

Electronics Workforce Development System

Hazardous Materials In a Clean Room



Brevard Community College

Cirent Semiconductor

Hillsborough Community College

Seminole Community College

University of Central Florida

University of South Florida

Valencia Community College





Introduction

Hazardous Materials

in a Clean Room

Module

This module will teach students an introduction to Hazardous Materials used in a typical production clean room environment. It will provide information on chemical hazards, which might be encountered in clean room workplaces. It will also provide information on safe handling and emergency procedures relating to hazardous chemicals. The course is complemented by a series of hands-on lab experiments.

Module Design

The Hazardous Materials in a Clean Room module was prepared at Brevard Community College based on recent needs identified by high-technology business and industry representatives. The module is designed to be used in conjunction with the book by Baldwin, Williams and Murphy, Chemical Safety Handbook for the Semiconductor/Electronics Industry: OEM Press, 1996. As such, it contains an extensive outline of the topics to be covered in the course, as well as additional material from other references. This module is one of a series of modules that form part of the Electronics Workforce Development System.

About the Electronics Workforce Development System

The Electronics Workforce Development System is aiming to increase the number of skilled technicians available in the engineering/electronics field. The focus of this system is to improve the quality of courses in basic mathematics, science and engineering core courses, as well as more specialized engineering technology courses that yield technicians needed by the electronics industry.

After completing their education, community college graduates may elect to immediately seek employment in the engineering technology field or choose to pursue a four-year degree. Brevard Community College, Hillsborough Community College, Seminole Community College and Valencia Community College have an articulation agreement with the University of Central Florida to offer a Bachelor of Science degree program in Electrical Engineering Technology (BSEET) or Engineering Technology (BSET).

About the NSF

The National Science Foundation (NSF), through the Advanced Technological Education (ATE) program has provided support for this project to strengthen science and mathematics preparation of technicians being educated for the high-performance workplace of advanced technologies.

Focusing on both national and regional levels, the ATE centers and projects result in major improvements in advanced technological education, serve as models for other institutions and yield nationally usable educational products.



Hazardous Materials in a Clean Room Syllabus

Course Information

Title	Hazardous Materials in a Clean Room
Course Number	ETI xxxx
Credits	3
Organization	Brevard Community College
Instructor	Meer Almeer
Office	Bldg. 7 Room 110
Phone	(321) 632-1111 Ext. 33800
E-mail	<u>AlmeerM@brevard.cc.fl.us</u>
Office Hours	TBA
Prerequisites	None
Course Description	This course is an introduction to hazardous materials used in a typical production clean room environment.
Textbooks	Baldwin, Williams and Murphy. <u>Chemical Safety Handbook for the Semiconductor/Electronics Industry</u> . Second edition, OEM Press, 1996. (Textbook is required.)

Grading Policy

Exam 1	25%	A	90 – 100
Exam 2	25%	B	80 – 89
Labs	25%	C	70 – 79
Final Exam	25%	D	58 – 69
		F	0 – 57

Material to be Covered

Session	Lesson	Topic
1	A	Understanding Hazardous Materials
2	B	Methods and Observations to Detect Hazardous Chemical Releases
3	C	Federal Mandated Hazardous Material Awareness Program
4	Exam 1	Test covers material from sessions 1-3
5	D	Chemical Labeling
6	E	Material Safety Data Sheets (MSDS)
7	F	Personal Protective Equipment Required for Hazardous Chemical Handling
8	Exam 2	Test covers material from sessions 5-7
9	G	Understanding and Reacting to Hazardous Material Emergencies in the Workplace
10	Final Exam	Comprehensive

Hazardous Materials in a Clean Room

Course Outcome Summary

Course Information

Title Hazardous Materials In A Clean Room

Course Number ETI xxxx

Credits 3

Organization Brevard Community College

Developer Meer Almeer

Development Date June 8, 2001

Instructional Level Associate Degree

Instructional Area Electronics Engineering Technology

Division/Department Technology/Technical Programs

Types of Instruction

Instructional Type	Contact Hours	Outside Hours	Credits
Classroom	28		3
Laboratory	20		
Totals	48	—	3

Target Population This course is designed to teach post-secondary students in either a two-year technical program (A.S./A.A.S.) or shorter-term certificate program in some type of industrial or manufacturing technology.

Description This course is an introduction to hazardous materials used in a typical production clean room environment.

Textbooks Baldwin, Williams and Murphy. Chemical Safety Handbook for the Semiconductor/Electronics Industry. Second edition, OEM Press, 1996. (Textbook is required.)

