

Tools and Techniques for Identifying High Hazard Chemicals*

Chemical category	Hazards	Safety Tips	European Union Risk Codes	Hazard Classes and Regulated Lists
Flammable liquids	<ol style="list-style-type: none"> 1. Common cause of many lab fires and explosions 2. Many hazardous waste fires are caused by mixing flammable or combustible materials with oxidizers. 3. Certain flammable liquids may be vulnerable to an intentional, uncontrolled release (see Department of Homeland Security list). 	<ol style="list-style-type: none"> 1. Store in approved flammable cabinet. 2. Keep a minimum quantity (typically less than 10 gallons) out side a flammable cabinet. 3. Keep containers closed, including waste containers. 4. Identify ignition sources (e.g., hot plates, Bunsen burners, drying ovens) and keep them separate from flammables. 5. Ground and bond containers to avoid static buildup during pouring. 	R10: flammable R11: highly flammable R12: extremely flammable	<u>DOT</u> Class 3 <u>Fire Code</u> Flammable liquid, Class IA-IC <u>Department of Homeland Security</u> Release –Flammable
Flammable and toxic gases	<ol style="list-style-type: none"> 1. Flammable gases (acetylene and hydrogen) are commonly used with analytical equipment and are a source of many lab fires. 2. Toxic gases (hydrogen sulfide, carbon monoxide) are commonly used in organic synthesis without adequate safety controls. 3. Explosions can occur with old lecture bottles (e.g., HF). 4. Certain flammable and toxic gases may be vulnerable to an intentional, uncontrolled release or theft and diversion (see Department of Homeland Security list). 	<ol style="list-style-type: none"> 1. Inspect containers at least quarterly. 2. Provide proper ventilation for all compressed gases. 3. Provide bracing as required by local fire regulations (e.g., brace at 1/3 and 2/3 length of cylinder). 4. Provide physical security and restrict access to toxic gases. 5. Ensure gases and gas lines are installed properly (e.g., no copper with acetylene, secure tubing [no quick disconnects]). 6. Determine how researchers are using lecture bottles and make sure that they follow safe practices. 	R12: extremely flammable R26: very toxic by inhalation	<u>DOT</u> Class 2.1 (flam gas) Class 2.3 (poisonous gas) <u>Fire Code</u> Flammable gas Toxic gas <u>Department of Homeland Security</u> Release –Flammable Release –Toxic Theft-WME Theft -Chemical weapons/precursors
Water-reactives	<ol style="list-style-type: none"> 1. Can react explosively or release flammable or toxic gases upon exposure to water 2. Water-reactive chemicals may be vulnerable to theft or sabotage/contamination (see Department of Homeland Security list). 	<ol style="list-style-type: none"> 1. Inspect containers at least quarterly. 2. Store containers away from flammable materials and water (e.g., sinks). 3. Store as specified by manufacturer (e.g., under an inert gas atmosphere, mineral oil, etc). 4. Ensure employees are trained and follow written SOP for use, spill and emergency response. 5. Enforce “No Work Alone” policy. 6. Use the smallest quantity possible. 7. Use adequate engineering controls (e.g., fume hoods, glove box, 	R14: reacts violently with water R15: contact with water liberates extremely flammable gases R29: contact with water liberates toxic gas	<u>DOT</u> Class 4.3 <u>Fire Code</u> Water reactive class 1 - some heat released Water reactive class 2 -toxic or flammable gas producing Water reactive class 3- explosive reaction

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		<p>explosion shield).</p> <p>8. Have the proper extinguishing media (e.g., lime or sand) available.</p>		<p><u>Department of Homeland Security</u> Theft-WME Sabotage/contamination</p>
Pyrophorics	<p>1. Fires and explosions can occur on exposure to air</p> <p>2. Pyrophorics may be vulnerable to theft or sabotage/contamination (see Department of Homeland Security list).</p>	<p>1. Inspect containers at least quarterly.</p> <p>2. Store containers away from flammable materials and water (e.g., sinks).</p> <p>3. Store and use under an inert gas atmosphere as specified by manufacturer.</p> <p>4. Use the smallest quantity possible.</p> <p>5. Ensure employees are trained and follow written SOP for use, spill and emergency response.</p> <p>6. Enforce "No Work Alone" policy.</p> <p>7. Use adequate engineering controls (e.g., fume hoods, glove box, explosion shield).</p> <p>8. Wear flame-resistant lab coats.</p> <p>9. Have the proper extinguishing media (e.g., lime or sand) available.</p>	R17: spontaneously flammable in air	<p><u>DOT</u> Class 4.2</p> <p><u>Fire Code</u> Pyrophoric</p> <p><u>Department of Homeland Security</u> Theft – Explosives/IEDP Sabotage/contamination</p>
Oxidizers	<p>1. Common cause of many lab fires and explosions.</p> <p>2. Many hazardous waste fires and explosions are caused by mixing oxidizers with flammable or combustible material.</p> <p>3. Some (e.g., perchlorates) may react with trace heavy metals to form explosives.</p> <p>4. Certain oxidizers may be vulnerable to theft (see Department of Homeland Security list).</p>	<p>1. Inspect containers at least quarterly.</p> <p>2. Keep separate from flammable and combustible materials.</p> <p>3. Store in a cool and dry location. Do not store on wooden shelf.</p> <p>4. Do not use corks or rubber stops.</p> <p>5. Keep containers closed.</p> <p>6. Avoid generated reactive or explosive byproducts or mixtures.</p> <p>7. Use perchloric acid in a "perchloric acid" hood.</p> <p>8. Be extremely careful with oxidizer wastes. Never combine them with any other wastes (especially flammable or combustible materials).</p>	R8: contact with combustible material may cause fire	<p><u>DOT</u> Class 5.1</p> <p><u>Fire Code</u> Oxidizer class 1 - slight increase in burning rate</p> <p>Oxidizer class 2 - moderate increase in burning rate or spontaneous ignition of combustible materials</p> <p>Oxidizer class 3 - severe increase in burning rate or vigorous self-</p>

