special techniques have been developed for handling chemicals safely. Local, state, and federal regulations hold institutions that sponsor chemical laboratories accountable for providing safe working environments. Beyond regulation, employers and scientists also hold themselves personally responsible for their own safety, the safety of their colleagues and the safety of the general public. A sound safety organization that is respected by all requires the participation and support of laboratory administrators, workers, and students. A successful health and safety program requires a daily commitment from everyone in the organization. To be most effective, safety and health must be balanced with, and incorporated into, laboratory processes. A strong safety and health culture is the result of positive workplace attitudes—from the chief executive officer to the newest hire; involvement and buy-in of all members of the workforce; mutual, meaningful, and measurable safety and health improvement goals; and policies and procedures that serve as reference tools, rather than obscure rules.

In order to perform their work in a prudent manner, laboratory personnel must consider the health, physical, and environmental hazards of the chemicals they plan to use in an experiment. However, the ability to accurately identify and assess laboratory hazards must be taught and encouraged through training and ongoing organizational support. This training must be at the core of every good health and safety program. For management to lead, personnel to assess worksite hazards, and hazards to be eliminated or controlled, everyone involved must be trained.

A. General Principles

1. Minimize All Chemical Exposures and Risks

Because few laboratory chemicals are without hazards, general precautions for handling all laboratory chemicals should be adopted. In addition to these general guidelines, specific guidelines for chemicals that are used frequently or are particularly hazardous should be adopted.

Laboratory personnel should conduct their work under conditions that minimize the risks from both known and unknown hazardous substances. Before beginning any laboratory work, the hazards and risks associated with an experiment or activity should be determined and the necessary safety precautions implemented. Every laboratory should develop facility -specific policies and procedures for the highest-risk materials and procedures used in their laboratory. To identify these, consideration should be given to past accidents, process conditions, chemicals used in large volumes, and particularly hazardous chemicals.

Perform Risk Assessments for Hazardous Chemicals and Procedures Prior to Laboratory Work:

(a) Identify chemicals to be used, amounts required, and circumstances of use in the experiment. Consider any special employee or laboratory conditions that could create or increase a hazard. Consult sources of safety and health information and experienced scientists to ensure that those conducting the risk assessment have sufficient expertise.

(b) Evaluate the hazards posed by the chemicals and the experimental conditions. The evaluation should cover toxic, physical, reactive, flammable, explosive, radiation, and biological hazards, as well as any other potential hazards posed by the chemicals.

(c) For a variety of physical and chemical reasons, reaction scale-ups pose special risks, which merit additional prior review and precautions.
(d) Select appropriate controls to minimize risk, including use of engineering controls, administrative

controls, and personal protective equipment (PPE) to protect workers from hazards. The controls must ensure that OSHA's Permissible Exposure Limits (PELs) are not exceeded. Prepare for contingencies and be aware of the institutional procedures in the event of emergencies and accidents.

One sample approach to risk assessment is to answer these five questions:

(a) What are the hazards?
(b) What is the worst thing that could happen?
(c) What can be done to prevent this from happening?
(d) What can be done to protect from these hazards?
(e) What should be done if something goes wrong?

2. Avoid Underestimation of Risk

Even for substances of no known significant hazard, exposure should be minimized; when working with substances that present special hazards, special precautions should be taken. Reference should be made to the safety data sheet (SDS) that is provided for each chemical. Unless otherwise known, one should assume that any mixture will be more toxic than its most toxic component and that all substances of unknown toxicity are toxic.
Determine the physical and health hazards associated with chemicals before working with them. This determination may involve consulting literature references, laboratory chemical safety summaries (LCSSs), SDSs, or other reference materials. Consider how the chemicals will be processed and determine whether the changing states or forms will change the nature of the hazard. Review your plan, operating limits, chemical evaluations and detailed risk assessment with other chemists, especially those with experience with similar materials and protocols.

Before working with chemicals, know your facility's policies and procedures for how to handle an accidental spill or fire. Emergency telephone numbers should be posted in a prominent area. Know the location of all safety equipment and the nearest fire alarm and telephone.

3. Adhere to the Hierarchy of Controls

The hierarchy of controls prioritizes intervention strategies based on the premise that the best way to control a hazard is to systematically remove it from the workplace, rather than relying on employees to reduce their exposure. The types of measures that may be used to protect employees (listed from most effective to least effective) are: engineering controls, administrative controls, work practices, and PPE. Engineering controls, such as chemical hoods, physically separate the employee from the hazard. Administrative controls, such as employee scheduling, are established by management to help minimize the employees' exposure time to hazardous chemicals. Work practice controls are tasks that are performed in a designated way to minimize or eliminate hazards. Personal protective equipment and apparel are additional protection provided under special circumstances and when exposure is unavoidable.

Face and eye protection is necessary to prevent ingestion and skin absorption of hazardous chemicals. At a minimum, safety glasses, with side shields, should be used for all laboratory work. Chemical splash goggles are more appropriate than regular safety glasses to protect against hazards such as projectiles, as well as when working with glassware under reduced or elevated pressures (e.g., sealed tube reactions), when handling potentially explosive compounds (particularly during distillations), and when using glassware in high-temperature operations. Do not allow laboratory chemicals to come in contact with skin. Select gloves carefully to ensure that they are impervious to the chemicals being used and are of correct thickness to allow reasonable dexterity while also ensuring adequate barrier protection.

Lab coats and gloves should be worn when working with hazardous materials in a laboratory. Wear closed-toe shoes and long pants or other clothing that covers the legs when in a laboratory where hazardous chemicals are used. Additional protective clothing should be used when there is significant potential for skin-contact exposure to chemicals. The protective characteristics of this clothing must be matched to the hazard. Never wear gloves or laboratory coats outside the laboratory or into areas where food is stored and consumed.

4. Provide Laboratory Ventilation

The best way to prevent exposure to airborne substances is to prevent their escape into the working atmosphere by the use of hoods and other ventilation devices. To determine the best choice for laboratory ventilation using engineering controls for personal protection, employers are referred to Table 9.3 of the 2011 edition of ‘‘Prudent Practices.’’ Laboratory chemical hoods are the most important components used to protect laboratory personnel from exposure to hazardous chemicals.

(a) Toxic or corrosive chemicals that require vented storage should be stored in vented cabinets instead of in a chemical hood.

(b) Chemical waste should not be disposed of by evaporation in a chemical hood.

(c) Keep chemical hood areas clean and free of debris at all times.

(d) Solid objects and materials, such as paper, should be prevented from entering the exhaust ducts as they can reduce the air flow.

(e) Chemical hoods should be maintained, monitored and routinely tested for proper performance.

A laboratory ventilation system should include the following characteristics and practices:

(a) Heating and cooling should be adequate for the comfort of workers and operation of equipment. Before modification of any building HVAC, the impact on laboratory or hood ventilation should be considered, as well as how laboratory ventilation changes may affect the building HVAC.

(b) A negative pressure differential should exist between the amount of air exhausted from the laboratory and the amount supplied to the laboratory to prevent uncontrolled chemical vapors from leaving the laboratory.

(c) Local exhaust ventilation devices should be appropriate to the materials and operations in the laboratory.

(d) The air in chemical laboratories should be continuously replaced so that concentrations of odoriferous or toxic substances do not increase during the workday.

(e) Laboratory air should not be recirculated but exhausted directly outdoors.

(f) Air pressure should be negative with respect to the rest of the building. Local capture equipment and systems should be designed only by an experienced engineer or industrial hygienist.

(g) Ventilation systems should be inspected and maintained on a regular basis. There should be no areas where air remains static or areas that have unusually high airflow velocities.

Before work begins, laboratory workers should be provided with proper training that includes how to use the ventilation equipment, how to ensure that it is functioning properly, the consequences of improper use, what to do in the event of a system failure or power outage, special considerations, and the importance of signage and postings.

5. Institute a Chemical Hygiene Program

A comprehensive chemical hygiene program is required. It should be designed to minimize exposures, injuries, illnesses and incidents. There should be a regular, continuing effort that includes program oversight, safe facilities, chemical hygiene planning, training, emergency preparedness and chemical security. The chemical hygiene program must be reviewed annually and updated as necessary whenever new processes, chemicals, or equipment is implemented. Its recommendations should be followed in all laboratories.

6. Observe the PELs and TLVs

OSHA’s Permissible Exposure Limits (PELs) must not be exceeded. The American Conference of Governmental Industrial Hygienists’ Threshold Limit Values (TLVs) should also not be exceeded.

B. Responsibilities

Persons responsible for chemical hygiene include, but are not limited to, the following:

1. Chemical Hygiene Officer

   (a) Establishes, maintains, and revises the chemical hygiene plan (CHP).

   (b) Creates and revises safety rules and regulations.

   (c) Monitors procurement, use, storage, and disposal of chemicals.

   (d) Conducts regular inspections of the laboratories, preparations rooms, and chemical storage rooms, and submits detailed laboratory inspection reports to administration.

   (e) Maintains inspection, personnel training, and inventory records.

   (f) Assists laboratory supervisors in developing and maintaining adequate facilities.

   (g) Seeks ways to improve the chemical hygiene program.

2. Department Chairperson or Director

   (a) Assumes responsibility for personnel engaged in the laboratory use of hazardous chemicals.

   (b) Provides the chemical hygiene officer (CHO) with the support necessary to implement and maintain the CHP.

   (c) After receipt of laboratory inspection report from the CHO, meets with laboratory supervisors to discuss cited violations and to ensure timely actions to protect trained laboratory personnel and facilities and to ensure that the department remains in compliance with all applicable federal, state, university, local and departmental codes and regulations.

   (d) Provides budgetary arrangements to ensure the health and safety of the departmental personnel, visitors, and students.

3. Departmental Safety Committee reviews accident reports and makes appropriate recommendations to the department chairperson regarding proposed changes in the laboratory procedures.

4. Laboratory Supervisor or Principal Investigator has overall responsibility for chemical hygiene in the laboratory, including responsibility to:

   (a) Ensure that laboratory personnel comply with the departmental CHP and do not operate equipment or handle hazardous chemicals without proper training and authorization.

   (b) Always wear personal protective equipment (PPE) that is compatible to the degree of hazard of the chemical.

   (c) Follow all pertinent safety rules when working in the laboratory to set an example.

   (d) Review laboratory procedures for potential safety problems before assigning to other laboratory personnel.

   (e) Ensure that visitors follow the laboratory rules and assumes responsibility for laboratory visitors.

   (f) Ensure that PPE is available and properly used by each laboratory employee and visitor.

   (g) Maintain and implement safe laboratory practices.

   (h) Provide regular, formal chemical hygiene and housekeeping inspections, including routine inspections of emergency equipment;

(i) Monitor the facilities and the chemical fume hoods to ensure that they are maintained and function properly. Contact the appropriate person, as designated by the department chairperson, to report problems with the facilities or the chemical fume hoods.

5. Laboratory Personnel

(a) Read, understand, and follow all safety rules and regulations that apply to the work area;

(b) Plan and conduct each operation in accordance with the institutional chemical hygiene procedures;

(c) Promote good housekeeping practices in the laboratory or work area.

(d) Notify the supervisor of any hazardous conditions or unsafe work practices in the work area.

(e) Use PPE as appropriate for each procedure that involves hazardous chemicals.

C. The Laboratory Facility

General Laboratory Design Considerations Wet chemical spaces and those with a higher degree of hazard should be separated from other spaces by a wall or protective barrier wherever possible. If the areas cannot be separated, then workers in lower hazard spaces may require additional protection from the hazards in connected spaces.

1. Laboratory Layout and Furnishing

(a) Work surfaces should be chemically resistant, smooth, and easy to clean.

(b) Hand washing sinks for hazardous materials may require elbow, foot, or electronic controls for safe operation.

(c) Wet laboratory areas should have chemically resistant, impermeable, slipresistant flooring.
(d) Walls should be finished with a material that is easy to clean and maintain.

(e) Doors should have view panels to prevent accidents and should open in the direction of egress.

(f) Operable windows should not be present in laboratories, particularly if there are chemical hoods or other local ventilation systems present.

2. Safety Equipment and Utilities

(a) An adequate number and placement of safety showers, eyewash units, and fire extinguishers should be provided for the laboratory.

(b) Use of water sprinkler systems is resisted by some laboratories because of the presence of electrical equipment or waterreactive materials, but it is still generally safer to have sprinkler systems installed. A fire large enough to trigger the sprinkler system would have the potential to cause far more destruction than the local water damage.

D. Chemical Hygiene Plan (CHP)

The OSHA Laboratory standard defines a CHP as ‘‘a written program developed and implemented by the employer which sets forth procedures, equipment, personal protective equipment and work practices that are capable of protecting employees from the health hazards presented by hazardous chemicals used in that particular workplace.’’ (29 CFR 1910.1450(b)). The Laboratory Standard requires a CHP: ‘‘Where hazardous chemicals as defined by this standard are used in the workplace, the employer shall develop and carry out the provisions of a written Chemical Hygiene Plan.’’ (29 CFR 1910.1450(e)(1)) . The CHP is the foundation of the laboratory safety program and must be reviewed and updated, as needed, and at least on an annual basis to reflect changes in policies and personnel. A CHP should be facility specific and can assist in promoting a culture of safety to protect workers from exposure to hazardous materials.

1. The Laboratory's CHP must be readily available to workers and capable of protecting workers from health hazards and minimizing exposure. Include the following topics in the CHP:

(a) Individual chemical hygiene responsibilities;

(b) Standard operating procedures;
(c) Personal protective equipment, engineering controls and apparel;

(d) Laboratory equipment;

(e) Safety equipment;

(f) Chemical management;

(g) Housekeeping;

(h) Emergency procedures for accidents and spills;

(i) Chemical waste;

(j) Training;

(k) Safety rules and regulations;

(l) Laboratory design and ventilation;

(m) Exposure monitoring;

(n) Compressed gas safety;

(o) Medical consultation and examination.

It should be noted that the nature of laboratory work may necessitate addressing biological safety, radiation safety and security issues.

2. Chemical Procurement, Distribution, and Storage

Prudent chemical management includes the following processes:

Chemical Procurement:

(a) Information on proper handling, storage, and disposal should be known to those who will be involved before a substance is received.

(b) Only containers with adequate identifying labels should be accepted.

(c) Ideally, a central location should be used for receiving all chemical shipments.

(d) Shipments with breakage or leakage should be refused or opened in a chemical hood.

(e) Only the minimum amount of the chemical needed to perform the planned work should be ordered.

(f) Purchases of high risk chemicals should be reviewed and approved by the CHO.

(g) Proper protective equipment and handling and storage procedures should be in place before receiving a shipment.

Chemical Storage:

(a) Chemicals should be separated and stored according to hazard category and compatibility.

(b) SDS and label information should be followed for storage requirements.

(c) Maintain existing labels on incoming containers of chemicals and other materials.
(d) Labels on containers used for storing hazardous chemicals must include the chemical identification and appropriate hazard warnings.

(e) The contents of all other chemical containers and transfer vessels, including, but not limited to, beakers, flasks, reaction vessels, and process equipment, should be properly identified.

(f) Chemical shipments should be dated upon receipt and stock rotated.

(g) Peroxide formers should be dated upon receipt, again dated upon opening, and stored away from heat and light with tightfitting, nonmetal lids.

(h) Open shelves used for chemical storage should be secured to the wall and contain 3/4-inch lips. Secondary containment devices should be used as necessary.

(i) Consult the SDS and keep incompatibles separate during transport, storage, use, and disposal.

(j) Oxidizers, reducing agents, and fuels should be stored separately to prevent contact in the event of an accident.

(k) Chemicals should not be stored in the chemical hood, on the floor, in areas of egress, on the benchtop, or in areas near heat or in direct sunlight.

(l) Laboratory-grade, flammable-rated refrigerators and freezers should be used to store sealed chemical containers of flammable liquids that require cool storage. Do not store food or beverages in the laboratory refrigerator.

(m) Highly hazardous chemicals should be stored in a well-ventilated and secure area designated for that purpose.

(n) Flammable chemicals should be stored in a spark-free environment and in approved flammable-liquid containers and storage cabinets. Grounding and bonding should be used to prevent static charge buildups when dispensing solvents.

(o) Chemical storage and handling rooms should be controlled-access areas. They should have proper ventilation, appropriate signage, diked floors, and fire suppression systems.

Chemical Handling:

(a) As described above, a risk assessment should be conducted prior to beginning work with any hazardous chemical for the first time.

(b) All SDS and label information should be read before using a chemical for the first time.

(c) Trained laboratory workers should ensure that proper engineering controls (ventilation) and PPE are in place.

Chemical Inventory:

(a) Prudent management of chemicals in any laboratory is greatly facilitated by keeping an accurate inventory of the chemicals stored.

(b) Unneeded items should be discarded or returned to the storeroom.

Transporting Chemicals:

(a) Secondary containment devices should be used when transporting chemicals.

(b) When transporting chemicals outside of the laboratory or between stockrooms and laboratories, the

transport container should be break-resistant.

(c) High-traffic areas should be avoided.

Transferring Chemicals:

(a) Use adequate ventilation (such as a fume hood) when transferring even a small amount of a particularly hazardous substance (PHS).

(b) While drum storage is not appropriate for laboratories, chemical stockrooms may purchase drum quantities of solvents used in high volumes. Ground and bond the drum and receiving vessel when transferring flammable liquids from a drum to prevent static charge buildup.

(c) If chemicals from commercial sources are repackaged into transfer vessels, the new containers should be labeled with all essential information on the original container.