Core Abilities and Indicators Matrix

Core Ability	Indicator
1. Thinks Critically	<ol style="list-style-type: none"> 1. Learner is able to link information from multiple fields into a coherent picture of the whole. 2. Learner is capable of abstract thought and theoretical insight. 3. Learner can identify a problem and come up with multiple solutions. 4. Learner can break down a problem into its constituent parts and analyze each part. 5. Learner can evaluate the problem and determine an appropriate solution for a particular situation.
2. Learns Efficiently	<ol style="list-style-type: none"> 1. Learner takes responsibility for his/her own learning. 2. Learner identifies and studies relevant facts. 3. Learner organizes information effectively. 4. Learner presents knowledge clearly and concisely. 5. Learner uses the appropriate resources to enhance the learning process.
3. Applies Knowledge Successfully	<ol style="list-style-type: none"> 1. Learner understands the relationship between theoretical concepts and their practical application. 2. Learner can evaluate the limitations of applying abstract knowledge to real-world solutions. 3. Learner can evaluate the usefulness of theoretical insight to practical applications. 4. Learner is able to extrapolate the solution to future applications from situations encountered. 5. Learner can successfully solve real-world problems with knowledge acquired conceptually.
4. Communicates Effectively	<ol style="list-style-type: none"> 1. Learner is able to express him/herself concisely. 2. Learner is able to convey complex technical information in an understandable manner. 3. Learner communicates effectively using the written word. 4. Learner knows how to present data using the best tools available. 5. Learner is able to summarize the most important fact or idea of a given topic.
5. Works Well with Others	<ol style="list-style-type: none"> 1. Learner can work cooperatively. 2. Learner can communicate effectively with others. 3. Learner is a team player. 4. Learner can assume responsibility in a group environment. 5. Learner is sensitive to the opinion of others.

Units and Competencies Matrix

Unit	Competency
A. Understanding Hazardous Materials	<ol style="list-style-type: none"> 1. What are hazardous chemicals? 2. Physical hazards. 3. Health hazards. 4. Acute vs. chronic exposure. 5. Routes of exposure.
B. Methods and Observations to Detect Hazardous Chemical Releases	<ol style="list-style-type: none"> 1. Automatic or mechanical detection systems. 2. Personal awareness.
C. Federal Mandated Hazardous Material Awareness Program	<ol style="list-style-type: none"> 1. OSHA Hazard Communications Standard (29CFR1910.1200).
D. Chemical Labeling	<ol style="list-style-type: none"> 1. Vendor supplied. 2. NFPA diamond. 3. Other.
E. Material Safety Data Sheets (MSDS)	<ol style="list-style-type: none"> 1. Overview. 2. Information contained.
F. Personal Protective Equipment Required for Hazardous Chemical Handling	<ol style="list-style-type: none"> 1. What is required? 2. When is it used? 3. How is it used?
G. Understanding and Reacting to Hazardous Material Emergencies in the Workplace	<ol style="list-style-type: none"> 1. Reaction to automatic or mechanical alarms. 2. Emergency first-aid in the event of hazardous chemical contact.

Purpose of the Course

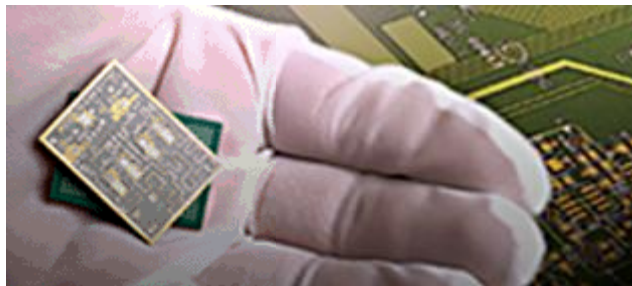
- To provide basic information on chemical hazards that might be encountered in clean room work places.
- To provide information on safe handling and emergency procedures relating to hazardous chemicals.



Hazardous Materials and Clean Rooms

Hazardous materials (chemicals) are used in many clean room operations:

- Computer chip manufacturing
- Circuit board/electronics fabrication
- Space hardware assembly operations
- Medical research
- Many others



Any chemical can be hazardous if improperly used, for example:

- Chanel No. 5 perfume



Chemical Hazard Categories

- Physical hazards
- Health hazards



Physical hazards:

Combustible liquid:	Flashpoint over 100 degrees
Flammable:	Most solvents
Compressed gas:	High-pressure cylinders
Explosive:	Hydrogen gas
Pyrophoric:	Can ignite in air
Organic peroxide:	Unstable O ² bond; reactive
Oxidizer:	Can release oxygen at high levels
Reactive:	Unstable; can produce dangerous side effects
Water reactive:	Reacts violently with water
Cryogenic:	Extreme low temperatures

Health hazards:

Carcinogens:	Cause cancer: <ul style="list-style-type: none">• Arsenic (suspected carcinogen)• Gasoline• Sulfuric Acid mists
Corrosive:	Causes destruction of living tissue on contact: <ul style="list-style-type: none">• Sulfuric acid• Nitric acid
Toxic:	Poison: <ul style="list-style-type: none">• Chlorine• Diborane
Irritant:	Irritation of tissue on contact: <ul style="list-style-type: none">• Some solvents• HMDS hexamethyldisilazane
Sensitizer:	Causes allergic reaction after repeated contact

Target organs:

Liver	Isopropyl alcohol	Hepatotoxin
Kidney	Isopropyl alcohol, Nitrogen trifluoride	Nephrotoxin
Nervous system	Phosphine, Diborane	Neurotoxin
Blood or circulatory system	Arsine, Boron tribromide	Hemotoxin
Reproductive system	Organic solvents	Mutagens/teratogens
Skin	Acids, Methanol	Cutaneous hazards
Lungs and respiratory system	Organic solvents	

A hazardous material is defined as:

“...a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term ‘health hazard’ includes chemicals that are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatoxins, nephrotoxins, neurotoxins, agents that act on the hematopoietic system and agents that damage the lungs, skin, eyes or mucous membranes.”

or

“...a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, pyrophoric, unstable (reactive) or water-reactive.”