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				sustained decomposition Oxidizer class 4- explosive reaction due to contamination or exposure to thermal or physical shock <u>Department of Homeland Security</u> Theft – Explosives/IEDP
Organic peroxides (O-O bonds)	<ol style="list-style-type: none"> 1. Some can react violently and explosively to heat or contamination. 2. Once they start burning, many will burn very quickly and much hotter than normal flammables. 	<ol style="list-style-type: none"> 1. Inspect containers at least quarterly. 2. Ensure all users have read the manufacturer's safety instructions and understand hazardous conditions to avoid (e.g., heat and contamination) and the dangerous reactions that can happen. 3. Ensure users understand the self accelerating decomposition temperature (SADT) and control temperature (CT). 4. Keep at the proper temperature recommended by the manufacturer. 5. Never return unused product back to original containers. 6. Use extremely clean equipment to avoid contamination. 7. Ensure employees are trained and follow written SOP for use, spill and emergency response. 	R7: may cause fire (many organic peroxides have this phrase)	<u>DOT</u> Class 5.2 <u>Fire Code</u> Organic peroxide Class I- capable of deflagration but not detonation Organic peroxide Class II-burn very rapidly and pose a moderate reactivity hazard Organic peroxide Class III-burn rapidly and pose a moderate reactivity hazard Organic peroxide Class IV- burn in the same manner as ordinary combustibles Organic peroxide Class V- burn with less intensity as

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				ordinary combustibles Unclassified detonatable- capable of detonation. Pose an extremely high explosion hazard
Peroxide formers	<ol style="list-style-type: none"> 1. Certain common solvents (e.g., tetrahydrofuran and ethyl ether) can form peroxides. 2. Explosions, which are due to the peroxides, often occur during purification step. 	<ol style="list-style-type: none"> 1. Inspect peroxide-forming chemicals at least quarterly. Do not open or handle if crystals are observed in the bottle or near the lid. 2. Ensure expiration dates are marked on bottles and preferably tracked in a database. 3. Educate all handlers of peroxide forming chemicals about their safe use. 4. Test for peroxides using test strips or other recommended method. 5. Dispose of prior to the expiration date. 	R19: may form explosive peroxides	List from http://www.ehs.berkeley.edu/pubs/guidelines/pecguidelines.html#appendixII
Highly toxic liquids and solids	<ol style="list-style-type: none"> 1. Exposure to a very small quantity could be lethal. 2. Certain toxic liquids and solids may be vulnerable to an intentional, uncontrolled release, theft, or sabotage (see Department of Homeland Security list). 	<ol style="list-style-type: none"> 1. Inspect containers at least quarterly. 2. Designate and label use areas. 3. Control access to use areas. 4. Use the smallest quantity possible. 5. Ensure employees are trained and follow written SOP for use, spill and emergency response. 6. Enforce "No Work Alone" policy. 7. Use adequate engineering controls (e.g., fume hoods, glove box). 8. Obtain pre-made solutions where possible. 9. Immediately clean up spills. 	R26: very toxic by inhalation R27: very toxic in contact with skin R28: very toxic if swallowed	<p><u>DOT</u> Class 6.1</p> <p><u>Fire Code</u> Highly toxic</p> <p><u>Department of Homeland Security</u> Release –Toxic Theft-WME Theft -Chemical weapons/precursors Sabotage/contamination</p>
Carcinogens and reproductive toxins	<ol style="list-style-type: none"> 1. Exposure may cause cancer, reproductive or developmental toxic effects. 	<ol style="list-style-type: none"> 1. Inspect containers at least quarterly. 2. Designate and label use areas. 3. Control access to use areas. 4. Use the smallest quantity possible. 5. Ensure employees are trained and follow written SOP for use, spill and emergency response. 6. Use adequate engineering controls 	R45: may cause cancer. R46: may cause heritable genetic damage. R47: may cause birth defects. R60: may impair fertility. R61: may cause harm to the unborn child. R62: possible risk of impaired	<p><u>Fire Code</u> Carcinogen</p> <p><u>OSHA</u> Regulated carcinogen list</p> <p><u>State/OSHA</u></p>

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		(e.g., fume hoods, glove box). 7. Obtain pre-made solutions where possible. 8. Immediately clean up spills.	fertility. R63: possible risk of harm to the unborn child.	Regulated carcinogen list Other (e.g., California Prop 65) International Agency for Research on Cancer list
Select Agents and toxins	1. Severe threat to public safety, and/or animal and plant health 2. May be vulnerable to theft	1. Prepare the required registrations for the possession, use or transfer. 2. Conduct required risk, threat and vulnerability assessments. 3. Provide required physical and operational security. 4. Provide inventory control. 5. Provide access control. 6. Follow all loss, theft and release reporting requirements. 7. Follow NIH/CDC procedures for the safe handling, storage, and controls for biohazardous agents and toxins. 8. Refer to select agent regulations for specific requirements.		US Department of Health and Human Services and USDA Select Agents and Toxins list NIH/CDC "Biosafety in Microbiological and Biomedical Laboratories" (BMBL)
Controlled substances	1. May be vulnerable to theft	1. Refer to Controlled Substances regulations for specific requirements.		US Department of Justice Controlled Substances List

**This table is meant to provide some "basic" information on classes of high hazard chemicals and tips to manage them. It is by no means complete and may not apply to your particular situation. Seek professional guidance and consult the appropriate federal, state and local requirements to ensure your chemical use is safe and legal.*