Shipping Chemicals: Outgoing chemical shipments must meet all applicable Department of Transportation (DOT) regulations and should be authorized and handled by the institutional shipper.

3. Waste Management

A waste management plan should be in place before work begins on any laboratory activity. The plan should utilize the following hierarchy of practices:

(a) Reduce waste sources. The best approach to minimize waste generation is by reducing the scale of operations, reducing its formation during operations, and, if possible, substituting less hazardous chemicals for a particular operation.

(b) Reuse surplus materials. Only the amount of material necessary for an experiment should be purchased, and, if possible, materials should be reused.

(c) Recycle waste. If waste cannot be prevented or minimized, the organization should consider recycling chemicals that can be safely recovered or used as fuel.

(d) Dispose of waste properly. Sink disposal may not be appropriate. Proper waste disposal methods include incineration, treatment, and land disposal. The organization's environmental health and safety (EHS) office should be consulted in determining which methods are appropriate for different types of waste.

Collection and Storage of Waste:

(a) Chemical waste should be accumulated at or near the point of generation, under the control of laboratory workers.

(b) Each waste type should be stored in a compatible container pending transfer or disposal. Waste containers should be clearly labeled and kept sealed when not in use.

(c) Incompatible waste types should be kept separate to ensure that heat generation, gas evolution, or another reaction does not occur.

(d) Waste containers should be segregated by how they will be managed. Waste containers should be stored in a designated location that does not interfere with normal laboratory operations. Ventilated storage and secondary containment may be appropriate for certain waste types.

(e) Waste containers should be clearly labeled and kept sealed when not in use. Labels should include the accumulation start date and hazard warnings as appropriate.

(f) Non-explosive electrical systems, grounding and bonding between floors and containers, and non-sparking conductive floors and containers should be used in the central waste accumulation area to minimize fire and explosion hazards. Fire suppression systems, specialized ventilation systems, and dikes should be installed in the central waste accumulation area. Waste management workers should be trained in proper waste handling procedures as well as contingency planning and emergency response.

Trained laboratory workers most familiar with the waste should be actively involved in waste management decisions to ensure that the waste is managed safely and efficiently. Engineering controls should be implemented as necessary, and personal protective equipment should be worn by workers involved in waste management.

4. Inspection Program

Maintenance and regular inspection of laboratory equipment are essential parts of the aboratory safety program. Management should participate in the design of a laboratory inspection program to ensure that the facility is safe and healthy, workers are adequately trained, and proper procedures are being followed.

Types of inspections: The program should include an appropriate combination of routine inspections, self-audits, program audits, peer inspections, EHS inspections, and inspections by external entities.

Elements of an inspection:

(a) Inspectors should bring a checklist to ensure that all issues are covered and a camera to document issues that require correction.

(b) Conversations with workers should occur during the inspection, as they can provide valuable information and allow inspectors an opportunity to show workers how to fix problems.

(c) Issues resolved during the inspection should be noted.

(d) An inspection report containing all findings and recommendations should be prepared for management and other appropriate workers.

(e) Management should follow-up on the inspection to ensure that all corrections are implemented.

5. Medical Consultation and Examination

The employer must provide all employees who work with hazardous chemicals an opportunity to receive medical attention, including any follow-up examinations that the examining physician determines to be necessary, whenever an employee develops signs or symptoms associated with a hazardous chemical to which the employee may have been exposed in the laboratory. If an employee encounters a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure, the affected employee must be provided an opportunity for a medical consultation by a licensed physician. All medical examinations and consultations must be performed by or under the direct supervision of a licensed physician and must be provided without cost to the employee, without loss of pay and at a reasonable time and place. The identity of the hazardous chemical, a description of the incident, and any signs and symptoms that the employee may experience must be relayed to the physician.

6. Records

All accident, fatality, illness, injury, and medical records and exposure monitoring records must be retained by the institution in accordance with the requirements of state and federal regulations (see 29 CFR part 1904 and § 1910.1450(j)). Any exposure monitoring results must be provided to affected laboratory staff within 15 working days after receipt of the results (29 CFR 1910.1450(d)(4)).

7. Signs

Prominent signs of the following types should be posted:

(a) Emergency telephone numbers of emergency personnel/facilities, supervisors, and laboratory workers;

(b) Location signs for safety showers, eyewash stations, other safety and first aid equipment, and exits; and

(c) Warnings at areas or equipment where special or unusual hazards exist.

8. Spills and Accidents

Before beginning an experiment, know your facility's policies and procedures for how to handle an accidental release of a hazardous substance, a spill or a fire. Emergency response planning and training are especially important when working with highly toxic compounds. Emergency telephone numbers should be posted in a prominent area. Know the location of all safety equipment and the nearest fire alarm and telephone. Know who to notify in the event of an emergency. Be prepared to provide basic emergency treatment. Keep your co-workers informed of your activities so they can respond appropriately. Safety equipment, including spill control kits, safety shields, fire safety equipment, PPE, safety showers and eyewash units, and emergency equipment should be available in wellmarked highly visible locations in all chemical laboratories. The laboratory supervisor or CHO is responsible for ensuring that all personnel are aware of the locations of fire extinguishers and are trained in their use. After an extinguisher has been used, designated personnel must promptly recharge or replace it (29 CFR 1910.157(c)(4)). The laboratory supervisor or CHO is also responsible for ensuring proper training and providing supplementary equipment as needed.

Special care must be used when handling solutions of chemicals in syringes with needles. Do not recap needles, especially when they have been in contact with chemicals. Remove the needle and discard it immediately after use in the appropriate sharps containers. Blunt-tip needles are available from a number of commercial sources and should be used unless a sharp needle is required to puncture rubber septa or for subcutaneous injection.

For unattended operations, laboratory lights should be left on, and signs should be posted to identify the nature of the experiment and the hazardous substances in use. Arrangements should be made, if possible, for other workers to periodically inspect the operation. Information should be clearly posted indicating who to contact in the event of an emergency. Depending on the nature of the hazard, special rules, precautions, and alert systems may be necessary.

9. Training and Information

Personnel training at all levels within the organization, is essential. Responsibility and accountability throughout the organization are key elements in a strong safety and health program. The employer is required to provide employees with information and training to ensure that they are apprised of the hazards of chemicals present in their work area (29 CFR 1910.1450(f)) . This information must be provided at the time of an employee's initial assignment to a work area where hazardous chemicals are present and prior to assignments involving new exposure situations. The frequency of refresher information and training should be determined by the employer. At a minimum, laboratory personnel should be trained on their facility's specific CHP, methods and observations that may be used to detect the presence or release of a hazardous chemical (such as monitoring conducted by the employer, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released), the physical and health hazards of chemicals in the work area and means to protect themselves from these hazards. Trained laboratory personnel must know shut-off procedures in case of an emergency. All SDSs must be made available to the employees.

E. General Procedures for Working With Chemicals

The risk of laboratory injuries can be reduced through adequate training, improved engineering, good housekeeping, safe work practice and personal behavior.

1. General Rules for Laboratory Work With Chemicals

(a) Assigned work schedules should be followed unless a deviation is authorized by the laboratory supervisor.

(b) Unauthorized experiments should not be performed.

(c) Plan safety procedures before beginning any operation.

(d) Follow standard operating procedures at all times.

(e) Always read the SDS and label before using a chemical.

(f) Wear appropriate PPE at all times.

(g) To protect your skin from splashes, spills and drips, always wear long pants and closed-toe shoes.

(h) Use appropriate ventilation when working with hazardous chemicals.

(i) Pipetting should never be done by mouth.

(j) Hands should be washed with soap and water immediately after working with any laboratory chemicals, even if gloves have been worn.

(k) Eating, drinking, smoking, gum chewing, applying cosmetics, and taking medicine in laboratories where hazardous chemicals are used or stored should be strictly prohibited.

(l) Food, beverages, cups, and other drinking and eating utensils should not be stored in areas where hazardous chemicals are handled or stored.

(m) Laboratory refrigerators, ice chests, cold rooms, and ovens should not be used for food storage or preparation.

(n) Contact the laboratory supervisor, Principal Investigator, CHO or EHS office with all safety questions or concerns.

(o) Know the location and proper use of safety equipment.

(p) Maintain situational awareness.

(q) Make others aware of special hazards associated with your work.

(r) Notify supervisors of chemical sensitivities or allergies.

(s) Report all injuries, accidents, incidents, and near misses.

(t) Unauthorized persons should not be allowed in the laboratory.

(u) Report unsafe conditions to the laboratory supervisor or CHO.

(v) Properly dispose of chemical wastes.

Working Alone in the Laboratory

Working alone in a laboratory is dangerous and should be strictly avoided. There have been many tragic accidents that illustrate this danger. Accidents are unexpected by definition, which is why coworkers should always be present. Workers should coordinate schedules to avoid working alone.

Housekeeping

Housekeeping can help reduce or eliminate a number of laboratory hazards. Proper housekeeping includes appropriate labeling and storage of chemicals, safe and regular cleaning of the facility, and proper arrangement of laboratory equipment.

2. Nanoparticles and Nanomaterials

Nanoparticles and nanomaterials have different reactivities and interactions with biological systems than bulk materials, and understanding and exploiting these differences is an active area of research. However, these differences also mean that the risks and hazards associated with exposure to engineered nanomaterials are not well known. Because this is an area of ongoing research, consult trusted sources for the most up to date information available. Note that the higher reactivity of many nanoscale materials suggests that they should be treated as potential sources of ignition, accelerants, and fuel that could result in fire or explosion. Easily dispersed dry nanomaterials may pose the greatest health hazard because of the risk of inhalation. Operations involving these nanomaterials deserve more attention and more stringent controls than those where the nanomaterials are embedded in solid or suspended in liquid matrixes.

Consideration should be given to all possible routes of exposure to nanomaterials including inhalation,

ingestion, injection, and dermal contact (including eye and mucous membranes) . Avoid handling nanomaterials in the open air in a freeparticle state. Whenever possible, handle and store dispersible nanomaterials, whether suspended in liquids or in a dry particle form, in closed (tightly-sealed) containers. Unless cutting or grinding occurs, nanomaterials that are not in a free form (encapsulated in a solid or a nanocomposite) typically will not require engineering controls. If a synthesis is being performed to create nanomaterials, it is not enough to only consider the final material in the risk assessment, but consider the hazardous properties of the precursor materials as well.

To minimize laboratory personnel exposure, conduct any work that could generate engineered nanoparticles in an enclosure that operates at a negative pressure differential compared to the laboratory personnel breathing zone. Limited data exist regarding the efficacy of PPE and ventilation systems against exposure to nanoparticles. However, until further information is available, it is prudent to follow standard chemical hygiene practices. Conduct a hazard evaluation to determine PPE appropriate for the level of hazard according to the requirements set forth in OSHA's Personal Protective Equipment standard (29 CFR 1910.132).

3. Highly Toxic and Explosive/Reactive Chemicals/Materials

The use of highly toxic and explosive/ reactive chemicals and materials has been an area of growing concern. The frequency of academic laboratory incidents in the U.S. is an area of significant concern for the Chemical Safety Board (CSB). The CSB issued a case study on an explosion at Texas Tech University in Lubbock, Texas, which severely injured a graduate student handling a high-energy metal compound. Since 2001, the CSB has gathered preliminary information on 120 different university laboratory incidents that resulted in 87 evacuations, 96 injuries, and three deaths.

It is recommended that each facility keep a detailed inventory of highly toxic chemicals and explosive/reactive materials. There should be a record of the date of receipt, amount, location, and responsible individual for all acquisitions, syntheses, and disposal of these chemicals. A physical inventory should be performed annually to verify active inventory records. There should be a procedure in place to report security breaches, inventory discrepancies, losses, diversions, or suspected thefts.

Procedures for disposal of highly toxic materials should be established before any experiments begin, possibly even before the chemicals are ordered. The procedures should address methods for decontamination of any laboratory equipment that comes into contact with highly toxic chemicals. All waste should be accumulated in clearly labeled impervious containers that are stored in unbreakable secondary containment.

Highly reactive and explosive materials that may be used in the laboratory require appropriate procedures and training. An explosion can occur when a material undergoes a rapid reaction that results in a violent release of energy. Such reactions can happen spontaneously and can produce pressures, gases, and fumes that are hazardous. Some reagents pose a risk on contact with the atmosphere. It is prudent laboratory practice to use a safer alternative whenever possible.

If at all possible, substitutes for highly acute, chronic, explosive, or reactive chemicals should be considered prior to beginning work and used whenever possible.

4. Compressed Gas

Compressed gases expose laboratory personnel to both chemical and physical hazards. It is essential that these are monitored for leaks and have the proper labeling. By monitoring compressed gas inventories and disposing of or returning gases for which there is no immediate need, the laboratory can substantially reduce these risks. Leaking gas cylinders can cause serious hazards that may require an immediate evacuation of the area and activation of the emergency response system. Only appropriately trained hazmat responders may respond to stop a leaking gas cylinder under this situation.

F. Safety Recommendations—Physical Hazards

Physical hazards in the laboratory include combustible liquids, compressed gases, reactives, explosives and flammable chemicals, as well as high pressure/energy procedures, sharp objects and moving equipment. Injuries can result from bodily contact with rotating or moving objects, including mechanical equipment, parts,

and devices. Personnel should not wear loosefitting clothing, jewelry, or unrestrained long hair around machinery with moving parts.

The Chemical Safety Board has identified the following key lessons for laboratories that address both physical and other hazards:

(1) Ensure that research-specific hazards are evaluated and then controlled by developing specific written protocols and training.

(2) Expand existing laboratory safety plans to ensure that all safety hazards, including physical hazards of chemicals, are addressed.

(3) Ensure that the organization's EHS office reports directly to an identified individual/office with organizational authority to implement safety improvements.

(4) Develop a verification program that ensures that the safety provisions of the CHP are communicated, followed, and enforced at all levels within the organization.

(5) Document and communicate all laboratory near-misses and previous incidents to track safety, provide opportunities for education and improvement to drive safety changes at the university.

(6) Manage the hazards unique to laboratory chemical research in the academic environment. Utilize available practice guidance that identifies and describes methodologies to assess and control hazards.

(7) Written safety protocols and training are necessary to manage laboratory

risk. *G. Emergency Planning*

In addition to laboratory safety issues, laboratory personnel should be familiar with established facility policies and procedures regarding emergency situations. Topics may include, but are not limited to:

(1) Evacuation procedures—when it is appropriate and alternate routes;

(2) Emergency shutdown procedures—equipment shutdown and materials that should be stored safely;

(3) Communications during an emergency—what to expect, how to report, where to call or look for information;

(4) How and when to use a fire extinguisher;

(5) Security issues—preventing tailgating and unauthorized access;
(6) Protocol for absences due to travel restrictions or illness;

(7) Safe practices for power outage;

(8) Shelter in place—when it is appropriate;

(9) Handling suspicious mail or phone calls;

(10) Laboratory-specific protocols relating to emergency planning and response;

(11) Handling violent behavior in the workplace; and

(12) First-aid and CPR training, including automated external defibrillator training if available.

It is prudent that laboratory personnel are also trained in how to respond to short -term, long-term and large-scale emergencies. Laboratory security can play a role in reducing the likelihood of some emergencies and assisting in preparation and response for others. Every institution, department, and individual laboratory should consider having an emergency preparedness plan. The level of detail of the plan will vary depending on the function of the group and institutional planning efforts already in place.

Emergency planning is a dynamic process. As personnel, operations, and events change, plans will need to be

updated and modified. To determine the type and level of emergency planning needed, laboratory personnel need to perform a vulnerability assessment. Periodic drills to assist in training and evaluation of the emergency plan are recommended as part of the training program.

H. Emergency Procedures

(1) Fire alarm policy. Most organizations use fire alarms whenever a building needs to be evacuated—for any reason. When a fire alarm sounds in the facility, evacuate immediately after extinguishing all equipment flames. Check on and assist others who may require help evacuating.

(2) Emergency safety equipment. The following safety elements should be met:

a. A written emergency action plan has been provided to workers;

b. Fire extinguishers, eyewash units, and safety showers are available and tested on a regular basis; and

c. Fire blankets, first-aid equipment, fire alarms, and telephones are available and accessible.

(3) Chemical spills. Workers should contact the CHO or EHS office for instructions before cleaning up a chemical spill. All SDS and label instructions should be followed, and appropriate PPE should be worn during spill cleanup.

(4) Accident procedures. In the event of an accident, immediately notify appropriate personnel and local emergency responders. Provide an SDS of any chemical involved to the attending physician. Complete an accident report and submit it to the appropriate office or individual within 24 hours.

(5) Employee safety training program. New workers should attend safety training before they begin any activities. Additional training should be provided when they advance in their duties or are required to perform a task for the first time. Training documents should be recorded and maintained. Training should include hands-on instruction of how to use safety equipment appropriately.

(6) Conduct drills. Practice building evacuations, including the use of alternate routes. Practice shelter-in-place, including plans for extended stays. Walk the fastest route from your work area to the nearest fire alarm, emergency eye wash and emergency shower. Learn how each is activated. In the excitement of an actual emergency, people rely on what they learned from drills, practice and training.

(7) Contingency plans. All laboratories should have long-term contingency plans in place (e.g., for pandemics). Scheduling, workload, utilities and alternate work sites may need to be considered.