— OSHA Hazard Communication Standard

Exposures

Acute:

- Effects occur rapidly as result of short-term exposure. (Sulfuric Acid)

Chronic:

- Effects caused by long-term or cumulative exposure. (Smoking/Asbestos)



Methods and Observations to Detect Hazardous Chemicals in Clean Room Workplaces

Automatic detection systems:

- Automatic toxic and explosive gas detection systems.

Personal observation:

- Unusual odors
- Obvious spills or leaks
- Unusual physical symptoms — pain, burning sensations, breathing problems, Dizziness, unusual feelings

Awareness of Chemicals

Federal Hazardous Materials Program

OSHA Hazard Communications Standard (29 CFR 1910.1200)
“HAZCOM”

“...any person working with, in the immediate proximity or routinely exposed to hazardous chemicals must receive training on awareness of chemical identification (labels and material safety data sheets), personal protection and emergency procedures...”



Chemical Labeling

All chemical containers must be labeled:

- NFPA diamond
- Manufacturers label
- Other



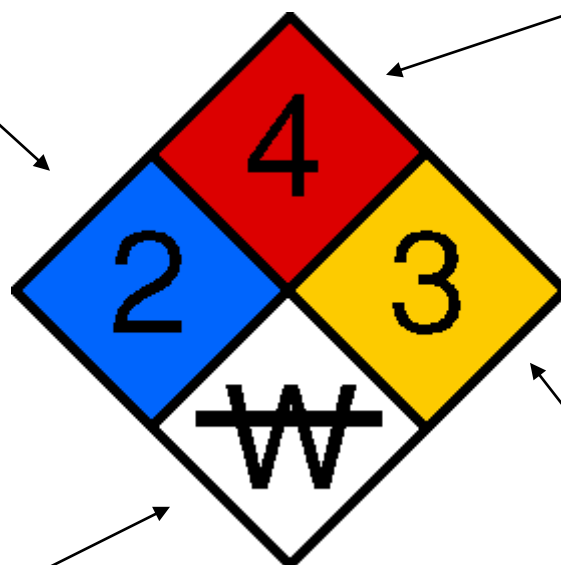
NFPA Diamond

Health

4 – Deadly
 3 – Extreme Danger
 2 – Hazardous
 1 – Slightly
 Hazardous
 0 – Normal Material

Fire Hazard

Flash Points
 4 – Below 73 F
 3 – Below 100 F
 2 – Below 200 F
 1 – Above 200 F
 0 – Will Not Burn



Specific

OXY – Oxidizer
 ACID – Acid
 ALK – Alkali
 COR – Corrosive
~~W~~ – Use No Water

Reactivity

4 – May Detonate
 3 – Shock and Heat
 (May Detonate)
 2 – Violent Chemical Change
 1 – Unstable If Heated

4 – Severe Hazard
 3 – Serious Hazard
 2 – Moderate Hazard
 1 – Slight Hazard
 0 – Minimal Hazard

VENDOR SUPPLIED LABEL

Signal Word	Name Of Chemical	Manufacturer Information
<p>WARNING</p> <p>Other Hazards</p> <p>First Aid</p> <p>Handling & Storage</p>	<p>Isopropyl Alcohol (2-Propanol) <i>Ashland Chemical</i></p> <p>FLAMMABLE LIQUID 3</p>	<p>7280270 I-341 POLY</p> <p>This Product Meets or exceeds purity specifications of: Semiconductor Equipment & Materials Institute (SEMI)</p> <p>FOR INDUSTRIAL USE ONLY Before use review material safety data sheet for further information, including chronic health effects. AOI EMERGENCY TELEPHONE NUMBER: 1-800-ASHLAND</p> <p>DOT Shipping Name: ISOPROPANOL Hazard Class: FLAMMABLE LIQUID Nonphotochemically Reactive CH₃CHOHCH₃ CAS: 67-63-0</p> <p>PPE Required</p> <p>NFPA Diamond</p>

Primary Hazard Symbol

**COMPUTER GENERATED
LABEL**

ISOPROPYL ALCOHOL

856245

3	FIRE HAZARD
1	HEALTH HAZARD
0	REACTIVITY

Flammable

CONSULT MSDS FOR ADDITIONAL HAZARDOUS INFORMATION AND INSTRUCTIONS

- 4 - Severe Hazard**
- 3 - Serious Hazard**
- 2 - Moderate Hazard**
- 1 - Slight Hazard**
- 0 - Minimal Hazard**

Material Safety Data Sheets (MSDS)

- Supplied by chemical manufacturer
- May be prepared by employer if produced by the employer (i.e., special mixture)
- Must be made available to employees
- No standard format

(**See attached company MSDS sheet)

Material Data Sheet Information

Most MSDS contains sections on:

Product name and manufacturer – Specific, generic and common name of chemical, name of supplier and 24-hour emergency phone number.

