

Periodic Table of the Elements of Safety

R.A.M.P. is an acronym developed by Robert H. Hill Jr. and David C. Finster to help researchers, educators and students remember the four key elements of laboratory safety: Recognize, Assess, Minimize and Prepare.

- Recognize common laboratory hazards. Do this by identifying hazards and understanding why they are dangerous. - Se -
- Assess the risks before, during and after an experiment. Assessing risk includes evaluating how you might be exposed to the hazard and what the probable results of that exposure would be.
- : Minimize your risk of exposure utilizing substitution, personal protective equipment, proper disposal practices and other control measures.
- **Prepare** for emergencies should they occur. Have an emergency response plan and the proper safety equipment in - Ar 1 place. Practice emergency drills and use of equipment.

Hazard Communication Pictograms

The international Globally Harmonized System of Classification and Labelling of Chemicals includes hazard pictograms to warn of the chief hazardous properties of chemical substances. Health Hazard: A cancer-causing agent or substance with respiratory, reproductive or organ toxicity that causes damage over time. **3 Flame:** Flammable materials or substances liable to self-ignite when

exposed to water or air (pyrophoric), or which emit flammable gas.

11 Harmful: An immediate skin, eye or respiratory tract irritant, or narcotic

19 Explosion: Explosives, including organic peroxides and highly

Substitutions	• • • • • •	• • • • • • •	• • • • •	• • • • • •	

26 Remove Hazard: Eliminate hazard or replace with non-hazardous Re alternative.

44 Prevention through Design: Change design to eliminate the De hazard.

76 Automation: Use machines to eliminate human contact with hazard. Au

108 Eliminate Open Flames: Remove hazard through design changes or



The Hierarchy of Controls is a hazard prevention and mitigation system organized along a scale from most comprehensive (hazard removal and replacement) to protection from unavoidable hazards. The hierarchy lays out a system whereby inherently safer systems are implemented before moving to higher-risk solutions.

Elimination: Eliminate hazards during the design or development stage by finding safer ways to achieve project goals.

Substitution: Replace the hazard with something safer.

Engineering: Isolate the hazard from the people.

Administrative: Change the way people work with procedures limiting the amount and duration of exposure.

Personal Protective Equipment (PPE): Protect the worker with personal protective equipment.