I. Laboratory Security

Laboratory security has evolved in the past decade, reducing the likelihood of some emergencies and assisting in preparation and response for others. Most security measures are based on the laboratory's vulnerability. Risks to laboratory security include, but are not limited to:

(1) Theft or diversion of chemicals, biologicals, and radioactive or proprietary materials, mission-critical or high-value equipment;

(2) Threats from activist groups;

(3) Intentional release of, or exposure to, hazardous materials;

(4) Sabotage or vandalism of chemicals or high-value equipment;

(5) Loss or release of sensitive information; and

(6) Rogue work or unauthorized laboratory experimentation. Security systems in the laboratory are used to detect and respond to a security breach, or a potential security breach, as well as to delay criminal activity by imposing multiple layered barriers of increasing stringency. A good laboratory security system will increase overall safety for laboratory personnel and the public, improve emergency preparedness by assisting with preplanning, and lower the organization's liability by incorporating more rigorous planning,

staffing, training, and command systems and implementing emergency communications protocols, drills, background checks, card access systems, video surveillance, and other measures. The security plan should clearly delineate response to security issues, including the coordination of institution and laboratory personnel with both internal and external responders.

[76 FR 33609, June 8, 2011; 77 FR 17888, March 26, 2012; 78 FR 4325, Jan. 22, 2013]

Appendix B
References (Non-Mandatory)

The following references are provided to assist the employer in the development of a Chemical Hygiene Plan. The materials listed below are offered as non-mandatory guidance. References listed here do not imply specific endorsement of a book, opinion, technique, policy or a specific solution for a safety or health problem. Other references not listed here may better meet the needs of a specific laboratory.

(a) Materials for the development of the Chemical Hygiene Plan:

1. American Chemical Society, Safety in Academic Chemistry Laboratories, 4th edition, 1985.
2. Fawcett, H.H. and W.S. Wood, Safety and Accident Prevention in Chemical Operations, 2nd edition, Wiley-Interscience, New York, 1982.
3. Flury, Patricia A., Environmental Health and Safety in the Hospital Laboratory, Charles C. Thomas Publisher, Springfield IL, 1978.
4. Green, Michael E. and Turk, Amos, Safety in Working with Chemicals, Macmillan Publishing Co., NY, 1978.
5. Kaufman, James A., Laboratory Safety Guidelines, Dow Chemical Co., Box 1713, Midland, MI 48640, 1977.
6. National Institutes of Health, NIH Guidelines for the Laboratory use of Chemical Carcinogens, NIH Pub. No. 81-2385, GPO, Washington, DC 20402, 1981.
7. National Research Council, Prudent Practices for Disposal of Chemicals from Laboratories, National Academy Press, Washington, DC, 1983.
8. National Research Council, Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Academy Press, Washington, DC, 1981.
9. Renfrew, Malcolm, Ed., Safety in the Chemical Laboratory, Vol. IV, J. Chem. Ed., American Chemical Society, Easlon, PA, 1981.
10. Steere, Norman V., Ed., Safety in the Chemical Laboratory, J. Chem. Ed. American Chemical Society, Easlon, PA, 18042, Vol. I, 1967, Vol. II, 1971, Vol. III, 1974.
11. Steere, Norman V., Handbook of Laboratory Safety, the Chemical Rubber Company Cleveland, OH, 1971.
12. Young, Jay A., Ed., Improving Safety in the Chemical Laboratory, John Wiley & Sons, Inc. New York, 1987.

(b) Hazardous Substances Information:

1. American Conference of Governmental Industrial Hygienists, Threshold Limit Values for Chemical Substances and Physical Agents in the Workroom Environment with Intended Changes, 6500 Glenway Avenue, Bldg. D-7, Cincinnati, OH 45211-4438.
2. Annual Report on Carcinogens, National Toxicology Program U.S. Department of Health and Human Services, Public Health Service, U.S. Government Printing Office, Washington, DC, (latest edition).
3. Best Company, Best Safety Directory, Vols. I and II, Oldwick, N.J., 1981.
4. Bretherick, L., Handbook of Reactive Chemical Hazards, 2nd edition, Butterworths, London, 1979.
5. Bretherick, L., Hazards in the Chemical Laboratory, 3rd edition, Royal Society of Chemistry, London, 1986.
6. Code of Federal Regulations, 29 CFR part 1910 subpart Z. U.S. Govt. Printing Office, Washington, DC 20402 (latest edition).
7. IARC Monographs on the Evaluation of the Carcinogenic Risk of chemicals to Man, World Health Organization Publications Center, 49 Sheridan Avenue, Albany, New York 12210 (latest editions).
8. NIOSH/OSHA Pocket Guide to Chemical Hazards. NIOSH Pub. No. 85-114, U.S. Government Printing Office, Washington, DC, 1985 (or latest edition).

9. Occupational Health Guidelines, NIOSH/OSHA. NIOSH Pub. No. 81-123 U.S. Government Printing Office, Washington, DC, 1981.
10. Patty, F.A., Industrial Hygiene and Toxicology, John Wiley & Sons, Inc., New York, NY (Five Volumes).
11. Registry of Toxic Effects of Chemical Substances, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Revised Annually, for sale from Superintendent of documents US. Govt. Printing Office, Washington, DC 20402.
12. The Merck Index: An Encyclopedia of Chemicals and Drugs. Merck and Company Inc. Rahway, N.J., 1976 (or latest edition).
13. Sax, N.I. Dangerous Properties of Industrial Materials, 5th edition, Van Nostrand Reinhold, NY., 1979.
14. Sittig, Marshall, Handbook of Toxic and Hazardous Chemicals, Noyes Publications. Park Ridge, NJ, 1981.

(c) Information on Ventilation:

1. American Conference of Governmental Industrial Hygienists Industrial Ventilation (latest edition), 6500 Glenway Avenue, Bldg. D-7, Cincinnati, Ohio 45211-4438.
2. American National Standards Institute, Inc. American National Standards Fundamentals Governing the Design and Operation of Local Exhaust Systems ANSI Z 9.2-1979 American National Standards Institute, N.Y. 1979.
3. Imad, A.P. and Watson, C.L. Ventilation Index: An Easy Way to Decide about Hazardous Liquids, Professional Safety pp 15-18, April 1980.
4. National Fire Protection Association, Fire Protection for Laboratories Using Chemicals NFPA-45, 1982. Safety Standard for Laboratories in Health Related Institutions, NFPA, 56c, 1980.
Fire Protection Guide on Hazardous Materials, 7th edition, 1978.
National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
5. Scientific Apparatus Makers Association (SAMA), Standard for Laboratory Fume Hoods, SAMA LF7-1980, 1101 16th Street, NW., Washington, DC 20036.

(d) Information on Availability of Referenced Material:

1. American National Standards Institute (ANSI), 1430 Broadway, New York, NY 10018.
2. American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103.

[55 FR 3327, Jan. 31, 1990; 57 FR 29204, July 1, 1992; 61 FR 5507, Feb. 13, 1996]

GHS Labeling

TOXICOLOGY TERMS

Acute exposure - short term exposure

Antagonism - The toxic effect of exposure to multiple chemicals is less than would be predicted from individual chemicals

Carcinogen -physical or chemical agent known to (or suspected to) cause cancers

CEL – Ceiling Exposure Limit - the ACGIH version of IDLH Chronic exposure -

long term exposure

IDHL - imminently dangerous to life and health - limit set by OSHA for instantaneous exposure

Mutagen - physical or chemical agents that produce genetic changes (mutations)

OSHA - Occupational Safety and Health Administration OR Occupational Safety and Health Act

PEL - Permissible exposure limit. OSHA's published exposure limits, based on a time weighted average

Sensitizer - a single exposure, or in some cases, several repeated exposures to a sensitizer (by inhalation, skin contact or ingestion) which may cause the person exposed to manufacture antibodies that will react with the material. Future exposures result in an allergic reaction.

STEL - short term exposure limit, usually for a 15 minute exposure

Synergism - The toxic effect of exposure to multiple chemicals is greater than would be predicted from individual chemicals

Systemic poison - one that attacks a specific system, such as circulatory or nervous

Teratogen - physical or chemical agents that produce an abnormality in a developing organism during uterine life

TLV - same as PEL, but these limits are established by the American Congress of Government & Industrial Hygienists (ACGIH)

TWA - time weighted average, normally for an 8 hour exposure

29CFR1910 Subpart Z
Toxic and Hazardous Substances

1910.1000	Air Contaminants
1910.1001	Asbestos, tremolite, anthophyllite, and actinolite
1910.1002	Coal Tar pitch volatiles
1910.1003	4-Nitrobiphenyl
1910.1004	alpha-Naphthylamine
1910.1005	{Reserved}
1910.1006	Methyl chloromethyl ether
1910.1007	3,3' – Dichlorobenzidine (and its salts)
1910.1008	bis-Chloromethyl ether
1910.1009	beta-Naphthylamine
1910.1010	Benzidine
1910.1011	4-Aminodiphenyl
1910.1012	Ethyleneimine
1910.1013	Beta-Propiolactone
1910.1014	2-Acetylaminofluorene
1910.1015	4-Dimethylaminoazobenzene
1910.1016	N-Nitrosodimethylamine
1910.1017	*Vinyl chloride
1910.1018	*Inorganic arsenic
1910.1025	*Lead
1910.1026	*Hexavalent Chromium
1910.1028	*Benzene
1910.1029	Coke oven emissions
1910.1030	Occupational exposure to bloodborne pathogens
1910.1043	Cotton dust
1910.1044	*1,2 – Dibromo-3- chloropropane
1910.1045	*Acrylonitrile
1910.1047	*Ethylene Oxide
1910.1048	*Formaldehyde
1910.1101	*Asbestos
1910.1200	Hazard Communication
1910.1450	Occupational exposure to hazardous chemicals in laboratories
1910.1499	Source of standards
1910.1500	Standards organizations

*Note: Substances with a standard which requires monitoring

Environmental Health & Safety Glossary

A

accumulation area- an area where hazardous waste is collected, generally for less than 90 days, prior to treatment, storage, or disposal.

ACGIH - American Conference of Governmental Industrial Hygienists, which develops and publishes recommended occupational exposure limits for hundreds of chemical substances and physical agents.

Acid- Any chemical with a low pH that in water solution can burn the skin or eyes. Acids turn litmus paper red and have pH values of 0 to 6.

Action Level- Term used by OSHA and NIOSH to express the level of toxicant which requires medical surveillance, usually one half of the PEL.

Activated Charcoal- Charcoal is an amorphous form of carbon formed by burning wood, nutshells, animal bones, and other carbonaceous materials. Charcoal becomes activated by heating it with steam to 800-900oC. During this treatment, a porous, submicroscopic internal structure is formed which gives it an extensive internal surface area. Activated charcoal is commonly used as a gas or vapor adsorbent in air-purifying respirators and as a solid sorbent in air-sampling.

Acute Effect- Adverse effect on a human or animal which has severe symptoms developing rapidly and coming quickly to a crisis. Also see "chronic effect."

acute hazardous waste- those discarded commercial chemical products listed in 40 CFR Section 261.33(e) and certain wastes listed in 40 CFR Sections 261.31 and 261.32. These are primarily P-List wastes, but also include certain F- and K-List wastes.

analysis- the identification and quantification of chemicals.

Adsorption- The condensation of gases, liquids, or dissolved substances on the surfaces of solids.

AIHA- American Industrial Hygiene Association.

Air- The mixture of gases that surrounds the earth; its major components are as follows: 78.08% nitrogen, 20.95% oxygen, 0.03% carbon dioxide, and 0.93% argon. Water vapor (humidity) varies.

Air-line Respirator- A respirator that is connected to a compressed breathing air source by a hose of small inside diameter. The air is delivered continuously or intermittently in a sufficient volume to meet the wearer's breathing requirements.

Air-purifying Respirator- A respirator that uses chemicals to remove specific gases and vapors form the air or that uses a mechanical filter to remove particulate matter. An air-purifying respirator must only be used when there is sufficient oxygen to sustain life and the air contaminant level is below the concentration limits of the device.

Alkali- Any chemical with a high pH that in water solution is irritating or caustic to the skin. Strong alkalies in solution are corrosive to the skin and mucous membranes. Example: sodium hydroxide, referred to as caustic soda or lye. Alkalis turn litmus paper blue and have pH values from 8 to 14. Another term for alkali is base.

Allergy- An abnormal response of a hypersensitive person to chemical and physical stimuli. Allergic manifestations of major importance occur in about 10 percent of the population.

ANSI- The American National Standards Institute is a voluntary membership organization (run with private funding) that develops consensus standards nationally for a wide variety of devices and procedures.

Asphyxiant- A vapor or gas which can cause unconsciousness or death by suffocation (lack of oxygen). Asphyxiation is one of the principal potential hazards of working in confined spaces.

ASTM- American Society for Testing and Materials.

Atmosphere-supplying respirator- A respirator that provides breathing air from a source independent of the surrounding atmosphere. There are two types: air-line and self-contained breathing apparatus.

Atmospheric pressure- The pressure exerted in all directions by the atmosphere. At sea level, mean atmospheric pressure is 29.92 inches Hg, 14.7 psi, or 407 inches w.g.

B

Base- A compound that reacts with an acid to form a salt. It is another term for alkali.

Benign- Not malignant- A benign tumor is one which does not metastasize or invade tissue. Benign tumors may still be lethal, due to pressure on vital organs.

Biohazard- A combination of the words biological hazard. Organisms or products of organisms that present a risk to humans.

Boiling point- The temperature at which the vapor pressure of a liquid equals atmospheric pressure.

C

Carbon monoxide- A colorless, odorless toxic gas produced by any process that involves the incomplete combustion of carbon-containing substances. It is emitted through the exhaust of gasoline powered vehicles.

Carcinogen- A substance or agent capable of causing or producing cancer in mammals, including humans. A chemical is considered to be a carcinogen if: a) it has been evaluated by the International Agency for Research on Cancer (IARC) and found to be a carcinogen or potential carcinogen; or b) it is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens published by the National Toxicology Program (NTP) (latest edition); or c) it is regulated by OSHA as a carcinogen.

CAS- Chemical Abstracts Service is an organization under the American Chemical Society. CAS abstracts and indexes chemical literature from all over the world in "Chemical Abstracts." "CAS Numbers" are used to identify specific chemicals or mixtures.

Ceiling limit (C) - An airborne concentration of a toxic substance in the work environment, which should never be exceeded.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act)- enacted in 1980, this law makes those persons responsible for the release of a hazardous substance liable for the cost of its cleanup. Under this act the "Superfund" was created.

CFR (Code of Federal Regulations)-EPA rules are contained in in Chapter 40.

Chemical cartridge respirator- A respirator that uses various chemical substances to purify inhaled air of certain gases and vapors. This type respirator is effective for concentrations no more than ten times the TLV of the contaminant, if the contaminant has warning properties (odor or irritation) below the TLV.

CHEMTREC- Chemical Transportation Emergency Center. Public service of the Chemical Manufacturers Association that provides immediate advice for those at the scene of hazardous materials emergencies. CHEMTREC has a 24-hour toll-free telephone number (800-424-9300) to help respond to chemical transportation emergencies.

Chronic effect- An adverse effect on a human or animal body, with symptoms which develop slowly over a long period of time or which recur frequently. Also see "acute."

Combustible liquid- Combustible liquids are those having a flash point at or above $37.8^{o}C$ ($100^{o}F$).

Concentration- The amount of a given substance in a stated unit of measure. Common methods of stating concentration are percent by weight or by volume, weight per unit volume, normality, etc.

Corrosive- A substance that causes visible destruction or permanent changes in human skin tissue at the site of contact.

CFR- Code of Federal Regulations. A collection of the regulations that have been promulgated under United States Law.

Conditionally exempt small quantity generator- generators of less than 100 kilograms of hazardous waste and 1 kilogram of acutely hazardous waste in a calendar month.

Corrosivity- one of the four characteristics of a hazardous waste, it refers to the pH of an acid or base or its ability to corrode steel.

Cutaneous- Pertaining to or affecting the skin.

CWA (Clean Water Act)-passed in 1972 and amended in 1987, this act covers releases to surface waters in the United States.

D

Degrees Celsius (Centigrade)- The temperature on a scale in which the freezing point of water is 0oC and the boiling point is 100oC. To convert to Degrees Fahrenheit, use the following formula: oF = (oC x 1.8) + 32.

Degrees Fahrenheit- The temperature on a scale in which the boiling point of water is 212oF and the freezing point is 32oF.

Density- The mass per unit volume of a substance. For example, lead is much more dense than aluminum.

Dermatitis- Inflammation of the skin from any cause.

Dermatosis- A broader term than dermatitis; it includes any cutaneous abnormality, thus encompassing folliculitis, acne, pigmentary changes, and nodules and tumors.

Discarded commercial chemical products -defined in 40 CFR Section 261.33, these wastes are chemicals that have been discarded and are typically pure grade, technical grade, or formulations in which the chemical is the sole active ingredient.

Disposal-the discharge, deposit, or placing of waste into the environment, usually by burial in landfills or injection underground. Disposal of most hazardous waste in the land is prohibited unless the wastes have been treated to meet certain levels established by EPA.

Dose-response relationship- Correlation between the amount of exposure to an agent or toxic chemical and the resulting effect on the body.

DOL- U.S. Department of Labor. OSHA and MSHA are part of the DOL.

DOT-the U.S. Department of Transportation, which governs the transportation of hazardous waste and hazardous materials.

Dusts- Solid particles generated by handling, crushing, grinding, rapid impact, detonation, and decrepitation of organic or inorganic materials, such as rock, ore, metal, coal, wood and grain. Dusts do not tend to flocculate, except under electrostatic forces; they do not diffuse in air but settle under the influence of gravity.