Product ingredients – Hazardous components of the chemical or mixture. Proprietary or “secret” ingredients available from EHS.

Potential health effects – Symptoms of acute or chronic exposure, target organs, effects on pregnant women and any cancer related evidence.

First aid – Immediate first aid in case of contact, inhalation or ingestion.

Fire fighting instructions – Procedures to extinguish chemical fire. Special fire hazards, flash point, explosive limits, ignition data, NFPA ratings.

Accident response – Information on emergency reaction to chemical spills or release. Clean-up measures and disposal information.

Safe handling and storage information – Procedures for safe handling, use and storage.

Personal protection – Recommended personal protective equipment. Exposure guidelines for health and safety.

Physical and chemical properties – May include boiling point, vapor pressure, volatility, color, odor, density, specific gravity, etc.

Stability and reactivity – Possibilities of dangerous reaction if mixed with another substance, incompatible substances or other things to avoid.

Toxicological information – Detailed scientific information for physicians or other health care professionals.

Ecological information – Effects of the chemical on plants, crops, fish and other wildlife.

Disposal considerations – Waste management information. Proper disposal requirements.

Transportation information – Proper shipping or packaging. U.S. Department of Transportation requirements.

Regulatory information – Additional federal and state compliance and reporting requirements.

Miscellaneous information – Other useful information.

Personal Protective Equipment (PPE)

Will be supplied by employer

Need depends on job being performed:

- For example, chemical resistant gloves, safety goggles, respirator

Know what is required:

- OJT
- Read job specifications
- Read Chemical labels
- Read PPE Section of MSDS

Know how to use PPE:

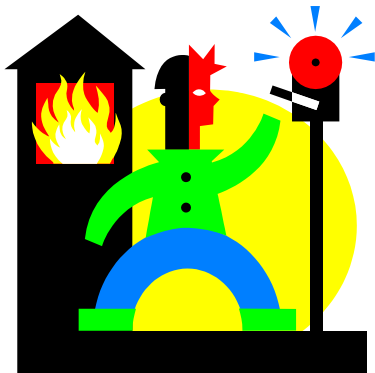
- OJT
- Read operational specifications
- Read instructions on PPE label

Know when to use PPE:

- Any time there is a possible exposure for contact, inhalation or ingestion

Emergency Procedures

- Every facility has specific procedures to be followed exactly in the event of hazardous material emergencies.
- You will receive training on proper emergency procedures.
- Know what to do in the event of:
 - Fire or fire alarm
 - Release of toxic material
 - Spills or accidental releases of hazardous materials



Emergency First Aid for Chemical Exposure

Each company has specific procedures in the event of hazardous material exposure — KNOW THEM!

General first-aid procedures:

- Contact with eyes or skin:
 - Immediately flush the affected area with copious amounts of cool flowing water
 - Remove any contaminated clothing
 - Get medical attention
- Inhalation:
 - Get out of the area of exposure
 - Get to fresh air
 - Get medical attention
- Ingestion:
 - Read label or MSDS for treatment
 - Get medical help
- Know how to contact medical aid
- Report all exposures to immediate supervisor

Glossary of Terms

Common terms found in Hazard Communication Programs

----- A -----

ACGIH	American Conference of Governmental Industrial Hygienists. Develops TLVs.
Acid	Has sour taste and may cause severe skin burns. Turns litmus paper red, pH 0 to 6.
Acute Effect	Severe symptoms develops rapidly to crisis. Includes dizziness, nausea, rashes, inflammation, tearing and unconsciousness.
Acute Toxicity	Adverse effects from single dose or exposure.
Aerosol	A fine suspension of particles in air.
Air Line Respirator	Breathing device connected to Grade D compressed air source, PF = 1000.
Air-Purifying Respirator	Breathing device uses absorbents/filters and removes specific contaminants. Needs sufficient oxygen atm contaminant level below limits of device. PF 10 – 100.
Alkali	Bases can severely burn skin. Turns litmus paper blue, pH 8 to 14.
Allergic Reaction	Abnormal physiological response to a chemical by a sensitive person.
Anesthetic	Causes loss of sensation, impaired judgment, drowsiness, unconsciousness.
ANSI	American National Standards Institute. Develops national consensus standards.
Antidote	Prevents or counteracts effects of a poison.
Aquatic Toxicity	Adverse effects to marine life results from exposure to harmful substances.

