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## **Appendix E:**

# **Chemical Hazards**

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Chemical	Hazards (NFPA Rating: H/F/R)	Flash Point (°F)	Explosive Limit (Lower/Upper)	Incompatibilities
Acetaldehyde	3/4/2	−6	4%/60%	Strong oxidizers, acids, bases, alcohols, ammonia and amines, phenols, ketones, HCN, H <sub>2</sub> S [Note: Prolonged contact with air may cause formation of peroxides that may explode and burst containers; easily undergoes polymerization]
Acetic acid	3/2/0	104	4%/19.9%	Metals; acetic anhydride; alcohols; amines; ammonium nitrate; chlorine trifluoride; nitric acid; permanganates; peroxides; sodium hydroxide; sodium peroxide; hydrogen peroxides; acetaldehyde; caustics (e.g., ammonia, ammonium hydroxide, calcium hydroxide, potassium hydroxide, sodium hydroxide); acid anhydrides; chlorosulfonic acid; oleum; chromium trioxide; potassium hydroxide; carbonates; bromine pentafluoride; perchloric acid; chromic anhydride; potassium- <i>tert</i> -butoxide; calcium salts; ethyleneimine; attacks some forms of plastics, rubbers, and coatings; 2-aminoethanol; ethylene diamine; phosphorus trichloride; chromic acid anhydride; phosphorus isocyanate; diallyl methyl carbinol + ozone; nitric acid + acetone; xylene; sodium salts
Acetic anhydride	3/2/1	NA	2.9%/10.3%	Strong oxidizing agents, strong reducing agents, bases, alcohols, metal powders, moisture
Acetone	1/3/0	−4	2.5%/12.8%	Strong oxidizing agents, strong acids, perchlorates, aliphatic amines, chromyl chloride, hexachloromelamine, chromic anhydride, chloroform + alkali, potassium <i>tert</i> -butoxide
Acetonitrile	2/3/0	−4	4.4%/16%	Oxidizing agents; reducing agents; acids; bases; alkali metals; fluorine; nitric acid; perchlorates; sulfuric acid; chlorosulfonic acid; oleum; dinitrogen tetroxide; sulfites; indium; moisture; attacks some forms of plastics, rubbers, and coatings; nitrating agents; N-fluoro compounds (e.g., perfluorourea + acetonitrile); lanthanide perchlorates; iron (III) perchlorate; 2-cyano-2-propyl nitrate; trichlorosilane; diphenyl sulfoxide
Allylbenzene	NA	177	NA/NA	NA

Allylchloride	2/3/1	30	2.9%/11.1%	Explosion hazard when exposed to acids or oxidizing agents; explosive reaction with alkyl aluminum chlorides + aromatic hydrocarbons (e.g., benzene or toluene); violently exothermic polymerization reaction with Lewis acids (e.g., aluminum chloride, boron trifluoride, and sulfuric acid); incompatible with ethylene imine, ethylenediamine, chlorosulfonic acid, oleum, sodium hydroxide, and nitric acid
Aluminum chloride	3/0/2	NA	NA/NA	Water; organic materials; aluminum chloride reacts violently with water, producing hydrochloric acid and heat
Ammonia gas	3/1/0	NA	15%/28%	Strong oxidizers, acids, halogens, salts of silver and zinc [Note: Corrosive to copper and galvanized surfaces]
4 Allyl 1,2 methylenedioxybenzene	NA	NA	NA/NA	NA
Ammonium chloride	2/0/0	NA	NA/NA	Acids, alkalis, and their associated carbonates; substance reacts with lead and silver salts to form a fulminating compound; substance reacts with ammonium compounds, bromine pentafluoride, bromine trifluoride, hydrogen cyanide, iodine heptafluoride, nitrates, and potassium chlorate
Ammonium formate	2/0/0	NA	NA/NA	Strong oxidizing agents
Ammonium hydroxide	3/1/0	NA	16%/27%	Acrolein; acrylic acid; chlorosulfonic acid; dimethyl sulfate; fluorine; gold + aqua regia; hydrochloric acid; hydrofluoric acid; iodine; nitric acid; oleum; propiolactone; propylene oxide; silver nitrate; silver oxide; silver oxide + ethyl alcohol; nitromethane; silver permanganate; sulfuric acid; halogens; forms explosive compounds with many heavy metals and halide salts
Aniline	3/2/0	158	1.3%/11%	Strong acids and strong oxidizers; albumin; solutions of iron, zinc, aluminum, toluene diisocyanate, and alkalis; ignites spontaneously in the presence of red fuming nitric acid and with sodium
Benzaldehyde	2/2/0	NA	1.4%/8.5%	Performic acid and other oxidizing materials; an explosion occurred after mixing sodium hydrosulfite, aluminum powder, potassium carbonate, and benzaldehyde
Benzene	2/3/0	12	1.2%/7.8%	Strong oxidizers, many fluorides and perchlorates, nitric acid