Dyspnea- Shortness of breath, difficult or labored breathing.

E

EPA-the U.S. Environmental Protection Agency.

Evaporation- The process by which a liquid is changed into the vapor state.

Evaporation rate- The ratio of the time required to evaporate a measured volume of a liquid to the time required to evaporate the same volume of a reference liquid (butyl acetate, ethyl ether) under ideal test conditions. The higher the ratio, the slower the evaporation rate. The evaporation rate can be useful in evaluating the health and fire hazards of a material.

F

Facility-all contiguous land, and structures on the land, used for treating, storing, or disposing of hazardous waste.

Federal Register- Publication of U.S. government documents officially promulgated under the law, documents whose validity depends upon such publication. It is published on each day following a government working day. It is, in effect, the daily supplement to the Code of Federal Regulations, CFR.

Fire point- The lowest temperature at which a material can evolve vapors fast enough to support continuous combustion.

First Aid- Emergency measures to be taken when a person is suffering from overexposure to a hazardous material, before regular medical help can be obtained.
Flammable limits- Flammables have a minimum concentration below which propagation of flame does not occur on contact with a source of ignition. This is known as the lower flammable explosive limit (LEL). There is also a maximum concentration of vapor or gas in air above which propagation of flame does not occur. This is known as the upper flammable explosive limit (UEL). These units are expressed in percent of gas or vapor in air by volume.
Flammable liquid- Any liquid having a flash point below 37.8oC (100oF), except any mixture having components with flashpoints of 100oF or higher, the total of which make up 99 percent or more of the total volume of the mixture.

Flammable range- The difference between the lower and upper flammable limits, expressed in terms of percentage of vapor or gas in air by volume, and is also often referred to as the "explosive range."
Flash point- The minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. Two tests are used - open cup and closed cup.

Fume- Airborne particulate formed by the evaporation of solid materials, e.g. metal fume emitted during welding. Usually less than one micron in diameter.

G

Gage pressure- Pressure measured with respect to atmospheric pressure.

Gas- A state of matter in which the material has very low density and viscosity; can expand and contract greatly in response to changes in temperature and pressure; easily diffuses into other gases; readily and uniformly distributes itself throughout any container. A gas can be changed to the liquid or solid state only by the combined effect of increased pressure and decreased temperature. Examples include sulfur dioxide, ozone, and carbon monoxide.

Generator-an organization that produces hazardous waste. A generator may be classified as a conditionally exempt, small quantity, or large quantity, based on the amount of hazardous waste it generates.

Generator identification number-a number assigned by the EPA to each generator.

Gram (g)- A metric unit of weight. One ounce equals 28.4 grams.

H

Hazardous material-material that poses physical or health hazards. It includes etiological agents, radioactive material, and many chemicals.

Hazardous waste- defined in 40 CFR Part 261 as any substance (a) that has a characteristic of a hazardous waste (i.e., ignitability, corrosivity, reactivity, or EP toxicity) or (b) is included in the EPA's list of hazardous wastes. Listed wastes include spent solvents and discarded commercial chemical products; the latter includes acute hazardous wastes and toxic wastes.

HEPA filter- (High Efficiency Particulate Air Filter) A disposable, extended medium, dry type filter with a particle removal efficiency of no less than 99.97 percent for 0.3m particles.

I

IARC- International Agency for Research on Cancer.

IDLH- Immediately Dangerous to Life and Health. An atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere.

Ignitability-one of the four characteristics of a hazardous waste, it refers to a waste's capability to burn.

Ignition source- Anything that provides heat, spark or flame sufficient to cause combustion/explosion.

Ignition temperature- The minimum temperature to initiate or cause self-sustained combustion in the absence of any source of ignition.

Impervious- A material that does not allow another substance to pass through or penetrate it. Frequently used to describe gloves.

Inches of mercury column- A unit used in measuring pressures. One inch of mercury column equals a pressure of 1.66 kPa (0.491 psi).

Inches of water column- A unit used in measuring pressures. One inch of water column equals a pressure of 0.25 kPa (0.036 psi).

incineration-a method of thermally treating hazardous waste by burning it under carefully controlled conditions.

Incompatible- Materials which could cause dangerous reactions from direct contact with one another.

Ingestion- Taking in by the mouth.

Inhalation- Breathing of a substance in the form of a gas, vapor, fume, mist, or dust.

Insoluble- Incapable of being dissolved in a liquid.

Irritant- A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.

L

Lab pack- large containers (usually constructed of metal, fiberboard, or plastic) filled with smaller individual containers of compatible wastes and packed with enough absorbent material (e.g., vermiculite) to absorb all the liquid, if any, should it spill.

Landfill-a disposal method for hazardous waste involving its burial.

large quantity generator- generators of more than 1,000 kilograms of hazardous waste or 1 kilogram of acutely hazardous waste in a given month.

Latent period- The time that elapses between exposure and the first manifestation of damage.

LC50- Lethal concentration that will kill 50 percent of the test animals within a specified time. See LD50.

LD50- The dose required to produce the death in 50 percent of the exposed species within a specified time.

Liter (L)- A measure of capacity - one quart equals 0.9L.

Lower explosive limit (LEL)- The lower limit of flammability of a gas or vapor at ordinary ambient temperatures expressed in percent of the gas or vapor in air by volume. This limit is assumed constant for temperatures up to 120oC (250oF) . Above this, it should be decreased by a factor of 0.7 because explosibility increases with higher temperatures.

M

Malignant- As applied to a tumor. Cancerous and capable of undergoing metastasis, or invasion of surrounding tissue.

manifest-a special shipping paper for hazardous waste, also known as the "Uniform Hazardous Waste Manifest". A description of the manifest is in the appendix of 40 CFR Section 262.

Metastasis- Transfer of the causal agent (cell or microorganism) of a disease from a primary focus to a distant one through the blood or lymphatic vessels. Also, spread of malignancy from site of primary cancer to secondary sites.

Meter- A metric unit of length, equal to about 39 inches.

Micron (micrometer, m)- A unit of length equal to one millionth of a meter, approximately 1/25,000 of an inch.

Milligram (mg)- A unit of weight in the metric system. One thousand milligrams equals one gram.

Milligrams per cubic meter (mg/m3)- Unit used to measure air concentrations of dusts, gases, mists, and fumes.

Milliliter (mL)- A metric unit used to measure volume. One milliliter equals one cubic centimeter.

Millimeter of mercury (mmHg) - The unit of pressure equal to the pressure exerted by a column of liquid mercury one millimeter high at a standard temperature.

Mists- Suspended liquid droplets generated by condensation from the gaseous to the liquid state or by breaking up a liquid into a dispersed state, such as by splashing, foaming, or atomizing. Mist is formed when a finely divided liquid is suspended in air.

MSDS (Material Safety Data Sheet)-technical information documents provided by the manufacturer describing the toxicity, physical hazards, and methods of safe handling for a chemical product.

MSHA- Mine Safety and Health Administration, U.S. Department of Labor.

Mucous membranes- Lining of the hollow organs of the body, notably the nose, mouth, stomach, intestines, bronchial tubes, and urinary tract.

N

Neutralization-a method of chemically treating corrosive hazardous waste by the addition of an acid or a base to make the waste neutral.

NFPA- The National Fire Protection Association is a voluntary membership organization whose aim is to promote and improve fire protection and prevention. The NFPA publishes 16 volumes of codes known as the National Fire Codes.

NIOSH- The National Institute for Occupational Safety and Health is a federal agency. It conducts research on health and safety concerns, tests and certifies respirators, and trains occupational health and safety professionals.

NTP- National Toxicology Program. The NTP publishes an Annual Report on carcinogens.

Nuisance dust- Have a long history of little adverse effect on the lungs and do not produce significant organic disease or toxic effect when exposures are kept under reasonable control.

O

Off-site facility- a TSD facility or reclamation facility that handles hazardous waste at a site separate from the place where the waste was generated.

On-site- generally refers to contiguous property owned by an organization. "On-site" is specifically defined in 40 CFR Section 260.10.

OSHA- U.S. Occupational Safety and Health Administration, U.S. Department of Labor.

Oxidizer- A substance that gives up oxygen readily. Presence of an oxidizer increases the fire hazard.

Oxygen deficiency- That concentration of oxygen by volume below which atmosphere supplying respiratory protection must be provided. It exists in atmospheres where the percentage of oxygen by volume is less than 19.5 percent oxygen.

Oxygen -enriched atmosphere- An atmosphere containing more than 23.5 percent oxygen by volume.

P

Particulate matter- A suspension of fine solid or liquid particles in air, such as dust, fog, fume, mist, smoke or sprays. Particulate matter suspended in air is commonly known as an aerosol.

PEL- Permissible exposure limit. An exposure limit that is published and enforced by OSHA as a legal standard.

Personal protective equipment (PPE)- Devices worn by the worker to protect against hazards in the environment. Respirators, gloves, and hearing protectors are examples.

pH- Means used to express the degree of acidity or alkalinity of a solution with neutrality indicated as seven.

Placarding-the posting of a sign on the exterior of a vehicle to indicate the classification of the hazardous material being transported by the vehicle. DOT requires placarding whenever hazardous materials are being transported.

Polymerization- A chemical reaction in which two or more small molecules (monomers) combine to form larger molecules (polymers) that contain repeating structural units of the original molecules. A hazardous polymerization is the above reaction, with an uncontrolled release of energy.

ppm- Parts per million parts of air by volume of vapor or gas or other contaminant. Used to measure air concentrations of vapors and gases.

psi- Pounds per square inch (for MSDS purposes) is the pressure a material exerts on the walls of a confining vessel or enclosure. For technical accuracy, pressure must be expressed as psig (pounds per square inch gauge) or psia (pounds per square absolute; that is, gauge pressure plus sea level atmospheric pressure, or psig plus approximately 14.7 pounds per square inch).

R

RCRA- Resource Conservation and Recovery Act of 1976; amended in 1980 and 1984, this act authorizes EPA to regulate hazardous waste.

Reactivity (RCRA)-one of the four characteristics of a hazardous waste, it refers to a waste's capability to undergo a dangerous chemical change or transformation in which the waste decomposes, combines with other substances, or interchanges constituents with other substances. It also includes the generation of toxic gases that can occur in such chemicals as cyanide.

Reactivity (chemical)- A substance's susceptibility to undergo a chemical reaction or change that may result in dangerous side effects, such as an explosion, burning, and corrosive or toxic emissions.

Reclamation and recovery -the regeneration of a waste to a usable raw material, such as the distillation of spent solvents.

Recycling -a general term for the reuse of wastes, it includes reclamation and recovery.

Release- can be to the atmosphere, through exhaust from ventilation systems or evaporation; to land, through uncontrolled leaks or spills; or to waterways, through the sanitary sewer.

Respirable size particulates- Particulates in the size range that permits them to penetrate deep into the lungs upon inhalation.

Respirator (approved)- A device which has met the requirements of 30 CFR Part 11 and is designed to protect the wearer from inhalation of harmful atmospheres and has been approved by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA).

Respiratory system- Consists of (in descending order) - the nose, mouth, nasal passages, nasal pharynx, pharynx, larynx, trachea, bronchi, bronchioles, air sacs (alveoli) of the lungs, and muscles of respiration.

Route of entry- The path by which chemicals can enter the body. There are three main routes of entry: inhalation, ingestion, and skin absorption.

S

SARA- Superfund Amendments and Reauthorization Act of 1986. (U.S.EPA)

Satellite accumulation area- a collection area near the point of generation of hazardous wastes that is under the control of the person/operator generating the waste. Such areas are exempt from EPA accumulation time requirements.

SCBA- Self-contained breathing apparatus.

Sensitizer- A substance which on first exposure causes little or no reaction but which on repeated exposure may cause a marked response not necessarily limited to the contact site-Skin sensitization is the most common form of sensitization in the industrial setting.

Short-term exposure limit (STEL)- ACGIH-recommended exposure limit. Maximum concentration to which workers can be exposed for a short period of time (15 minutes) for only four times throughout the day with at least one hour between exposures.

"**Skin"** - A notation (sometimes used with PEL or TLV exposure data) which indicates that the stated substance may be absorbed by the skin, mucous membranes, and eyes -- either airborne or by direct contact -- and that this additional exposure must be considered part of the total exposure to avoid exceeding the PEL or TLV for that substance.

Sludge- any solid, semi-solid, or liquid waste generated.

Small quantity generator (SQG) -generators that generate of 100 to 1,000 kilograms of hazardous waste and less than l kilogram of acutely hazardous waste per calendar month.

Solubility in water- A term expressing the percentage of a material (by weight) that will dissolve in water at ambient temperature. Solubility information can be useful in determining spill cleanup methods and re-extinguishing agents and methods for a material.

Solvent- A substance, usually a liquid, in which other substances are dissolved. The most common solvent is water.

solvent recovery- reclamation by removal of contaminants from solvents resulting in a product that can be reused. Prior to reclamation, the spent solvent must be managed as a hazardous waste.

Sorbent- (1) A material that a removes toxic gases and vapors from air inhaled through a canister or cartridge. (2) Material used to collect gases and vapors during air-sampling.

Specific gravity- The ratio of the mass of a unit volume of a substance to the mass of the same volume of a standard substance at a standard temperature. Water at 4oC (39.2oF) is the standard usually referred to for liquids; for gases, dry air (at the same temperature and pressure as the gas) is often taken as the standard substance. See Density.

Spent solvents- solvents that have been used and are no longer usable. An example is degreasing solvent from a garage.

Stability- An expression of the ability of a material to remain unchanged. For MSDS purposes, a material is stable if it remains in the same form under expected and reasonable conditions of storage or use. Conditions which may cause instability (dangerous change) are stated. Examples are temperatures above 150oF, shock from dropping.

Storage- holding of hazardous wastes for a temporary period pending treatment, storage, or disposal.

Superfund- created by CERCLA in 1980, Superfund pays for the cleanup and removal of released hazardous substances at abandoned hazardous waste sites. The fund is chiefly generated by a tax on petroleum and certain chemicals.

Synergism- Cooperative action of substances whose total effect is greater than the sum of their separate effects.

Systemic- Spread throughout the body, affecting all body systems and organs, not localized in one spot or area.

T

TCLP (Toxic Characteristic Leachate Procedure)- a test to determine if a waste contains toxic properties and is thus a hazardous waste.

Threshold- The lowest dose or exposure to a chemical at which a specific effect is observed.

Time-weighted average concentration (TWA)- Refers to concentrations of airborne toxic materials which have been weighted for a certain time duration, usually 8 hours.

TLV - Threshold Limit Value- A time-weighted average concentration under which most people can work consistently for 8 hours a day, day after day, with no harmful effects. A table of these values and accompanying precautions is published annually by the American Conference of Governmental Industrial Hygienists.

Toxicity (chemical)- A relative property of a chemical agent and refers to a harmful effect on some biologic mechanism and the conditions under which this effect occurs.

Toxicity (RCRA) -the four characteristics of hazardous waste, it relates to the danger to human

health and the environment from certain metals and pesticides.

Treatment- a chemical or physical process that makes waste less hazardous or non-hazardous or recovers materials or energy resources. Examples include incineration, neutralization, and evaporation.

TSCA (Toxic Substance Control Act)- passed in 1976, this law provides regulatory coverage of chemicals that have been or will be introduced into U.S. commerce. PCBs are regulated under TSCA.

TSD (Treatment, Storage, or Disposal) facility -the three types of hazardous waste facilities for which the EPA grants permits. Commercial disposal firms often own several TSD facilities and divide wastes according to the capabilities of the facilities.

U

Upper explosive limit (UEL)- The highest concentration (expressed in percent vapor or gas in the air by volume) of a substance that will burn or explode when an ignition source is present.

V

Vapor pressure - Pressure (measured in pounds per square inch absolute - psia) exerted by a vapor. If a vapor is kept in confinement over its liquid so that the vapor can accumulate above the liquid (the temperature being held constant), the vapor pressure approaches a fixed limit called the maximum (or saturated) vapor pressure, dependent only on the temperature and the liquid.

Vapors- The gaseous form of substances that are normally in the solid or liquid state (at room temperature and pressure). The vapor can be changed back to the solid or liquid state either by increasing the pressure or decreasing the temperature alone. Vapors also diffuse. Evaporation is the process by which a liquid is changed into the vapor state and mixed with the surrounding air. Solvents with low boiling points will volatilize readily. Examples include benzene, methyl alcohol, mercury, and toluene.

Viscosity- The property of a fluid that resists internal flow by releasing counteracting forces.

Volatility- The tendency or ability of a liquid to vaporize. Such liquids as alcohol and gasoline, because of their well-known tendency to evaporate rapidly, are called volatile liquids.

W

Water column- A unit used in measuring pressure. See also Inches of water column.

Waste minimization- any method to reduce the volume or hazardous waste generated either by reducing the volume of hazardous material used or by directly treating hazardous waste.

Eyewash/Shower Installation & Hazard Assessment Guidelines

State of Wisconsin
Issued August 11, 1995
Revised July 24, 2000

Eyewash/Shower Installation and Hazard Assessment Guidelines

State of Wisconsin's Eyewash/Shower Installation and Hazard Assessment Guidelines

Introduction: Personnel in many state agencies/institutions routinely use corrosives and/or materials that can cause irreversible eye or bodily injury[1].

Goal: The goal of this document is to provide guidelines to minimize personnel exposure.

Purpose: This document is intended to:

1) Provide agencies/institutions with a mechanism to evaluate where eyewash/shower facilities are needed.

2) Serve as a compliance guide for Department of Commerce requirements for eyewash/shower installations[2] and personal protective equipment[3].