Article	Manufactured item typically not hazardous.
Asphyxiant	Vapor or gas that causes unconsciousness or death by suffocation (lack of oxygen).
ASTM	American Society for Testing and Materials.
Asymptomatic	Showing no symptoms.
Atm	Atmosphere, air pressure. 1 atm = 760 mmHg.
Auto-Ignition	Degrees a container is heated so flammable liquid ignites and burns.

----- **B** -----

Benign	Not tending to progress. Not cancerous.
Biodegradable	Capable of being broken down into innocuous products by living things.
Biopsy	Removal and examination of tissue from a living body.
Boiling Point	Temperature liquid changes to vapor.
Bonding	Connecting via clamp and wire. Stops static discharge for flammable transfer. Grounding.
Bulk Density	Mass of powdered or granulated solid material, per unit of volume.

----- **C** -----

C	Ceiling limit. ACGIH terminology. See TLV
Carcinogen	Substance that causes growth of abnormal tissue or tumors in humans or animals.
Carcinoma	A malignant tumor. A form of cancer.
C.A.S.	Chemical Abstracts Service. "C.A.S. Numbers" uniquely identifies specific chemicals.
Caustic	See alkali.

Cc	Cubic centimeter. Volume. 1 ml = 20 drops
Ceiling Limit	Maximum airborne human exposure limit — not to be exceeded even momentarily. See PEL.
Central Nervous System	Brain and spinal cord (CNS). If damaged, effects are irreversible.
CERCLA	Comprehensive Environmental Response, Compensation, Liability Act. “Superfund” cleanup of hazardous waste disposal sites.
CFR	Code of Federal Regulations.
Chemical	Element or compound produced by reaction.
Cartridge Respirator	Breathing device. Purifies inhaled air of specific contaminants.
Chemical Family	Group of single elements or compounds with a common general name.
Chemical Name	Scientific designation of chemical I.D.
Chemical Pneumonitis	Lung inflammation cause by accumulation of fluids due to chemical irritation.
Chemical Structure	Arrangement of molecule of atoms and bonds.
CHEMTREC	Chemical Transportation Emergency Center.
Chronic Effect	Adverse effects developed slowly or recurring.
Chronic Exposure	Long-term contact with a substance.
Chronic Toxicity	Adverse effects from repeated doses or exposures over long periods of time.
Clean Air Act	EPA regulation that reduces air pollution (CCA).
Clean Water Act	EPA regulation that reduces water pollution (CWA).
CO	Carbon monoxide. Colorless, odorless toxic gas produced by incomplete combustion. Reduces blood’s ability to carry oxygen.

CO ₂	Carbon dioxide. Colorless gas produced by combustion and decomposition of organics.
COC	Cleveland Open Cup. Flashpoint test method.
Combustible	Able to catch on fire and burn.
Combustible Liquid	Liquid having a flashpoint > or = 100° F but < 200° F.
Compressed Gas	Gas with pressure > 40 psi (70° F) or gas mixture pressure > 104 psi (at 130° F) or liquid vapor pressure > 40 psi (100° F).
Concentration	Relative amount of a substance when combined or mixed with other substances.
Confined Space	Area with limited openings for entry/exit, emergency escape. Difficult and lacks ventilation. Contains known or potential hazards and not intended for continuous human occupancy.
Conjunctivitis	Inflammation of conjunctiva, the membrane that lines the eyelids and covers the eyeballs.
Consumer Product	Item for general public purchase and normal use. Not typically OSHA hazardous material.
Container	Any drum, vial, package, vessel, tank, etc., but not a pipe that is used for hazardous chemicals.
Corrosive	Liquid or solid that causes visible destruction of skin tissue on contact. Packaging per DOT. A liquid that severely corrodes steel.
CPSC	Consumer Products Safety Commission.

----- D -----

Decomposition	Breakdown of material by heat, reaction or decay into elements or simple compounds.
Density	Mass (weight) per volume unit of substance.
Depressant	Substance that reduces bodily functional activity or instinctive desire (e.g. appetite).

Dermal Toxicity	Adverse effects resulting from skin exposure to a substance.
Dermatitis	Inflammation of the skin.
Dike	Barrier controls or confines hazardous substances. Prevents entry into waterways.
Dilution Ventilation	Air flow designed to dilute contaminants to acceptable levels. See General Exhaust.
DOL	U.S. Department of Labor. Includes the Occupational Safety and Health Administration (OSHA).
DOT	U.S. Department of Transportation. Regulates transportation of chemicals and wastes.
DOT Hazard	Hazardous materials shipments must be labeled with DOT hazard classes: Corrosive, Flammable Liquid, Organic Peroxide, ORM-E and Poison B.
Drug	Chemical recognized by U.S. Pharmacopoeia or National Formulary and intended for diagnosis, cure or prevention of disease.
Dry Chemical	Powdered fire extinguishing agent, usually sodium or potassium bicarbonate. ABC type.