114 Policies: Policies governing proper lab procedure, access and



23 Wearing Earbuds: Contributes to distraction and makes it difficult to hear if something is going wrong or if a lab partner needs help.			Eye Wash: Flushing with water is the primary first aid for chemical exposure to the eyes.
41 Working Alone: Inability to get help if rendered unconscious or incapacitated.			9 Spill Kit: Used for response to various types of spills.
73 Open-Toe Shoes: Improper lab attire for the feet.			17 First Aid Kit: Keep on hand for treatment of minor injuries. Be sure to report any injury to your supervisor, teacher, principal investigator, or lab manager, no matter how small.
105 Open Undated Peroxides: Explosion and fire risk from peroxide formation in chemicals stored too long without being tested.			35 Response Plans: Emergency response protocols should be developed and available in every lab, including emergency contact numbers and detailed instructions for specific scenarios.
- Dick Accordent Techniques	Safety Heroes	Safety Martyrs	53 Safety Shower: Must be located within 100 feet or 10 seconds from any chemical use area.
Strategies for assessing and reducing risk.	Pliny the Elder: Ancient Roman philosopher described the use of loose-fitting animal bladder skins to protect workers in mines from lead oxide dust, the first recorded instance of use of a protective device to reduce exposure to airborne contaminants.	89 Radium Girls: The Radium Girls were female factory workers at US Radium Corporation beginning around 1917, who contracted radiation poisoning from painting watch dials with self-luminous paint. Told that the paint was non-hazardous, they utilized unsafe work practices.	Green Chemistry
24 Original Label: Information provided on manufacturer's labels.	58 Leonardo da Vinci: Credited with the idea for an air-purifying respirator made of wet woven cloth, designed to protect sailors from a weapon utilizing toxic dust.	90 Marie Curie: Pioneering researcher on radioactivity, discovered radium and polonium. Curie died in 1934 from aplastic anemia contracted from long-term exposure to radiation.	
42 Safety Data Sheet: Mandated information distributed for each hazardous substance with detailed information on risks, handling, exposure controls, and first aid.	59 Paracelsus: Swiss physician, alchemist, and astrologer, father of toxicology. Credited with the adage, "the dose makes the posion."	91 Candalario Esquibel: First of seven employees at Los Alamos National Laboratory killed in lab accidents in the 1950s. Died in explosion involving thallous azide, which detonates when heated or subjected to shock.	85 Chemical Substitutes: Substitute safer materials for polluting or toxic substances whenever possible.
74 Survey Meter: Measures various forms of contamination in the lab environment.	60 Powell Johnson: African-American inventor received "eye protector" patent in 1880 "for use of furnace men, puddlers, firemen, and others exposed to glare of strong light."	92 Janet Parker: Medical photographer died of smallpox in 1978 after being accidently exposed to a strain of the virus in a lab. As a result, all known stocks of smallpox were destroyed or transferred to one of two WHO reference laboratories with BSL-4 facilities.	117 Cold Storage: Updating refrigerators, cleaning door seals and filters, disposing of unneeded materials and consolidation of chemicals and reagents are all good ways to reduce energy costs.
106 Test Strips: Used to test for presence of peroxides or other unwanted materials in solutions.	61 William Stewart Halsted: First chief of surgery at Johns Hopkins Hospital, invented rubber surgical gloves in order with to prevent medical staff from developing dermatitis from surgical chemicals.	93 Andrew Riley: Killed at SRI International in 1992 in explosion involving Dewar flask containing a palladium electrode immersed in deuterium oxide. Was part of a team conducting research into cold fusion.	2 Close Sash: Close the sash on a fume hood when not in use to reduce electricity consumption in the lab.
25 What If: Questions used in risk analysis to identify weaknesses in planning or design.	62 Alice Hamilton: Physician and scientist, expert in field of industrial health and considered the founder of industrial hygiene.	94 Karen Wetterhahn: American chemist specializing in toxic metal exposure spilled a few drops of dimethyl mercury on her hand while wearing latex gloves. Months later she died from mercury poisoning. Her death in 1996 led to new understanding of the type and level of protection required for handling highly toxic metallic compounds.	10 Mercury Free: Eliminate the use of mercury in experiments whenever possible to avoid the need to dispose of this hazardous metal.
43 Bowtie: Method of visualizing risk using diagram outlining threats, preventative measures, outcomes and consequences.	63 Rachel Carson: Biologist and environmentalist whose book Silent Spring highlighted the dangers of DDT and other pesticides to wildlife. Carson's call for independent oversight of chemical use influenced the founding of the EPA.	95 Elizabeth Griffin: Research assistant at Emory University died in 1997 of herpes B virus contracted from an infected macaque monkey. A foundation set up in her name promotes evidence-based biosafety and biosecurity practices around the world.	18 Reduce Quantity: Reduce the amount of materials and resources used when possible.
75 Checklist: Hazard mitigation through use of checklist to avoid oversights and unconscious errors.	64 Herbert Stokinger: Toxicologist who lead the American Conference of Governmental Industrial Hygienists committee that produced the Threshold Limit Values (TLVs).	96 Ss Sheharbano "Sheri" Sangi: Research assistant at UCLA who suffered burns from a fire ignited from using a plastic syringe to transfer pyrophoric tert-butyl lithium. The severe burns caused her death. This marked the first criminal case resulting from an incident in an academic lab.	36 Minimize Waste: Find alternatives to disposal such as sharing, redistribution and recycling.
107 Job Hazard Analysis: Method to identify potential hazards and determine preventative measures.	65 Glenn Seaborg: Nobel Prize-winning chemist and American Chemical Society president. The ACS Division of Chemical Health and Safety was founded with his support.	97 Texas Tech: Chemistry lab explosion in 2010 seriously injured graduate student working with a high-energy metal, nickel hydrazine. First academic laboratory accident to be investigated by the US Chemical Safety Board, leading to more focus on physical hazards of chemicals, and deeper scrutiny of laboratory safety in academia.	54 Water Conservation: Conserve water by using flow-reducing valves, reducing rinse cycles and running dishwashers only when they are full.
	66 James Hodgson: US Secretary of Labor helped shape the Occupational Safety and Health Act of 1970, established the Occupational Safety and Health Administration (OSHA) to administer the Act.	98 Michele Dufault: Yale University student who died from asphyxiation when her hair became caught in a lathe while working alone in an academic laboratory machine shop. Her death in April 2011, weeks before graduation, led many colleges and universities to adopt new safety standards in the laboratory.	86 Microscale: Scaling down experiments saves time and resources, cuts down on storage needs and promotes safety in the lab.
	67 Jay Young: Chemistry educator and one of the founders of the modern discipline of chemical health and safety, authoring and revising the original versions of several seminal lab safety publications	99	118 Efficient Ordering: Utilize good inventory practices to reduce the amount of materials purchased and stored.
	68 Howard Fawcett: Co-organizer and first chair of the ACS Division of Chemical Health and Safety (CHAS), published four influential books and numerous papers on safety. In his honor, the CHAS Award was renamed the Howard H. Fawcett Chemical Health and Safety Award in 1998.	100	
	69 H.K. Livingston: First chair of the ACS Committee on Chemical Health and Safety (1963).	101	
	70 Leslie Bretherick: Chemist and author of standard reference guide to dangerous chemical reactions, Bretherick's Handbook of Reactive Chemical Hazards, now in its 8th edition.	102	
	71 You?: Every lab worker can be a hero if they adhere to the Elements of Safety!	103	





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