3) Institute a process by which Department of Facilities Development (DFD) in the Department of Administration will consider for approval, requests for eyewash/shower facilities.

Procedures: Where corrosive and/or materials that can cause irreversible eye or bodily injury are used, a job hazard analysis (JHA) shall be performed and documented by staff knowledgeable in this area. Note: A sample checklist for evaluating eyewash/shower installations is provided in Appendix B. An outline for conducting a JHA can be found in Appendix C. The JHA should include such information as the types and quantities of materials in use, frequency and duration of use, and the physical-working environment. If a hazard exists, the following hierarchy of control shall be followed:

1) Substitute less hazardous materials.
2) Modify equipment and work practices to minimize hazards.
3) If a hazardous exposure still exists, appropriate personal protective equipment shall also be provided and worn in the work area as well as providing "suitable facilities for quick drenching or flushing of the eyes and body".
4) Equipment maintenance and personnel training shall be included where appropriate. Each plumbed device should be checked weekly to test equipment performance and to flush debris or bacterial sediment.

1 See Appendix A.
2 Wisconsin Administrative Code, Chapter Comm 32.30
3 29 CFR 1910.132

Drenching/Flushing Requirements: Where drenching/flushing facilities are to be installed, they shall meet the following two criteria:

1) These facilities shall be immediately accessible within the area the hazard is present; this is defined as within 10-15 seconds with no obstructions to interfere with accessibility.
2) These facilities shall provide 15 minutes of continuous flush at a rate of .4 gallons per minute for eye flushing (eyewash unit), 20 gallons per minute for body drenching (full body shower) and 3 gallons per minute for irrigation and flushing of body areas (hand-held drench hose)4. Note: The different flow rates are due to the different hazards that may be present and therefore warrant different drenching/flushing requirements.

- In addition, these facilities should have the ability to flush both eyes simultaneously and be highly visible. There also should be no sharp projections in the operating area of the unit and the nozzles must be protected from airborne contaminants. Finally, these devices must be protected against freezing.

The decision to install a full body shower versus a hand-held drench hose or a simple eyewash unit is contingent on the information obtained through the JHA. Many hazards can be managed and economically addressed by the installation of a flexible hose, eye/face or body shower. See Appendix D for Department of Commerce, Acceptable Hand-Held Drench Hose.

The recommended practice for installing eyewashes/showers is defined by the American National Standards Institute (ANSI) Z 358.1-1998 Standard, Emergency Eyewash and Shower Equipment. The ANSI standard should be followed for new construction and major remodeling projects. Work areas with plumbing should have plumbed drenching/flushing facilities.

Typical Scenarios:

1) Laboratories and studios using corrosive of injurious materials shall have plumbed drenching/flushing facilities[5].
2) Where plumbing is not available or feasible, non-pressurized, self-contained eyewash units may be used, but they must provide 15 minutes of continuous flush as indicated in ANSI Z358.1-1998. Maintenance of this equipment is very important.

3) For first aid situations, small eyewash bottles may be appropriate when documented by the JHA and when a follow-up emergency medical plan is in place. Note: These units are not to be used in place of required drenching/flushing facilities.

---

4 ANSI Z358.1-1998 (sections 4, 5 and 8)
5 CRC Handbook of Laboratory Safety

Routine custodial or maintenance activities using corrosive or injurious materials shall be reviewed with the JHA. Emphasis should be placed on substitution and/or work practice modification to minimize these hazards.

5) The Material Safety Data Sheets for specific chemicals shall be consulted during the JHA for drenching/flushing requirements.

*These guidelines are available on the Wisconsin Bureau of State Risk Management's Internet web site: http://www.doa.state.wi.us/dsas/risk/.

Appendix A

DEFINITION – Materials that can cause irreversible eye or bodily injury:

“A chemical that causes visible destruction of, or irreversible alterations in living tissue by chemical action at the site of contact. For example, a chemical is considered to be corrosive if, when tested on the intact skin of albino rabbits by the method described by the U.S. Department of Transportation in Appendix A to 49 CFR Part 173, it destroys or changes irreversibly the structure of the tissue at the site of contact following an exposure period of four hours.”

Appendix B

Eyewash/Shower Installation Checklist

Agency: _____ Location:
Building: _____ Room(s):

Question	Yes	No
1. Are corrosive/injurious materials present in the area?	☐	☐
2. Has a review of Material Safety Data Sheets (MSDS's) documented eye hazards?	☐	☐
3. Has a job hazard analysis documented eye hazards?	☐	☐
4. Has a review of existing procedures concluded that the process cannot be changed to eliminate the hazard?	☐	☐
5. Has a review of the materials currently being used concluded that it is not feasible to substitute non-hazardous materials to eliminate the hazard?	☐	☐
6. Have Department of Commerce orders been issued to install eyewash/shower stations?	☐	☐
7. Are chemical splash goggles (and face shield if needed) available for employees/students in the area?	☐	☐
8. Do area supervisors or instructors enforce wearing splash goggles/face shield?	☐	☐
9. Have employees/students been informed of the hazards in the area?	☐	☐
10. Have employees/students been trained on how to protect themselves from the hazards in the area?	☐	☐
11. Have eye injuries been reported for this area in the past?	☐	☐
12. Is documentation available to support the above answers?*	☐	☐

“Yes answers to questions 2 through 5 imply that eyewash/shower stations must be installed.

A “Yes” answer to questions 1 and 6 does not mandate that eyewash/shower stations be installed, but rather suggests that a review of procedures and processes such as those indicated in questions 2 through 5 must be initiated.

“No” answers to questions 7 through 12 imply that administrative and managerial improvements need to be initiated, possibly in addition to eyewash/shower installations.

Date: _____ Assessed By: _____

Appendix C

Job Hazard Assessment Outline

1) **Review Injury/Illness Records:**

   Worker's Compensation reports as well as the OSHA 200 logs can provide valuable information as to where injuries may be occurring.

2) **Hazard Exposure:**

   Analyze jobs, operations, etc. and identify the potential hazards associated with each job task. This is the first step in helping to categorize workplace risks.

3) **Ask For Input:**

   Employees and supervisors are excellent resources when it comes to identifying workplace hazards, plus they can provide invaluable information on how to eliminate a hazard. Do not hesitate to take advantage of their expertise.

4) **Review Material Safety Data Sheets (MSDS's):**

   MSDS's are a good place to start when you are looking to evaluate hazard exposure and the need for personal protective equipment. MSDS's should be used to complement your Job Hazard Analysis.

5) **Review Loss Control/Industrial Hygiene Surveys:**

   Previous loss control and industrial hygiene surveys are other excellent sources to look for information on hazard identification. Outside resources can also provide credibility to your efforts and lend an extra set of eyes in helping to characterize hazards.

6) **Consider Ways To Eliminate Hazards:**

   After you have identified the existence of hazards, you need to evaluate ways to eliminate the hazard. Consider the possibility of substituting less hazardous materials, evaluate how equipment and work practices can be modified to eliminate or minimize the hazard. If personal protective equipment is still required, make certain that personnel are trained in its use and maintenance and this training is documented.

7) **Document:**

   Throughout the JHA make certain that you keep accurate and detailed notes. You will need these notes to keep track of hazards you have identified as well as to document progress in hazard abatement.

Appendix D

Department of Commerce
Acceptable Hand-Held Drench Hoses

Hand-Held Drench Hoses can be used for emergency flushing of the eyes and face if they meet the following criteria:

1) The nozzle must be mounted in a rack or holder, which keeps it pointing up.

2) The control valve shall be designed so that it goes from “off” to “on” in a single movement, in “1” second or less and remains on without requiring the use of the operator’s hands. A paddle type device is preferred.

3) Drench hoses shall deliver a controlled flow of water at a velocity low enough not to be injurious to the user. They shall also deliver a minimum of 3 gallons of water per minute[6].

6 ANSI Z358.1-1998 (section 8)

SAMPLE MEDICAL SURVEILLANCE PROGRAM

Employees involved in handling hazardous materials may encounter problems from the materials themselves or from emergency situations such as spills or fires. The goals of providing occupational health care to this group include assessment of exposure risks; establishment of baseline health status; identification of life-style related risk factors which may predispose to life-style related illnesses such as heart attack and stroke, certain cancers, injuries, suicide and homicide; and the presence of underlying illnesses which could either predispose to an adverse exposure outcome or lead to a more severe outcome; and provision of health and safety education relevant to life-style related and occupation-related injuries and illnesses.

A comprehensive medical surveillance program should be provided to the following employees:

1. All employees who are, or may be, exposed to chemical or bio-hazardous substances or health hazards for 30 days or more a year; or
2. All employees who wear a respirator for 30 days (or parts of days) or more a year; or
3. All employees who may have been exposed in an emergency situation to hazardous substances at concentrations above the permissible exposure limits.

The recommended frequency of medical examinations and consultations is as follows:

1. Prior to assignment.

2. At least once every twelve months.

3. At termination of employment or reassignment to an area where the employee would not be covered, if the employee has not had an exam within the last six (6) months.

4. As soon as possible, upon notification by an employee that he has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards.

5. At more frequent times, if the examining physician, in consultation with the laboratory manager determines that an increased frequency of examination is medically necessary.

Prior to the evaluation, the company will provide to the examining physician a description of the employee's duties as they relate to the employee's exposure; the employee's exposure levels or anticipated exposure levels; a description of any personal protective equipment used or to be used; and, information from previous medical exams of the employee which is not readily available to the examining physician.

The first part of each employee's evaluation consists of the completion of a two-part questionnaire and blood drawing.

Part A of the questionnaire consists of a chronological occupational history (job, location, duration, potential hazardous exposures) since the employee entered the work force and an in-depth description of current job duties and worksites with perceived work-related symptoms and potential exposures as known.

Part B consists of a Health Risk Appraisal developed by the Centers for Disease Control questions regarding personal habits and life-style choices which have been identified as risk factors for certain illnesses as noted above. With this information available, the employee undergoes a comprehensive medical history with review of the questionnaire, past medical history such as childhood illnesses; immunizations; allergies; previous surgical procedures; previous injuries; family history; reproductive history; a Review of Systems; and a comprehensive physical examination.

This examination includes height, weight, pulse, respiration, and blood pressure; evaluation of the head and neck; chest (heart and lungs); peripheral vascular system; abdomen and rectum (including hernia examination); genitourinary system; musculoskeletal examination including the spine; skin; and nervous system. Other aspects of the examination include eye tests (near and distant vision, color vision, peripheral vision, depth perception); Tonometry - screening for Glaucoma; audiometric screening performed at 500, 1,000, 2,000, 3,000, 4,000, and 6,000 hertz pure tone in an approved booth; 12 lead EKG with interpretation; pulmonary function tests including forced expiratory volume in 1 second (FEV-1), forced vital capacity (FVC), and FEV-1 to FVC ratio with interpretation and comparison to normal predicted values corrected for ambient temperature, humidity, age, height, race, and sex; blood tests including Triglycerides, Cholesterol, HDL Cholesterol, Total/HDL Cholesterol ratio, Alkaline Phosphatase, LDH, SGOT, SGPT, GGTP, Total Bilirubin, Total Protein, Albumin, Globulin, Albumin/Globulin ratio, Sodium, Potassium, Chloride, Carbon Dioxide, Uric acid, Glucose, BUN, Creatinine, BUN/Creatinine ratio; Calcium, Phosphate, Iron; Complete Blood Count - White Blood Count, Hemoglobin, Hematocrit, MCV, MCH, MCHC; Differential Blood Count (Polys, Eos, Lymphs, Baso, Mono); blood lead, blood cadmium, blood arsenic, blood mercury, Urinalysis (Glucose, Acetone, Albumin, Blood, pH, leukocyte esterase nitrite and microscopic examinations of the sediment if indicated: Stool examination for occult blood during examination and the opportunity to collect three additional stool specimens to be examined for occult blood when returned to the physician; Papanicolaou (PAP) test for cervical cancer (women only); a Tetanus Toxoid booster is offered to the employee if it is indicated.

The results of the examination together with a computerized printout of the Health-Risk Appraisal which allows the employee to compare his risk of certain diseases to his achievable risk of certain diseases should he/she choose to alter certain high risk life-style/health risks, is then reviewed with the employee and appropriate recommendations given.

Written summaries of the medical evaluation will be mailed to the company and to the employee. This summary includes results of the medical exam and tests; the physician's opinion as to whether the employee has any detected medical conditions which could place him/her at increased risk of material impairment of his/her health; any

recommended limitations upon the employee's assigned work; and a statement that the employee has been informed by the physician of the results of the medical exam and any medical conditions which require further treatment. The written summary to the company does not reveal specific findings or diagnosis unrelated to occupational exposure. At the employee's written request, a summary is also sent to his/her personal physician.

Periodic informal review, as well as a yearly written summary and evaluation of the surveillance program is essential in order to assure a relevant, appropriate program of the highest quality.

Prepared by WC Environmental, LLC 2001.

LABORATORY AND OCCUPATIONAL SAFETY BIBLIOGRAPHY

Claudia J. Dettelbacher and James A. Kaufman
Revised by Leah M. Cremonini (2001) and Russell Phifer (2005)

ARTS and CRAFTS

Art Hazard News, M. McCann, Editor, Newsletter from Center for Occupational Hazards, 5 Beekman Street, New York, NY 10038. ($15/year)

Artist Beware, M. McCann, Watson-Guptill Publications, 1515 Broadway, New York, NY, 10036. ($18)

The Artist's Complete Health and Safety Guide, Monona Rossol, 2nd Ed., Allworth Communications, inc, 10 East 23rd St., New York, NY 10010, 1994. ($19.95)

Making Art Safe, Merle Spandorfer, Deborah Curtiss, and Jack Snyder, M.D. Van Nostrand Reinhold, 115 Fifth Ave. New York NY 10003, 1993 ($29.95)

BIOLOGICAL AND ANIMAL HAZARDS

Bioaerosols, Harnet A. Burge, CRC Press Inc. 2000 Corporate Blvd. NW, Boca Raton, Florida 33431, 1995. ($67.95)

Biosafety in Microbiological and Biomedical Laboratories, CDC-NIH, 4th Edition, United States Government Printing Office, Washington, DC 20402, 1999.

Biosafety in the Laboratory, Prudent Practices for the Handling and Disposal of Infectious Materials, Nat'l. Acad. Press, 2101 Const. Ave. NW, Wash., DC, 20418, 1989. (54.95)

The Bloodborne Pathogens Standard, Jon T. O'Neal, MD, MPH, Van Nostrand Reinhold, 115 Fifth Avenue, New York, NY 10003, 1996.

Laboratory-Acquired Infections, 2nd Edition, C. H. Collins, Butterworth and Company, Borough Green, Sevenoaks, Kent TN15 8PH, England, 1988.

Occupational Health and Safety in the Care and Use of Research Animals, National Research Council, National Academy Press, Washington, DC, 1997.

Occupational Exposure to Bloodborne Pathogens, 29 CFR 1910.1030, 1991.

Physical and Biological Hazard of the Workplace, Peter H. Wald, M.D., Gregg M. Stave, M.D., Van M. Stave, M.D., Van Nostrand Reinhold, NY, NY 10003, 1994, ($79.95)

Science, Medicine and Animals, National Academy of Sciences, Institute of Medicine, 2101 Constitution Avenue, Washington, DC 20418, 1991.

UFAW Handbook on the Care and Handling of Laboratory Animals, 6th Edition, 1987, Longman Scientific and Technical, Burnt Mill, Essex, England.

CARCINOGENS

Annual Report on Carcinogens, Summary, United States Department of Health and Human Services, Research Triangle Park, NC 27709, 1994. (FREE)

CHEMICAL SAFETY

1,001 Chemicals in Everyday Products, Grace Ross Lewis, Van Nostrand Reinhold, 115 Fifth Ave., New York, NY 10003, 1994 (19.95)

ACS Guide to Spill Response Planning in Laboratories, American Chemical Society, Washington, DC, 2000 (Free)

Chemical Protective Clothing, Krister Forsberg, S. Z. Mansdorf, Van Nostrand Reinhold, 115 Fifth Ave., New York, NY 10003, 1993. (14.95)

Chemical Protective Clothing Performance Index Book, K. Forsberg, L. Keith, John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158-0012, 1989.

Chemical Regulatory Cross Reference, 3rd Edition, J. J. Keller and Associates, 145 West Wisconsin Avenue, PO Box 368, Neenah, WI 54957-0368, 1990. ($60).

Chemical Safety in the Laboratory, Stephen K. Hall, CRC Press, Inc. 2000 Corporate Blvd. NW Boca Raton, FL 33431, 1994.

Chemical Safety Manual for Small Businesses, American Chemical Society, 2nd Edition, Washington, D.C. 1992.

Chemical Sensitivity, William J. Rea, Vol. 1, CRC Press, Inc. 2000 Corporate Blvd. NW, Boca Raton, Florida 33431, 1992. ($69.45)

A Comprehensive Guide to the Hazardous Properties of Chemical Substances, Pradyot Patnaik, Van Nostrand Reinhold, New York, NY 10003, 1992 ($99.95)

Dangerous Properties of Industrial Materials, 10th Edition, Lewis, Richard J, Editor, Wiley & Sons Company, 135 West Fiftieth Street, New York, NY 10020, 2000.