----- E -----

Edema	Abnormal accumulation of watery fluid in tissues (e.g. lungs).
EPA	U.S. Environmental Protection Agency. Enforces CCA, CWA, FIFRA, RCRA, TSCA, etc.
Evaporation Rate	The speed material vaporizes (evaporates) compared to rate of known material (water or ether).
Exothermic	Chemical reaction that produces heat.
Explosive	Chemical causes sudden release of pressure and gas when subjected to shock or high temperature.
Exposure	Subjected to hazardous chemicals via skin ingestion, inhalation or absorption.

Extinguishing Media Fire-fighting substance used to control a material in the event of fire.

Eye Protection Safety glasses, splash goggles, face shields.

----- **F** -----

F Fahrenheit. Scale for measuring temperature. Water boils at 212° F and freezes at 32° F.

f/cc Fibers per cubic centimeter of air.

FDA U.S. Food and Drug Administration.

Fibrosis Abnormal thickening of fibrous connective tissue, usually in the lungs (e.g. asbestosis).

FIFRA Federal Insecticide, Fungicide and Rodenticide Act. Regulates pesticides.

First Aid Emergency medical measures taken before professional medical help arrives.

Flammability Limits Range of gas or vapor concentration in air. May ignite if ignition source is present.

Flammable Aerosol Airborne dispersion with flame projection > 18 inches or produces a flashback.

Flammable Gas Flammable gas-air mixture < 13 percent (volume) or flammable gas-air mixture range > 12 percent.

Flammable Liquid Liquid with flashpoint < 100° F.

Flammable Solid Causes fire through friction, absorption of moisture, spontaneous reaction. Ignited readily and burns vigorously.

Flashback Flame from torch burns back. Hissing sound, smoky or sharp flame.

Flash Point Temperature at which liquid gives off enough flammable vapor to burn if ignited.

Food	FDA nutritional product, ingredient, baby formula, except not vitamins A and D.
Fume	Airborne dispersion of minute solid particles arising from heating a solid, such as lead.

----- **G** -----

g	Gram. A metric unit of mass weight.
Generic Name	Nonproprietary name for a material.
g/kg	Grams per kilogram.
Grounding	Procedure to carry electrical charge to the ground through a conductive path.

----- **H** -----

Hand Protection	Gloves or other specific protection to prevent exposure to hazardous materials.
Hazardous Chemical	Material that is a physical or health hazard.
Hazardous Material	Chemical that is a physical or health hazard.
Hazardous Decomposition	Toxic materials produced in dangerous amounts if material reacts with other agents or burns.
Hazardous Polymerization	Chemical reaction atoms that combine to form large molecules and release large quantities of energy.
Hazardous Warning	Words, pictures or symbols on labels to inform of material hazards.
HAZ-COM	Hazard Communication Standard OSHA 29 CFR 1910.1200. Right-to-Know laws.
Health Hazard	A chemical that causes acute or chronic health effects. Includes carcinogens, toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatoxins, nephrotoxins, neurotoxins or acts on lungs, hematopoietic system, skin, eyes or mucous membranes.

Highly Toxic

Chemical in any of the following categories:

- a. $LD_{50} < 50$ milligrams (per kg body weight) administered orally to albino rats.
- b. $LD_{50} < 200$ milligrams (per kg body weight) administered by 24-hour continuous contact.
- c. $LC_{50} < 200$ parts per million in air or < 2 mg/l mist, fume or dust. Administered one-hour inhalation.

----- **I** -----

IARC

International Agency for Research on Cancer. IARC Monographs, a listing of carcinogens.

Ignitable

Capable of being set afire.

Impervious

Material barrier that does not allow another substance to pass through or penetrate it.

Incompatible

Materials that cause undesired reactions from direct contact with one another.

Ingestion

Taking in a substance through mouth (eating).

Inhalation

Breathing in a substance in the form of a gas, vapor, fume, mist, fiber or dust.

Inhibitor

Chemical added to another substances. Prevents an unwanted chemical change from occurring.

Insoluble

Incapable of dissolving in a liquid.

Irritant

Substance contact causes inflammation response of the eye, skin or respiratory system.

----- **K** -----

kg

Kilogram. A metric weight unit. $1000\text{ g} = 1\text{ kg}$.

----- **L** -----

L

Liter. A metric unit of liquid volume.

Laboratory

Designated area for research and testing, and, if covered by OSHA Chemical Hygiene Plan, is exempt from most requirements of 1910.1200.

LC ₅₀	Lethal Concentration 50. Amount of material in air that kills 50 percent of test animals. Administered one to four hours. Expressed as ppm.
LC _{Lo}	Lethal Concentration — Low. Least amount of gas or vapor capable of killing a specified species in a specified time.
LEL	Lower Explosive Limit; least vapor or gas concentration (percent in air) that produces fire if ignited. If < LEL, mixture is too “lean” to burn. Also see UEL.
LFM	Linear feet per minute, unit of air velocity.
Local Exhaust	System for capturing and exhausting contaminants from point produced.
----- M -----	
M	Meter. A metric unit length. 1 meter = 39 inches.
m ³	Cubic meter. A metric volume measure. 1 cubic meter = 35.3 ft ³ .
Malignant	Become progressively worse, results in death.
Mechanical Ventilation	Powered device, such as fan exhausting contaminants from workplace or enclosure.
Melting Point	Temperature at which solid changes to liquid.
Metabolism	Physical and chemical processes taking place among ions, atoms and molecules of the body.
mg	Milligram. A metric weight unit. 1000 mg = 1 g.
mg/kg	Milligrams per kilogram. Expresses a toxicological dose.
mg/m ³	Milligrams per cubic meter. A concentration of dusts, gases, fumes or mists in air.
Micron	Micrometer. One-millionth of a meter.