Division of Chemical Health and Safety, 205th American Chemical Society National Meeting, Denver, CO 1993

2004 Emergency Response Guidebook, US Department of Transportation, Research and Special Programs, 2004.

Fire Protection Guide to Hazardous Materials, 12th Edition, National Fire Protection Association, One Batterymarch Park, Quincy, MA 02269, 1997. ($97.25)

First Aid Manual for Chemical Accidents, Marc J. Lefevre, Revised by Shirley A. Conibear, Second Edition, John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 101581989. ($79.95)

Handbook of Chemical Health and Safety, Robert J. Alaimo, Editor, Oxford University Press, American Chemical Society, Washington, DC, 2001. ($125.00)

Handbook of Hazardous Materials, Alliance of American Insurers, Loss Control Department, North Wacker Drive, Chicago, IL 60606.

Handbook of Organic Industrial Solvents, Alliance of American Insurers, Loss Control Department, 20 North Wacker Drive, Chicago, IL 60606.

Handbook of Reactive Chemical Hazards, L. Bretherick, Editor, 4th Edition, Butterworths, Boston, MA, 1990. ($100)

Hazardous and Toxic Material: Safe Handling and Disposal, 2nd Edition, H. Fawcett, Editor, John Wiley and Sons, 605 Third Avenue, New York, NY 10158-0012.

Hazardous Chemicals Desk Reference, Richard J. Lewis Sr., Editor, Van Nostrand Reinhold Company, 115 Fifth Avenue, New York, NY 10003, 1993. ($99.95)

Hazardous Chemicals Information and Disposal Guide, M. A. Armour, et. al., Editors, Terochem Labs, Ltd., PO Box 8188, Station F, Edmonton, Alberta, Canada T6H 4P1. New Edition for Lewis Publisher, Chelsea, MI, 1987

Hazardous Chemicals Information and Disposal Guide, 3rd Edition, M. A. Amour, L.M. Browne, G. L. Weir, University of Alberta, 3rd Edition, 1987

Hazardous Laboratory Chemicals Disposal Guide, M. Armour, 2nd Ed., Lewis Publishers/CRC Press, Inc. 2000 Corporate Blvd., N.W., Boca Raton, Florida, 33431, 1996. ($109.95)

Hazardous Materials Guide: Shipping, Materials Handling and Transportation - Regulations, Proposed Changes and Reference Data, J. J. Keller and Associates, Inc., 145 West Wisconsin Avenue, PO Box 368, Neenah, WI 54957-0368, 1990.

Pocket Guide to Chemical Hazards, U.S. Department of HHS, NIOSH, PHS, CDC and Prevention, Supt. of Documents, Wash., DC 20402, June 1997. ($7.50)

A Practical Guide to Chemical Spill Response, John W. Hosty, Van Nostrand Reinhold, 115 Fifth Avenue, New York, NY 10003, 1992. ($34.95)

Rapid Guide to Hazardous Chemicals in the Workplace, Richard J. Lewis Sr., John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158-0012, 2000 ($36.95)

Registry of Toxic Effects of Chemical Substances, R. J. Lewis Sr. and R. L. Tatken, Editors, US Dept. HHS, 1980 Edition, (NIOSH), Pub. No. 81- 116, Superintendent of Documents, United States Government Printing Office, Washington, DC 20402.

Teratogens: Chemicals which Cause Birth Defects, V. K. Meyers, Editor, Elsevier Science Publishing, 52 Vanderbilt Avenue, New York, NY 10017, 1988.

Threshold Limit Values and Biological Exposure Indices, ACGIH, 6500 Glenway Avenue, Building D7, Cincinnati, OH 45211-4438, Most Recent Edition. ($40.00)

Toxic Substances Control Primer, 2nd Edition, M. D. Woroec, Bureau of National Affairs, 9435 Key West Avenue, Rockville, MD 20850-3397, 1988.
Working Safety With Chemicals, Christine E. Gorman, Editor, 2nd edition, Genium Publishing Corp., One Genium Plaza, Schenectady, NY 12304, 1997. ($19.95).

ELEMENTARY SCIENCE SAFETY

Exploring Safely, Terry Kwan and Juliana Texley, National Science Teachers Association, Arlington, VA, 2002, 125 pages ($19.95)

Guidelines for Self-Assessment (Elementary School), National Science Teachers Association, Arlington, VA.

Science Classroom, Edited by Peter Markow, Ken Roy, and James A. Kaufman, Laboratory Safety Institute, 192 Worcester Road, Natick, MA 01760, 2000.

ENVIRONMENTAL SAFETY

Agricultural Health and Safety, Helen McDuffie, CRC Press, Inc., 2000 NW Corporate Blvd.,Boca Raton, Florida 33431, July 1995 ($99.50)

The Environmental Audit Handbook, Business and Legal Reports, Inc., 64 Wall Street, Madison, CT 06443, 1990.

Environmental Hazards and Human Health, Richard B. Philip, CRC Press, Inc. 2000 Corporate Blvd. NW, Boca Raton, Florida 33431, July 1995, ($59.95)

Environmental Health and Safety, Princeton Univ., Environmental Health & Science, 1999.

Environmental Health, Dade W. Moeller, Harvard University Press, 1992.

Health Safety and Environmental Control, Reynold L. Hoover, Robert L. Hancock, Kevin L. Hylton, O. Bruce Dickerson, George E. Harris, Van Nostrand Reinhold, 115 Fifth Ave. New York NY 10003, 1989.

Introduction to Green Chemistry, American Chemical Society, Wash., DC, 2002. ($19.95)

Pollution Prevention and Waste Minimization in Laboratories, Peter A. Reinhardt, K. Leigh Leonard, Peter C. Ashbrook, Editors, CRC Press, Inc. 2000 Corporate Blvd. NW Boca Raton, FL 33431, 1996 ($109.95)

The VNR Dictionary of Environmental Health and Safety, Frank S. Lisella, Van Nostrand Reinhold, 115 Fifth Ave., New York, NY 10003, 1994. ($49.95)

HEALTH CARE FACILITIES

Essentials of Modern Hospital Safety, William Charney, Joseph Schirmer, Lewis Publishers, Inc., 121 South Main Street, Chelsea, MI 48118, 1990.

LABORATORY DESIGN

Guidelines for Laboratory Design: Health and Safety Considerations, L. DiBerardinis, et. al., 3rd ed., John Wiley & Sons, 605 3rd Ave., NY, York, NY 10158, 1993. ($145.00)

NSTA Guide to School Science Facilities, James Biehle, Lemoyne Motz and Sandra West, National Science Teachers Assn., Arlington, VA, 2000. ($39.95)

Safe Laboratories, Peter Ashbrook and Malcolm Renfrew, CRC Press LLC, 2000 NW Corporate Boulevard, Boca Raton, FL 33431, 1991. ($104.95)

LABORATORY SAFETY

Care and Handling of Laboratory Glassware, Customer Service Department, Corning Glass Works, Corning, NY 14831. (Free)

Fire Protection for Laboratories Using Chemicals, National Fire Protection Association, Batterymarch Park, Quincy, MA 02169, current edition. ($94.95)

The Foundations of Laboratory Safety, A Guide for the Biomedical Laboratory, S. R. Rayburn, Springer-Verlag, 175 Fifth Avenue, New York, NY 10010, 1990.

The Guidebook to Successful Safety Programming, Raymond J. Colvin, Lewis Publishers, Inc. 121 S. Main Street, PO Drawer 519, Chelsea, MI 48118, 1992 ($98.75)

Guidelines for Laboratories, BG Chemie, Guideline NO. 12, 1993.

Handbook of Chemical Health and Safety, Robert J. Alaimo, Editor, Oxford University Press, American Chemical Society, Washington, DC, 2001. ($125.00)

Handbook of Laboratory Health and Safety Measures, S. B. Pal, Editor, 2nd Edition, John Wiley and Sons, 605 Third Avenue, New York, NY 10158, 1995. ($75)

Handbook of Laboratory Safety, 5th Edition, Keith Furr, Editor, CRC Press, 2000 Corporate Blvd., Boca Raton, FL, 1995. ($189.95) All prior editions are available in the Library

Improving Safety in the Chemical Laboratory: A Practical Guide, J. A. Young, 2nd edition, John Wiley and Sons, 605 Third Avenue, New York, NY, 10158, 1991. ($125.00)

Laboratory Fume Hoods, A User's Manual, G. Thomas Saunders, Editor, John Wiley and Sons, Inc. 605 Third Ave, New York, NY 10158, 1993. ($54.95)

Laboratory Instrumentation, Fourth Edition, Mary C. Haven, Gregory A. Tetrault, and Jerald R. Schenken, Van Nostrand Reinhold 115 Fifth Ave. New York, NY 10003, 1995.

Laboratory Safety and Health, J. A. Kaufman, A 4-hour audio-course produced for the ACS, LSI, 192 Worcester Road, Natick, MA 01760. ($149.00)

Laboratory Safety Guidelines: Expanded Edition, James A. Kaufman, Laboratory Safety Institute, 192 Worcester Road, Natick, MA 01760, 2000. ($15.00)

Laboratory Safety Training Guide, Princeton University, Environmental Health and Science, 1999.

Laboratory Ventilation Guidebook, O. Jeff Burton, CIH, PE, CSP 2000

Learning By Accident, Volume 1 and 2, edited by Fariba Mojtabai and James Kaufman, Laboratory Safety Institute, Natick, MA, 1999 and 2000 ($19.95 each)

Less is Better, American Chemical Society Task Force on RCRA, American Chemical Society, 1155 Sixteenth Street NW, Washington, DC 20036, 1985. (FREE)

NCCLS Laboratory Safety, Professions Government Industry, 1992.

Prudent Practices in the Laboratory, Handling and Disposal of Chemicals, National Research Council, National Academy Press, 2101 Constitution Ave, NW Washington DC 20418, 1995. ($89.95)

Safe Storage of Laboratory Chemicals, David A. Pipitone, Editor, 2nd Edition, John and Sons, 605 Third Avenue, New York, NY 10158, 1991.

Safety in Academic Chemistry Laboratories, American Chemical Society, 1155 Sixteenth Street NW, Washington, DC 20036, 2004. (single copies free)

Safety in the Chemical Laboratory, Volumes 1-4, Articles from the J. Chem. Ed. column on lab safety, ACS Division of Chemical Education, Easton, PA 18042. (About $6 each)

OCCUPATIONAL SAFETY

Accident and Emergency Management, Louis Theodore, Joseph Reynolds, Francis Taylor, et. al., John Wiley and Sons, Inc., 605 Third Avenue, New York, NY 10158-0012, 1989.

Accident – Facts, National Safety Council, Itasca, IL 60611, Annual. ($40.00)

Asbestos Compliance Encyclopedia, Business and Legal Reports, Bureau of Law and Business, 64 Wall Street, Madison, CT 06443-1513, 1988.

Audits and Inspections, a summary of recommendations, James A. Kaufman, Laboratory Safety Institute, Natick, MA, 2002. ($10.00)

Basic Guide to Accident Investigation and Loss Control, Jeffrey W. Vincoli, CSP, Van Nostrand Reinhold, 115 Fifth Ave., New York, NY 10003, 1994. ($39.95)

Best's Safety Directory: Industrial Safety, Hygiene, Security, Two Volumes, A. M. Best Company, Oldwick, NJ, 1991.

Building Student Safety Habits for the Workplace, Center for Chemical Education, Miami University, Miami, OH 2000. Instructor edition $58.00; student edition $52.00

Developing Safety Training Programs, Joseph A. Saccaro, Van Nostrand Reinghold, 115 Fifth Ave. New York, NY 10003, 1994. ($39.95)

Directory of Chemical Process Safety Services, American Institute of Chemical Engineers, 345 East 47th Street, New York, NY 10017, 1991.

Emergency Responder Training Manual for the Hazardous Materials Technician, Center for Labor Ed. & Res., Van Nostrand Reinhold, 115 5th Ave., New York, NY 10003, 1992. ($59.95)

Employee Guide to Chemical Hygiene and Safety, Environmental Health and Safety, East Carolina University, Greenville, NC 27858, 1990.

Encyclopedia of Occupational Health and Safety, Two Volumes, 3rd Edition, Dr. Luige Permeggiani, ILO, CH-1211 Geneva 22, Switzerland, 1989.

Fundamentals of Industrial Hygiene, J. B. Olishifski and F. E. McElroy, Editors, National Safety Council, Third Printing, 1976.

Guide to Developing and Managing an Emergency Service, United States Fire Administration, 1992

Guide to Occupational Exposure Values, ACGIH, Inc., 6500 Glenway Avenue, Building D7, Cincinnati, OH, 45211-4438, 1990.

Health and Safety Audits, John W. Spencer, CIH, CSP, National Medical Advisory Service, Government Institutes, Inc. 4 Research Place, Suite 200, Rockville, MD 20850, 1992.

Health and Safety Beyond the Workplace, Lester V. Cralley, Lewis J. Cralley, and West Clark Cooper, John Wiley and Sons, New York, 1990.

Health and Safety in Small Industry: A Practical Guide for Managers, Lewis Publishers, 121 South Main Street, PO Drawer 519, Chelsea, MI 48118, 1989.

Health and Safety Handbook for Education Employees, National Education Association, 1201 Sixteenth Street, N.W. Washington, DC 20036, 1988.

Health and Safety of Workers: Case Studies in the Politics of Prof. Responsibility, R. Bayer, Ed., Oxford U. Press, 200 Madison Av., NY, NY 10016, 1988. ($30)

Health and Safety Policy Statements, edited by James A. Kaufman, Laboratory Safety Institute, Natick, MA ($10.00)

Industrial Safety Data Sheet, Alphabetical and Numerical Index, National Safety Council, 444 North Michigan Avenue, Chicago, IL 60611, 1990/1991.

Introduction to Industrial Hygiene, by Ronald M. Scott, CRC Press, Inc. 2000 Corporate Blvd., NW, Boca Raton, Florida, 33431, 1995. ($59.95)

Introduction to Occupational Health and Safety, J. LaDou, Editor, National Safety Council, 444 North Michigan Avenue, Chicago, IL 60611, 1986.

Joint Safety and Health Committee Training Course, National Safety Council, 444 North Michigan Avenue, Chicago, IL 60611.

Laser Safety Training Guide, Princeton University, Environmental Health and Science, 1998

The Law and Occupational Injury, Disease, and Death, Warren Freedman, Quorom Books, 1990.

Leadership in Safety Management, James R. Thomen, John Wiley and Sons, Inc. 1991

Maintainability: A Key to Effective Serviceability, Benjamin Blanchard and Elmer Peterson, Wiley and Sons, Inc. 605 Third Avenue, New York, NY 1994, ($95.95)

Managing Safety and Health Programs, Ray Boylston, Van Nostrand Reinhold, 115 Fifth Avenue, New York, NY 10003, 1990.

MIT Accident Prevention Guide, Volumes 1-5, Massachusetts Institute of Technology, Cambridge, MA

Occupational Health in the 1990s, Developing a Platform for Disease Prevention, P. J. Landrigan and I. J. Selikoff, NY Acad. of Sci., 2nd East 63rd St., NY,, NY 10021, 1989.

Occupational Medicine, Joseph LaDou, Appleton and Lange, 25 Van Zant Street, East Norwalk, Connecticut 06855, 1990. ($34.50)

Occupational Safety and Health Standards for General Industry, CCH Incorporated, 4025 W. Peterson Ave., Chicago, IL 60646, 1999

Organizing for Health and Safety-Labor Research Review, Midwest Center for Labor Research 3411 West Oiversey Ave. Suite 10, Chicago, IL 60647 1990 ($8.00)

OSHA: Compliance Manual, J. J. Keller and Associates, Inc., 145 West Wisconsin Avenue, PO Box 368, Neenah, WI 54957-0368, 1991.

OSHA Inspections: Preparation and Response, Richard Kaletsky, ($64.95)

Physical and Biological Hazard of the Workplace, Peter H. Wald, M.D., Gregg M. Stave, M.D., Van M. Stave, M.D., Van Nostrand Reinhold, 115 Fifth Ave. New York NY 10003, 1994, ($79.95)

A Practical Guide to the Occupational Safety and Health Act, Walter Connolly, Jr. Donald

Crowell, II, Law Journal Seminars-Press 111 8th Ave., NY, York, NY 10011, 1991.

Protective Gloves for Occupational Use, Guhn A. Mellstrom, Jan E. Wahlberg, Howard I. Maibach, CRC Press, Inc. 2000 Corporate Blvd. NW Boca Raton, FL 33431, 1994.

Safety Engineering, James Covan, John Wiley and Sons, Inc. 605 Third Avenue, New York, NY 10158-0012, 1995 ($64.95)

Safety Auditing; A Management Tool, Donald W. Kase, Kay J. Wiese, Van Nostrand Reinhold, 115 Fifth Ave. New York NY 10003, 1990.

Seventy Years of Progress, edited by James A. Kaufman, Laboratory Safety Institute, Natick, MA, 2002. ($8.50)

Supervisor's Guide to Safety and Health Programs, Water Environment and Federation, Alexandria, VA 22314 1992.

The Work Environment: Occupational Health Fundamentals, Doan J. Hansen, Lewis Publishers, Inc. 121 South Main St., PO Drawer 519, Chelsea, MI 48118, 1991.

Workplace Health Protection, Industrial Hygiene Program Guide, Robert G. Confer, CRC Press, Inc. 2000 Corporate Blvd. NW Boca Raton, FL 33431, 1994.

OSHA LABORATORY STANDARD

Accident Prevention and OSHA Compliance, Patrick A. Michaud, CRC Press, 2000 Corporate Blvd. NW, Boca Raton, Florida 33431, 1995. ($65)

Chemical Hygiene Plan, Arthur D. Little, Arthur D. Little, Inc. Technology and Product Development Directorate, Acorn Park, Cambridge, MA 02140, 1996

Compliance System For Hazardous Chemicals in Laboratories, Chemical Communication Systems, Inc., 225 West Germantown Turnpike, Plymouth Meeting, PA 19462, 1990.

Developing a Chemical Hygiene Plan, Jay A. Young, et. al., ACS, Distribution Office, Department 225, 1155 Sixteenth Street NW, Washington, DC 20036, 1990.

Keller's Official OSHA Safety Handbook, J.J. Keller and Associates, 3003 W. Breezewood Lane, PO Box 368, Neenah, WI 54957, 3rd Edition, 1996.

Laboratory Health and Safety Handbook: A Guide for the Preparation of a Chemical Hygiene Plan, R. Scott Strickoff and Douglas B. Walters, John Wiley and Sons, Inc., 605 Third Avenue, New York, 10158, 1990.

Living with the Laboratory Standard: A Guide for Chemical Hygiene Officers, ACS, Council Committee on Chemical Safety, Washington, DC, 1998 ($10.00)

Model Chemical Hygiene Plan, Brian Wazlaw and James A. Kaufman, Laboratory Safety Institute, 192 Worcester Road, Natick, MA 01760, 2000. ($99.00)

OSHA Inspections, Preparation and Response, Rick Kaletsky Editor, McGraw-Hill Companies, Inc. 1997

RADIATION

The Radiation Safety Manual, Princeton University, Environmental Health and Science, 1998.

RISK

40 Low -Waste, Low Risk Chemistry Labs, David Dougan, Editor, J. Weston Walch, Publisher, Po Box 658, Portland, ME 04104, 1997.

Risk Analysis: A Guide to Principles and Methods for Analyzing Health and Environmental Risks, J. J. Cohrssen and V. T. Covello, NTIS, U. S. Department of Commerce 5285 Port Royal Road, Springfield, VA 22161, 1989. ($17.50)

SECONDARY SCHOOL SCIENCE SAFETY

Building Student Safety Habits for the Workplace, PACT, Chemical Technology Resources, Terrific Science Press, Miami University Middletown, 4200 E. University Blvd., Middleton, OH 45042, 2000 ($52.00/58.00)

Bulletin, Building the Framework, The Curriculum: Challenge and Change, NASSP, 1995.

Chemistry Safety Manual, for High School Chemistry Teachers and Laboratory Supervisors, Michigan Technological Univ., Dow Corning Corp., Midland, MI 48640.

Classroom Science Safety and the Law, William Rist, Flinn Scientific, Batavia, IL, 2001, $19.95

Concise Manual of Chemical and Environmental Safety in Schools and Colleges, Volumes 1-3, J. B. Lippincott Company, East Washington Square, Philadelphia, PA 19105, 1990.

CRC Handbook of Chemistry and Physics, David R. Lide, CRC Press, Inc., 2000 Corporate Blvd. NW Boca Raton, FL 33431, 1994.

Flinn Chemical Catalog Reference Manual, Flinn Scientific, PO Box 231, 917 West Wilson Street, Batavia, IL 60510, Annual. (Free to schools)

Guidelines for Self-Assessment (High School), National Science Teachers Association, Arlington, VA

Guidelines for Self-Assessment (Middle/Junior School), National Science Teachers Association, Arlington, VA.

Reduction of Hazardous Wastes from High School Chemistry Laboratories, G. H. Wahl, Jr., Editor, Chem. Dept., NC State Univ., Raleigh, NC 27695-8204, 1990. ($19.95)

Safe at School, Awareness and Action for Parents of Kids Grades K -12, Carol Silverman Saunders, Pamela Espeland, editor, Free Spirit Publishing, Inc. 400 First Avenue North, Suite 616, Minneapolis, MN 55401, 1994 ($14.95)

Safe Science: Be Protected, Kenneth Roy, Laboratory Safety Institute, Natick, MA, 2002. ($24.95)

Safety in Physics Education, American Association of Physics Teachers, 5112 Berwyn Road, College Park, MD 20740, 2001. ($24.95)

Safety in School, Science labs, Clair G. Wood, James A. Kaufman and Associates, LSI, 192 Worcester Road, Natick, MA 01760, 1995. ($24.95)

Safety in the Secondary School Science Laboratory, U.S. Dept. HHS, August 1977, Contact your State Dept. of Ed., Local NIOSH Office, or the Council of State Science Supervisors. LSI Reprints ($35.00)

The Science Teacher, Vol. 65, NO.8, 1998.

School Science Laboratories: A Guide to some Hazardous Chemicals, Consumer Product Safety Comm., Washington, DC, 1984, 1-800-638-2772. (Single copies free); Reprints from LSI ($10.00)

Science Demonstrations: Safety and Liability, James A. Kaufman, Laboratory Safety Institute, Natick, MA. ($5.00)

Speaking of Safety, James A. Kaufman, Editor, Newsletter, Laboratory Safety Institute, Natick, MA 01760. (Subscription $50.00/year)

Teach Physics Safety, American Association of Physics Teachers, 5112 Berwyn Road, College Park, MD 20740.

Teacher Liability and Indemnification, James A. Kaufman et al., Laboratory Safety Institute, Natick, MA. ($7.50)

There's No Safety In Numbers, Marilyn Steele et al., Laboratory Safety Institute, Natick, MA. ($7.50)

TOXICOLOGY

The Dose Makes the Poison, 2nd Edition, Alice Ottoboni, Van Nostrand Reinhold, NY, NY, 1991.

Industrial Toxicology, P. L. Williams and J. L. Burson, Editors, Van Nostrand Reinhold Company,135 West Fiftieth Street, New York, NY 10020, 1985. ($50)

National Toxicology Program, US Dept. HHS, Public Health Service, 1991, 1993, 1994

Organic Dusts: Exposure, Effects, and Prevention, Ragnar Rylander and Robert R. Jacobs, CRC Press, Inc., 2000 Corporate Blvd. NW, Boca Raton, Florida 33431, 1994

Sixth Annual Report on Carcinogens, National Toxicology Program Public Information Office, MD B2-04, Box 12233, Research Triangle Park, NC 27709. (Free)

WASTE DISPOSAL

Destruction of Hazardous Chemicals in the Laboratory, G. Lunn and E. B. Sansone, 2nd Edition, John Wiley & Sons, Inc., 605 3rd Ave., NY, NY 10158-0012, 1994. ($105.00)

EPA Guide for Infectious Waste Management, EPA, Environmental Protection Agency, No. 530-sw-86-014, Government Printing Office, Washington, DC 1986.

Handbook of Hazardous Waste Management for Small Quantity Generators, Phifer and McTigue, Jr., Lewis Publishers, 121 South Main Street, Chelsea, MI 48118, 1988.

Handbook of Laboratory Waste Disposal, M. Pitt and E. Pitt, John Wiley and Sons, 605 Third Avenue, New York, NY 10158, 1985. ($88.00)

Hazardous Waste Control in Research and Education, Takashi Korenaga, Hirshi Tsukube, Sumio Shinoda, ISEI Nakamura, CRC Press, Inc. 2000 Corporate Blvd. NW Boca Raton, FL 33431, 1994 ($79.95)

Hazardous Waste Management at Educational Institutions, National Assn. of College and Univ. Business Officers, One Dupont Circle, Wash., DC 20036, 1987. (Out of Print)

Hazardous Waste Management Compliance Handbook, Environmental Resource Center, Van Nostrand Reinhold, 115 Fifth Ave. New York NY 10003, 1992.

Hazardous Waste Management Handbook for Schools, Clean Harbors of Natick, 15 Mercer Street, Natick, MA 01760, 1988.

Hazardous Waste Management System: General (6 NYCRR Part 370), New York State Department of Environmental Conservation, Division of Hazardous Substances Regulation, 50 Wolf Road, Albany, NY 12233, 1988.

Hazardous Waste Planning, J. Andy Soesilo, Stephanie R. Wilson, CRC Press, Inc. 2000 Corporate Blvd., NW, Boca Raton, Florida, 33431 July 1995, ($59.95)

Hazardous Waste Regulations, The Commonwealth of Massachusetts, Two Parts, Government Bookstore, Boston, MA 1988. ($18.15)

Infectious and Medical Waste Management, Peter A. Reinhardt, J. G. Gordon, Lewis Publishers, Inc., 121 South Main Street, Chelsea, Michigan 48118, 1991.

Infectious Waste Management, A Practical Guide, Michael L. Garvin, Editor, CRC Press, Inc. 2000 Corporate Blvd. NW Boca Raton, FL 33431, 1995 ($74.95)

Laboratory Waste Management; A Guidebook, ACS Task Force on Laboratory Waste Management, American Chemical Society, Washington, DC 1994, Oxford Press

Pollution Prevention and Waste Minimization in Labs., Reinhardt, Leonard, and Ashbrook, Ed., CRC Press, Inc. 2000 Corp. Blvd. NW Boca Raton, FL 33431, 1996 ($109.95)

RCRA and Laboratories, American Chemical Society, 1155 Sixteenth Street NW, Washington, DC 20036, 1986. (FREE)

Small Quantity Generator, A Self-Help Guide for Small Quantity Generators of Hazardous Waste in Mass., MA DEQE, Engineering Div. of Hazardous Waste, One Winter Street, Boston, MA 02108, 1989.

Understanding the Small Quantity Generator Hazardous Waste Rules, U.S. EPA, Office of Solid Waste and Emergency Response, Washington, DC, 20460, 1986. (Free)

Waste Disposal in Academic Institutions, James A. Kaufman, Lewis Publishers, 1990. Available from LSI, Natick, MA 01760. ($165.00)

The Waste Management Manual for Laboratory Personnel, ACS, Dept. of Govt. Relations and Science Policy, 1155 16th St., NW, Wash., DC 20035, 1990. LSI Reprint ($10.00)

ABOUT THE AUTHORS:

This bibliography was prepared by LSI Director, Dr. James A. Kaufman and LSI Intern Claudia J. Dettelbacher in 1991. It was revised by LSI Intern Leah M. Cremonini in 2001. In 2005, the bibliography was revises by Russell Phifer of W.C. Environmental for RJG Associates. (The original 30 page version is available from LSI for $15.00.)

Purchasing Information: All the books and publications listed above are available for sale from The Laboratory Safety Institute (LSI). Call for current pricing (508-647-1900).

Sample Safety Inspection Checklist

(Courtesy University of South Alabama Safety & Environmental Compliance Dept.)

	Yes	No	N/A
Safety Inspection/Audit Checklist			
Chemical Hygiene Plan			
Have all departments and research labs reviewed the Chemical hygiene plan?			
Are there any operations that require prior approval before beginning? (ex., Radiation Safety, Bio-safety committee)			
Standard Operating Procedures (SOP's)			
Are there written SOP's covering the basic laboratory safety and hygiene practices? Check last review date			
Is there a procedure for identifying particularly hazardous substances used in the lab? Do they have a department specific written procedure? Check last review date.			
Training of laboratory personnel documented.			
Director/PI has written training plan for his/her lab			
Training is current with Chemical Hygiene Plan & Hazard Communication Standard			
Training is complete on Hazardous waste management			
Training is complete on Blood borne Pathogen requirements			
HAZARDOUS MATERIALS			
Laboratory doors are labeled with emergency contact notification names & numbers, hazards present & necessary precautions			
Labels are clean and intact on all chemical containers			
Contents of stock solution buffer bottles are clearly identified (no laboratory abbreviations)			
Synthesized, unnamed chemical compounds are labeled by their reactants and possible products or by a useful generic description (not by chemical structure only)			
Containers with non-hazardous substances (i.e., water) clearly labeled to avoid confusion			
Chemical Controls			
Chemicals are not stored on laboratory benches is excessive quantities			
Expired or chemicals not used (for more than one year) are disposed of as hazardous waste			
	Yes	No	N/A
Defined area for highly toxic or carcinogens clearly marked			
Secondary containment is provided for liquid chemicals			
No hazardous materials are stored in, around under or			

above sinks			
Incompatible chemicals are segregated and stored in compatible hazard classes.			
All chemical containers are closed, except when actively adding or removing materials from them (i.e., no open funnels left in container)			
Containers of peroxide-forming chemicals are dated upon receipt and disposed of as hazardous waste (see Appendix B-Chemical Hygiene Plan)			
Material Safety Data Sheets (MSDS) and laboratory chemical inventory are up-to-date and readily available			
Chemicals (liquids) are stored below eye level and not directly on the floor			
Flammable & Combustible Liquids			
What quantities of Class 1A liquids are stored in the lab?			
If there are more than 10 gallons of flammable liquids, doe the lab have the necessary fire protection systems available?			
How many flammable liquid storage cabinets are in the room and what is the capacity of each?			
Does the content of the storage cabinet exceed the maximum capacity of the cabinet?			
Flammable liquids (including flammable liquid waste) stored outside of a storage cabinet does not exceed 10 gallons?			
No flammable liquid storage cabinet are in the hallway			
Flammables are not dispensed from gravity-fed or bottom dispensing containers—use lid mounted pumps (including 5%Ethanol solutions)			
Flammables are not stored in combustible containers			
Ether and other highly flammable liquids are used away from sources of heat and ignition (including Bunsen burners in hoods and gas water heaters)			
Flammable storage cabinets vented at bottom and door locked when not being accessed			
	Yes	No	N/A
Acutely Hazardous Substances			
Have all acutely hazardous substances been identified?			
Is a current inventory available with appropriate MSDS information?			
Are areas or hoods where these substances are in use posted with a designated hazard sign?			
Have special procedures for these substances been identified?			
Are special procedures in practice? Verify procedures.			

Are all users adequately trained? Documentation available			
All compressed gas cylinders secured with cap in place, if not in use. Eight tank limit for non-flammable gases & five tank limit for flammable gases.			
All necessary PPP (personal protective equipment) available and used as needed.			
Radioactive Materials			
Stock materials of radioactive materials are secured against unauthorized removal?			
Do personnel wear lab coats, gloves and radiation dosimeters when handing materials?			
Are all labs using radioactive materials registered with the Radiation Safety Office?			
Chemical Waste Storage			
Have all chemical waste streams been identified as non-hazardous or hazardous and constituents been completely identified?			
Specific storage containers provided for (check applicable categories: () chemical waste ( ) recyclable solvents ( ) sharps ( ) radioactive waste			
All hazardous chemical waste is arranged to be picked up by Safety & Environmental Compliance Department—not drain disposed or evaporated			
All hazardous chemical waste is secondary contained.			
Solutions with heavy metals are collected separately and disposed of as hazardous waste			
The satellite hazardous waste accumulation storage are is clearly labeled			
Training for personnel handling hazardous waste is documented?			
	Yes	No	N/A
The Safety & Environmental Compliance Department is called for waste pick up when jugs are ¾ full			
Waste containers sturdy, compatible with the waste, routinely checked for leaks and kept closed when not be filled.			
Waste is segregated by compatible storage groups			
Are there any non-hazardous chemicals that are drain disposed? If so, what are they?			
Labeling			
All hazardous waste containers have the proper labels with the full chemical name or a list of full name and a percentage of each when waste mixtures are involved.			
The satellite accumulation area is clean with waste containers clearly marked, secondary contained and			

safety stored			
Synthesized, unnamed chemicals (including experimental drugs and chemicals) are labeled by their reactants and possible products or a useful generic description and possible hazardous. Do not label with chemical formulas only.			
BIOHAZARDOUS WASTE			
Storage			
Solid biohazardous waste is bagged in 2 mil polyethylene bags as per the Bio-Medical Waste Management Plan			
Biohazardous liquid waste is either chemically treated with disinfectant, when generated, or directly afterwards or autoclaved.			
All waste is properly segregated as per the Bio-Medical Waste Management Plan			
Labeling			
Transport container labels are filled out with the date, name of the generator and the name of the waste processor			
Do the containers meet DOT and ADEM standards?			
Treatment			
Written notebook log kept for autoclaved materials			
Log of autoclave validation runs includes: date, time, duration of run, pressure, temperature and number of ampoules included in waste treatment validation run			
	Yes	No	N/A
Animal carcasses are properly bagged and labeled before being placed in designated freezers. Freezers are labeled?			
Non-hazardous animal bedding is double bagged and disposed of properly			
Bio-hazardous animal bedding is bagged, autoclaved (when necessary) and transported to the incinerator			
All potentially infectious/contaminated sharps are placed in red, rigid plastic sharps containers			
When the sharps container is ¾ full it is sealed and placed is container for transport to disposal facility. Container must have appropriate packing and labeling			
All work surfaces are cleaned with a disinfectant solution that is active against the organisms in use. Clean and soiled storage areas must be separate. Procedures for cleaning and frequency must be defined. Verify procedure against practice			
PERSONAL HEALTH AND SAFETY			
Food and Drink			
Food and drink is not permitted in laboratories			
Food and drink is stored only in refrigerators/freezers			

dedicated and labeled "for food only"			
Standard Practices			
Employees wash areas of exposed skin prior to leaving the laboratory			
Hands must be washed after removing gloves and before leaving laboratory			
Hands must be kept away from face while working in the laboratory area. No cosmetic applications, taking medication, touching eyes, nose or mouth			
HEALTH AND SAFETY EQUIPMENT			
Safety Showers and Eye Washes			
Approved safety showers and eye washes provided within 10 seconds travel time from the work area for immediate use.			
All eye washes and showers have unobstructed access			
Units inspected monthly by the department and annually by Maintenance for proper functioning.			
Sign indicating location of safety shower and eye wash unobstructed.			
	Yes	No	N/A
Personal Protective Equipment			
Ha the correct PPE been selected based on a hazard analysis or manufacturer's recommendation?			
PPE required for lab work: ( ) Lab Coats, ( ) Safety glasses with side shields/goggles, ( ) Hearing protection, ( ) Face Shield, ( ) Proper foot-wear, ( ) Gloves, ( ) PPE for Radiological work, ( ) Aprons			
All necessary equipment is available, in good condition, and properly used.			
Laboratory Fume Hoods			
Storage inside of hood is kept to a minimum			
Equipment in use does not interfere with proper functioning of the hood			
All work is done at least 6 inches inside hood			
Front sash is lowered below chin level when hood is in use			
Certified within the last year (check certification located on front or side of hood)			
Hood has continuous flow monitor			
The back ventilation slot is open a minimum of 2 inches			
Drains are protected from hazardous materials entering			
Biological Safety Cabinet (i.e., Laminar flow hoods)			
Certified within the last year (check certification located on front or side of hood)			
Proper type of hood for work being conducted			