Mist	Suspended liquid droplets in the air generated by condensation or the break up of liquid.
Mixture	Any combination of two or more chemicals if result is not a chemical reaction.
mL	Milliliter. A metric volume. 1 ml = 1 cc.
mm Hg	Millimeters (mm) of mercury (Hg). A unit of low pressure or partial vacuum measurement.
Molecular Weight	Weight (mass) of molecule. Sum of atomic weights of atoms that make up the molecule.
mppcf	Million particles per cubic foot. A unit for measuring particles suspended in air.
MSDS	Material Safety Data Sheet. OSHA mandated safety information for hazardous chemicals.
MSHA	Mining Safety and Health Administration. The U.S. Department of Interior certifies respirators.
Mutagen	Material that can alter a cell's genetic information and may lead to undesirable inherited conditions.
----- N -----	
Narcosis	Stupor, unconsciousness or arrested activity produced by the influence of chemicals.
Natural Ventilation	Air movement caused by wind, temperature difference or other non-mechanical factors.
Nausea	Tendency to vomit or feeling sick in the stomach.
NCI	National Cancer Institute.
Nephrotoxin	A substance that causes injury to kidneys.
Neurotoxin	Material that affects nerve cells and may produce behavioral abnormalities.
Neutralize	Inactivating acids, caustics or oxidizers.
NFPA	National Fire Protection Association.

ng	Nanogram. One-billionth of a gram.
NIOSH	National Institute for Occupational Safety and Health of U.S. Public Health Service.
Nonflammable	Not easily ignited and, if ignited, will not burn rapidly. Inflammable.
Non-Sparking Tools	Tools made from beryllium, copper or al. Bronze reduces the possibility of ignition.
NRC	National Response Center. A notification center in Washington that must be called when significant spills occur (1-800-424-8802).
NTP	National Toxicology Program. Publishes the <u>Annual Report on Carcinogens</u> .
----- O -----	
Odor	Description of the smell of a substance.
Odor Threshold	Lowest concentration of a substance's vapor, in air, that can be smelled.
Oral	Taken into body through the mouth.
Oral Toxicity	Adverse effects resulting from taking a substance into the body via the mouth.
OSHA	Occupational Safety and Health Administration. U.S. DOL, which enforces safety and health laws.
Overexposure	Exposure to a hazardous material beyond allowable exposure levels.
Oxidizer	Chemical that initiates or promotes combustion in other materials causing fire.

----- **P** -----

PEL	Permissible Exposure Limit. OSHA enforced air contaminant levels, which nearly all workers may be repeatedly exposed to eight hours a day, 40 hours a week, over a 30-year work lifetime without adverse effects.
Pesticide	Substance intended to destroy insects, rodents, or other pests. Regulated by the U.S. EPA.
Percent (%) Volatile	Percent volatile by volume. Amount of liquid or solid that evaporates at 70° F.
pH	Symbol of hydrogen ion (H-) concentration. A pH of seven is neutral. Numbers increasing from seven to 14 indicate greater alkalinity, and decreasing from seven to 0 mean greater acidity.
Pipe	Long hollow tube to conduct chemicals.
Physical Hazard	Combustible liquid, compressed gas, oxidizer, explosive, flammable, organic peroxide, pyrophoric, unstable or water-reactive.
Pneumoconiosis	Lung condition with permanent deposition of particulate matter and tissue reaction.
Poison, Class A	DOT hazard class for extremely dangerous poisons. A very small amount is dangerous to life.
Poison, Class B	DOT hazard class for liquid, solid or semi-solid substances (not Class A) that are toxic to man and a hazard to health during transportation.
Port	Point of access in a pipe or vessel.
ppb	Part per billion. A concentration of gas or vapor in air (by volume).
ppm	Parts per million. Gas or vapor concentration (by volume) in 1 million parts of air.
psi	Pounds per square inch.
Pulmonary	Relating to the lungs.

Pulmonary Edema Fluid in the lungs, which can lead to pneumonia.

Pyrophoric Ignites spontaneously in air at < 130° F.

----- **R** -----

Reaction Chemical transformation interaction of two or more substances to form new substances.

Reactivity Undergoes chemical reaction and releases energy, pressure buildup, high temperature or forms toxic or corrosive by-products.

Reducing Agent Occurs simultaneously with oxidation or loses electrons to reaction.

Reproductive Toxin Affects male or female reproductive systems, may impair ability to have normal children.