Equipment is properly labeled for the hazard present (radiation, UV,), Manufacturer approved for hazard.			
Hood ducted per manufacturers and ASHRA requirements and meet the CDC/NIH bio-safety specifications			
Compressed Gas Cylinders			
Cylinders stored in well protected, well vented and dry locations away from combustible materials			
Storage space is secured from damage either by passing or falling objects or subject to tampering by unauthorized persons.			
Cylinders are secured to a rigid structural component of the building with chains located 2/3 the height of the cylinder			
Protective caps in place while cylinders are in storage			
	Yes	No	N/A
Proper regulators are being used and closed when cylinders are not in use			
Air Pollution Control Equipment			
Are there any sources of air emissions other than chemicals being used in the hood?			
Is there any air pollution control equipment (vapor recovery systems, cyclones, scrubbers, bag houses, electrostatic precipitators) in use?			
If so, are they maintained and maintenance records kept?			
Housekeeping & Miscellaneous Laboratory Safety			
Bench tops clean, organized and environs maintained to eliminate harmful exposures or unsafe conditions			
Areas under sinks, window ledges, walls and floors kept orderly, Supplies stored at minimum 6 inches off floor or 18 inches from ceiling			
Vacuum lines equipped with traps designed specifically to accumulate/filter the hazardous materials being evacuated. If lab BL-3 or higher, does affluent receive heat or chemical treatment prior to disposal			
All moving machinery (i.e., vacuum pumps) belts adequately protected by a rigid belt guard or housing			
All sharps disposed properly			
The condition of the broken glass box is adequate and placed out of harms way. Box identified as to contents?			
Electrical Safety			
High voltage equipment (>600V) labeled, grounded and insulated			
No equipment has damaged or frayed cords			
Extension cords and power are not chained together			
Multiple adaptors used only if they are equipped with			

circuit breakers			
All equipment is grounded via 3-prong plugs			
Plug covers are intact and secure			
Hot plates and heaters are out of harm's way and monitored.			
Space heaters are not permitted in laboratory. Office areas may have space heaters if they meet Safety & Environmental Compliance Department requirement			
	Yes	No	N/A
Basic Safety			
Chemical shelves have lips or other type of restraint. Oxidizers are stored on wooden shelves and separated from other chemicals			
Cabinets and bookshelves are secured to the wall			
Overhead storage is minimized and restrained from falling			
Heavy equipment is secured or braced from falling			
Respiratory Protection			
Use of respiratory protection conforms to USA guidelines			
Respirators are inspected monthly and before any use			
The user has been fit tested by the Safety & Environmental Compliance Department representative			
Cartridges are changed on designated schedule and are the appropriate cartridge for the hazard			
Laser Safety			
Does the lab use any Class 3b or 4 lasers?			
Are the lasers registered with the Radiation Safety Department?			
Are the Standard Precautions for lasers prominently posted for each laser?			
Are appropriate warning signs and labels posted?			
Does the lab entrance have a warning light or lighted sign showing when the laser is in use?			
Have all workers been trained by the Laser Safety Officer?			
Does the lab have appropriate laser eyewear and has this been verified by the Radiation Safety Officer			
Non-Ionizing Radiation (NIR) Source			
Have proper warning signs been posted?			
Emergency Planning & Procedures			
"In Case of Emergency" or "Emergency Instructions" visibly posted and current			
Chemical spill kit/cleanup materials provided (if required by departmental plan)			

Training in spill clean-up procedures provided and documented (only if spill clean-up materials are provided)			
	Yes	No	N/A
First aid materials kept in adequate supply (in a sanitary and usable condition) and made readily available			
Fire Prevention			
Appropriate fire extinguisher mounted, unobstructed, available with 75 feet, in working order and inspected within the last year—check tag on extinguisher			
Fire extinguisher sign is clearly visible			
Fire blankets, labeled and unobstructed, if available			
18-i8nch vertical clearance maintained from sprinkler head (i.e., over shelving)			
Are all lab doors kept closed? Closure devices in place?			
Storage of combustible material is minimized			
Exits & Width of Exits			
Exits and aisles are clear and free of obstructions in case of emergency			
Exit signs clearly visible			
Width of exit aisles and pathways at least 44 inches			

Sample Chemical Hygiene Officer Certification Test

CHOOSE THE MOST CORRECT ANSWER.....

1. The sash cables on fume hoods should be inspected?
   A. Never
   B. Monthly
   C. Annually
   D. Two to five years

2. Prior to the implementation of the lab standard, laboratories were subject to what federal right to know regulation?
   A. 40CFR 261-264
   B. 29CFR 1910.1200
   C. ANSI standards
   D. 40CFR 300-399

3. Hazard rating numbers under GHS are …
   A. The same as NFPA
   B. The same as HMIS
   C. In the reverse order
   D. Unchanged

4. Why was the laboratory standard proposed?
   A. Laboratory workers requested their own standard
   B. The Assistant Secretary of Labor decided it was needed
   C. The American Chemical Society proposed it on behalf of its members
   D. Based on exposure data from NIOSH studies, it was determined that lab workers needed to address different hazards than industry

5. What facilities are usually not covered under the lab standard?
   A. Quality control laboratories
   B. Industrial laboratories
   C. Academic laboratories
   D. Medical laboratories

6. The decision on what laboratories are covered is based on what two definitions?
   A. Laboratory chemical and chemical manipulation
   B. Laboratory scale and laboratory process
   C. Laboratory use and laboratory scale
   D. Laboratory operations and Laboratory chemical

7. The key terminology for regulated chemicals in the standard is:
   A. Toxic substance
   B. Hazardous substance
   C. Hazardous chemical
   D. Toxic chemical

8. Most similar OSHA regulations use the term “regulated area” to describe a specific location where operations are controlled, but the lab standard used the term “designated area”. Why?
    A. OSHA wanted to make it more restrictive
    B. OSHA wanted to make it less restrictive
    C. Designated area means a location where carcinogens are used
    D. OSHA did it for no good reason

9. In the lab standard, the definition of laboratory scale is:
    A. A balance used for comparative measures
    B. The quantity of chemical used
    C. The use of chemicals in quantities small enough that they are easily manipulated by one person
    D. The use of chemical containers that can be manipulated manually by one person

10. In addition to the hazard communication standard, what OSHA regulation(s) did the lab standard generally replace as it applies to laboratories?
    A. Personal protection standard
    B. Process safety standard
    C. 1910 Subpart F
    D. 1910 Subpart Z

11. Toxic laboratory wastewaters are primarily regulated at the federal level by:
    A. RCRA
    B. NPDES
    C. TSCA
    D. They are generally exempt from regulation

12. Flammable vapors can ignite on contact with the surface of a hotplate if the surface is hotter than the vapor’s ….

    A. Bioling Point
    B. Autoignition Temperature
    C. Flash Point
    D. Flammability Limit

13. Which of the following information must be included on a hazardous material shipping paper?
    A. The CAS number, if one has been assigned
    B. The EPA number, if the material is a waste
    C. The PEL or TLV, if the material is toxic
    D. None of the above

14. Where can the hazardous materials table be found?
    A. 40CFR 261.33
    B. 49CFR 172.101
    C. 29CFR Subpart Z
    D. 29CFR 1910.134

15. NRC regulations are found in:
    A. 10CFR
    B. 16CFR
    C. 29CFR
    D. The Atomic Energy Act

16. The use of pesticides is regulated by:
    A. RCRA
    B. FIFRA
    C. TSCA
    D. CERCLA

17. Training of laboratory workers may be required by:
    A. US DOT
    B. HSCA
    C. TJC
    D. NIOSH

18. Which of the following are not routinely covered by the lab standard?
    A. Students
    B. Paid graduate assistants
    C. Maintenance workers who clean laboratories
    D. Chemistry teachers

19. Who has the ultimate responsibility for implementation of the standard?
    A. The laboratory manager
    B. Laboratory workers
    C. The Chemical Hygiene Officer
    D. The Chief Executive Officer

20. What is a “State Plan State”
    A. One which OSHA has designated to implement and enforce federal regulations
    B. One which OSHA finds deficient in managing its regulations
    C. One which has its own equivalent regulations to protect state and municipal employees which have been approved by OSHA
    D. One with an approved laboratory standard

21. An insidious hazard is one which:
    A. Attacks internally through the blood stream
    B. Is chemical, not physical
    C. Is not obvious
    D. Is airborne

22. Which contains the most correct label elements under GHS are:
    A. Pictogram, signal word, precautionary statement, hazard class
    B. Pictogram, hazard diamond, hazard statement, precautionary statement
    C. Pictogram, hazard warning, signal word, hazard class
    D. Pictogram, hazard & precautionary statements, signal word

23. Which of the following is NOT an example of incompatibility?
    A. mineral acids stored on metal shelves
    B. hydrochloric acid and sodium hydroxide
    C. isocyanate and sodium hydroxide
    D. picric acid and water

24. Which of the following can be abbreviated on hazardous material shipping papers?
    A. Unit of measure
    B. Proper shipping name
    C. Hazard class
    D. None of the above

25. What does this pictogram mean?

    A. Health hazard
    B. Physical hazard
    C. Irritant
    D. Reproductive hazard

26. Under 29CFR1910.132, the general industry requirement for PPE, the employer must …
    A. Assess the workplace hazards
    B. Select and Provide the necessary PPE
    C. Ensure that the PPE is used
    D. All of the above

27. According to the lab standard, under what specific conditions are medical consultation and examinations appropriate?
    A. When an employee develops signs or symptoms of exposure to a chemical used in the lab
    B. When monitoring reveals an exposure level exceeds an OSHA PEL
    C. When there is an event likely resulting in hazardous exposure
    D. All of the above .

28. What constitutes an emergency according to the lab standard?
    A. Imminent danger to the environment
    B. A fire or explosion
    C. Uncontrolled release of a hazardous chemical into the workplace
    D. Event which leads to serious injury or death of an employee

29. What specific rules govern the maintenance of employee medical records?
    A. 29 CFR 1910.20
    B. 29 CFR 1910.1020
    C. 29 CFR 1910.10
    D. 29 CFR 1910.1200

30. How frequently must the Chemical Hygiene Plan be reviewed?
    A. Whenever the CHO decides it is necessary
    B. Whenever there is a hazardous release resulting in injury or death
    C. At least annually
    D. Annually

31. Static electricity from clothing is known to initiate detonation of sensitive explosives and flammable gas mixtures when exposed to certain humidity levels. Which of the following levels is safest?
    A. Less than 25% relative humidity
    B. 40% relative humidity
    C. 75% relative humidity
    D. Greater than 75% relative humidity

32. The OSHA General Duty Clause:
    A. Requires employers to train all employees to do their job safely
    B. Requires employers to prevent hazardous exposures
    C. Requires employers to provide a safe workplace
    D. Requires employers to monitor all incidents resulting in injury or death

33. OSHA substance specific standards exist for which of the following compounds:
    A. Formaldehyde
    B. Cadmium
    C. Vinyl chloride
    D. All of the above

34. A laboratory facility must comply with the bloodborne pathogen standard if:
    A. Employees are likely to require first aid occasionally
    B. Human tissue is processed
    C. Employees are expected to provide first aid as part of their job functions
    D. There is a first aid station

35. In which section of an SDS would you find the pH of a product?
    A. Hazard information
    B. Disposal considerations
    C. First aid measures
    D. Physical and chemical properties

36. Refresher training to comply with the laboratory standard should be performed:
    A. Whenever the employer decides
    B. Annually
    C. Semi-annually
    D. As part of regular, routine safety meetings

37. If the composition of a new chemical produced exclusively for a laboratory's use is known, then:
    A. It should be considered hazardous until medical data concludes it is safe
    B. A record search of appropriate data should be made
    C. The employer should determine if it is hazardous
    D. It can be considered non-hazardous until determined otherwise

38. The “Rainbow Passage” is known for:
    A. Testing sobriety
    B. Preventing discrimination in the workplace
    C. Chromatic separation of carcinogens
    D. Testing respirator fit

39. The employer must determine if exposure to regulated hazardous chemicals is above regulated levels:
    A. For all airborne contaminants in the workplace
    B. For those chemicals determined to be hazardous
    C. For all chemicals present in the workplace
    D. For those chemicals in subpart Z for which there is a standard which requires monitoring.

40. The new GHS labeling requirements:
    A. Are in effect now for everyone
    B. Will be phased in through 2020
    C. Apply currently only to manufacturers
    D. Scheduled to be implemented by employers in 2016

41. How frequently must the Chemical Hygiene Plan be updated?
    A. Whenever it is reviewed
    B. As needed
    C. At least annually
    D. Annually

CHO CERTIFICATION SAMPLE TEST ANSWERS

1. C.
2. B.
3. C. .
4. B. (See Paragraph 2 of the initial summary)
5. A.
6. C.
7. C. (see the last paragraph on page 3313 of the standard)
8. B. (See page 3315, center column; C is a correct statement but it does not answer the question)
9. C. (The final regulation eliminated the need for a chemical to be manipulated manually. They can be manipulated with mechanical assistance - Pg. 3316, 1st paragraph)
10. D.
11. B. (The National Pollution Discharge Elimination System, established by the Clean Water Act, sets discharge limits for toxic wastewaters. RCRA exempts toxic laboratory wastewaters)
12. B.
13. B.
14. B.
15. A.
16. B.
17. A.
18. A.
19. D.
20. C.
21. C.

22. D.

23. D.

24. A.

25. C.

26. D.

27. D.

28. C.

29. B.

30. C.

31. D. Low relative humidity can produce dangerous voltages on the body, even with cotton. (Hammer, W., Occupational Safety Management and Engineering, Prentiss-Hall, Englewood, NJ., 1981)

32. C.

33. D. (29CFR 1910.1048, 1027, 1017)

34. C. "Occupational exposure means reasonably anticipated...contact with blood or other potentially infectious materials that may result from the *performance of an employee's duties*"

35. B. DOT requires that all cylinders, other than most ammonia cylinders (10 years), be hydrostatically tested every five years.

36. A. Refresher training frequency should probably be specified in the CHP, and always documented.

37. A or C.

38. D. It is widely referenced by OSHA for fit testing of respirators

39. D. Only those chemicals in subpart Z for which there is a standard which requires monitoring.

40. D.

41. B.

LABORATORY SAFETY COURSE EVALUATION FORM

Location:_____Date_____/_____/_____

Instructor: □ James Kaufman. Ph.D □ Raj Santhappa □ other _____

Course: □ One-Day □ Two-Day □ 24-Hour □ BITL □ CHO □ other _____

1. What did you like most about the course?

2. What areas of the course most need improvement?

3. Any other comments and/or recommendations you wish to make are welcome.

Please rate the following questions by writing the number that best represents your opinion.
An optional comment section is available for each question.

Least Satisfied									Most Satisfied
1	2	3	4	5	6	7	8	9	10

1. **Program Format:** The overall format and presentation of the course are appropriate to the material presented.
   Rating____ Comments:

2. **Technology:**
   a. PowerPoint presentations enhanced the material presented.
      Rating____ Comments:

   b. Videos enhanced the material presented.
      Rating____ Comments:

   c. Program Content: Content was appropriate for my laboratory safety needs.
      Rating____ Comments:

3. **Instruction:**
   a. Instructor(s) demonstrated expert knowledge of subject matter.
      Rating____ Comments:

(Please also complete Page 2)

Y. Evaluation

SCALE

Least Satisfied									Most Satisfied
1	2	3	4	5	6	7	8	9	10

b. Instructional techniques and skills were appropriate for the course material.
Rating____ Comments:

4. **Facilities:** Location and facilities were convenient and suitable for the course.
Rating____ Comment:

5. **Refreshments:** These were satisfactory in terms of amount and quality.
Rating____ Comment:

6. **Course Materials:** Content of notebook and handouts reinforced my learning experience.
Rating____ Comment:

Would you have preferred to receive your notebook in an electronic format instead of this three-ring printed version? Check one: Printed ___ PDF ___ CD ___ Thumb drive ___

OPTIONAL INFORMATION:

May we quote you? Your comments may be used for promotional purposes, posted on our website, or in support of grant applications. If you prefer to remain anonymous, please indicate a position title for us to use rather than your name.____No_____Yes

Name:_____Organization:_____

Email: _____

How did you hear about LSI?_____

Do you know someone who could benefit from receiving information about the Laboratory Safety Institute?
□ Upcoming Courses □ On-site Training Program □ Audits and Inspections □ Publications

Name:_____

Phone:_____

Email: _____