Respiratory Devices to protect wearer's respiratory system from inhalation of air contaminants.

Respiratory System Breathing mechanism includes lungs, trachea, larynx, mouth and nose.

RCRA Resource Conservation and Recovery Act. EPA controls generation, treatment, storage, transport, and disposal of hazardous wastes.

Routes of Entry Means by which materials enter the body — inhalation, absorption, ingestion or skin contact.

----- **S** -----

Self-Contained Breathing Apparatus (SCBA) High level respiratory protection device that consists of Grade D air supply delivered in positive pressure mode to full-face piece, carried by the wearer. PF = 1000.

Sensitizer Substance on first exposure that has minimum or no reaction. Repeated exposure can cause allergic response.

SETA Setaflash Closed Tester or flashpoint test.

Skin Notation on PEL or TLV that indicates a substance has been absorbed by the skin, mucous membranes or eyes.

Skin Absorption	Ability to permeate the skin and/or enter the bloodstream.
Solubility	Percent of a material that dissolves in water.
Solvent Sorbents	Substance in which materials are dissolved. Materials used to clean up chemical spills.
Special Fire Fighting Procedures	Procedures and/or personal protective equipment necessary when a particular substance is involved in fire. See MSDS.
Specific Gravity	Weight of a material compared to the weight of equal volume of water. Density or heaviness.
Spill or Leak Procedures	Methods, equipment and precautions used to control or clean up a leak or spill. See MSDS.
Splash Proof Goggles	Eye protection of non-corrosive material. Goggles fit snug against face and have indirect vent ports.
Spontaneously Combustible	Material that self-ignites, oxidizes or absorbs moisture to generate heat and ignite.
STEL	Short-Term Exposure Limit (10-15 min.). ACGIH terminology. See TLV.
Superfund	See CERCLA.
Supplied Air Respirators	Air-line, full-face respirators or self-contained breathing apparatus (SCBA).
Systemic Poison	Toxin that spreads throughout the body and affects all body systems and organs.
----- T -----	
Target Organ	Toxic substance that attacks organs or systems, such as liver (hepatotoxic), kidney (nephrotoxic), lungs (neurotoxic) or blood (hematopoetic).
TCLO	Toxic Concentration Low. The least amount gas or vapor that causes toxic effects in test species.

Teratogen	Substance that if a pregnant female is exposed to can result in malformations in the fetus.
TLV	<p>Threshold Limit Value. ACGIH airborne amount that nearly all persons can be exposed to day after day without adverse effects.</p> <p>TLV-TWA: allowable Time Weighted Average conc. Normal eight-hour day, 40-hour work week.</p> <p>TLV-STEL: Short-Term Exposure Limit. Maximum amount for continuous 15-minute exposure period (maximum four periods per day).</p> <p>TLV-C: Ceiling limit-concentration that should not be exceeded even instantaneously.</p>
TOC	TAG Open Cup. Flash point test method.
Toxic	<p>Chemical that causes acute or chronic injury to humans or in any of following categories:</p> <ul style="list-style-type: none"> a) Lethal Dose (LD50) > 50 mg/kg but < 500 mg/kg (administered orally to albino rats). b) Lethal Dose (LD50) > 200 mg/kg but < 1000 mg/kg (24 hours on skin of albino rabbits). c) Lethal Concentration (LC50) > 200 ppm but < 2000 ppm gas or vapor; or 2mg/l but < 20mg/l mist, fume or dust (administered one hour inhalation).
Toxicity	Sum of adverse effects resulting from exposure to a material.
Trade Name	Trademark or commercial identification of a material.
Trade Secret	Confidential formula, process, information or device that provides an advantage over competitors.
TSCA	Toxic Substances Control Act. EPA regulates manufacture and use of “toxic substances.”
TWA	Time-Weighted Average. OSHA and ACGIH exposure terminology. See TLV and PEL.

----- U -----

UEL	Upper Explosive Limit. Highest percent of gas or vapor in the air that produces fire when ignited.
UG	Microgram. One-millionth of a gram.
UN Number	Registry number assigned to dangerous goods. Required documentation per DOT regulations for shipping hazardous materials.
Unstable Reactive	Chemical that will vigorously polymerize, decompose or become self-reactive under conditions of shock, pressure or temperature.
Unusual Fire and Explosion Hazards	Occurs if overheated or burned and includes chemical reactions, decomposition or hazards in extinguishment. See MSDS.

----- V -----

Vapor	Gaseous form of solid or liquid if evaporated.
Vapor Density	Weight of vapor or gas compared to the weight of air. Heavy vapors sink.
Vapor Pressure	Force exerted by or above its own liquid.
Ventilation	Circulated air to replace contaminated air.
Viscosity	Tendency of fluid to resist flow (thickness).
Volatility	Measure of rate that a substance forms into a vapor.

----- W -----

Waste Disposal Methods	Safe procedures for removal of contaminated items or regulated types and quantities of wastes. See MSDS form.
Water-Reactive	Reacts with water and releases gas that is either flammable or a health hazard.