Chemical	Hazards (NFPA Rating: H/F/R)	Flash Point (°F)	Explosive Limit (Lower/Upper)	Incompatibilities
Benzyl chloride	3/2/2	153	1.1%/14%	Oxidizers, acids, copper, aluminum, magnesium, iron, zinc, tin [Note: Can polymerize when in contact with all common metals except nickel and lead; hydrolyzes in H <sub>2</sub> O to benzyl alcohol
Benzyl cyanide	2/1/0	223	NA/NA	Strong acids, strong bases, strong oxidizing agents, strong reducing agents, sodium hypochlorite
Bromobenzene	2/2/0	NA	0.5%/2.5%	Bromobutane + sodium, strong oxidizing agents, alkali metals
Bromoethane	3/1/0	NA	10%/16%	Risk of fire and explosion on contact with aluminum, zinc, or magnesium
Carbon dioxide	NA	NA	NA/NA	Dusts of various metals, such as magnesium, zirconium, titanium, aluminum, chromium, and manganese are ignitable and explosive when suspended in carbon dioxide; forms carbonic acid in water
Carbontetrachloride	3/0/0	NA	NA/NA	Aluminum, bromine trifluoride, calcium hypochlorite, dimethyl formamide, ethylene oxide, fluorine, lithium, magnesium, potassium, potassium- <i>tert</i> -butoxide, silver perchlorate, sodium, uranium, chlorine trifluoride, dinitrogen tetraoxide, methanol
Chloro-2-propanone	3/2/0	102	NA/NA	Strong acids, strong bases, strong oxidizing agents, strong reducing agents
Copper sulfate	2/0/0	NA	NA/NA	Moisture, air, steel, finely powdered metals, hydroxylamine, magnesium, hydrazine, nitromethane
Copper oxide	2/0/0	NA	NA/NA	Aluminum, boron, cesium acetylene carbide, hydrazine, magnesium, phospham, potassium, rubidium acetylene carbide, sodium, titanium, and zirconium; forms explosive acetylides with acetylene in caustic solutions; exposure to moist air at >212°F can result in spontaneous combustion
Cyclohexanone	1/2/0	111	1.1%/9.4%	Oxidizing agents, strong acids, amines, nitric acid, plastics, rubber, sulfuric acid, aliphatic amines, lead, red metals, resins

Dichloroethane	2/4/2	>233	13%/23%	Strong oxidizing agents, liquid oxygen, nitric acid, potassium, lithium, sodium, caustics (e.g., ammonia, ammonium hydroxide, calcium hydroxide, potassium hydroxide, sodium hydroxide), potassium- <i>tert</i> -butoxide, sodium potassium alloys, powdered aluminum, active metals (such as potassium and magnesium), nitrogen tetroxide, <i>N</i> -methyl- <i>N</i> -nitrosourea + potassium hydroxide, powdered magnesium
Ephedrine	1/0/0	NA	NA/NA	Oxidizing agents, direct light
Ethyl acetate	1/3/0	24	2.0%/9.0%	Chlorosulfonic acid, lithium aluminum hydride + 2-chloromethylfuran, lithium tetrahydroaluminate, oleum, potassium <i>t</i> -butoxide; substance coming in contact with nitrates or strong acids/oxidizers/alkalis may cause fire
Formamide	2/1/0	310	2.7%/19%	Strong oxidizing agents, acids, bases, aluminum
Formic acid	3/2/0	>233	18%/57%	Strong oxidizing agents, strong bases, finely powdered metals, permanganates, sulfuric acid, hydrogen peroxides, nitromethane, furfuryl alcohol, hydrated thallium nitrate
Hydrobromic acid (HBr)	3/0/0	NA	NA/NA	Strong oxidizers, strong caustics, moisture, copper, brass, zinc [Note: Hydrobromic acid is highly corrosive to most metals]
Hydrochloric acid (HCl)	3/0/0	NA	NA/NA	Hydroxides, amines, alkalis, copper, brass, zinc [Note: Hydrochloric acid is highly corrosive to most metals]
Hydrogen	0/4/0	Gas	4%/75%	Oxidizing agents, some metals, alkaline material, halogens
Hydrogen peroxide	4/0/1	NA	40%/100%	Strong oxidizing agents, strong reducing agents, acetic acid, acetic anhydride, alcohols, brass, copper, copper alloys, finely powdered metals, galvanized iron, hydrazine, iron, magnesium, nitric acid, sodium carbonate, potassium permanganate, cyanides (e.g., potassium cyanide, sodium cyanide), ethers [e.g., dioxane, furfuran, tetrahydrofuran (THF)], urea, chlorosulfonic acid, alkalis, lead, nitrogen compounds, triethylamine, silver, nickel, palladium, organic matter, charcoal, sodium borate, aniline, platinum, formic acid, cyclopentadiene, activated carbon, <i>tert</i> -butyl alcohol, hydrogen selenide, manganese dioxide, mercurous chloride, rust, ketones, carboxylic acids, glycerine, sodium fluoride, sodium pyrophosphate, soluble fuels (acetone, ethanol, glycerol), wood, asbestos, hexavalent chromium compounds, salts of iron, copper, chromium, vanadium, tungsten, molybdenum, and platinum [Note: Contact with combustible material may result in spontaneous combustion]

Chemical	Hazards (NFPA Rating: H/F/R)	Flash Point (°F)	Explosive Limit (Lower/Upper)	Incompatibilities
Hydriodic acid (HI)	3/0/0	NA	NA/NA	Explodes on contact with ethyl hydroperoxide; ignites on contact with magnesium, perchloric acid, potassium + heat, potassium chlorate + heat, and oxidants; violent reaction with $\text{HClO}_4$ + Mg, metals; potentially violent reaction with phosphorous
Hydroxylamine HCl	2/0/3	305	NA/NA	Strong oxidizing agents, heat plus sodium acetate or ether, carbonyl compounds, copper sulfate, zinc and phosphorus chlorides
Iodine	NA	NA	NA/NA	Incompatible with ammonia, powdered metals, alkali metals, or strong reducing agents; reaction can be violent or explosive with acetaldehyde and acetylene; reacts with ammonium hydroxide to form shock-sensitive iodides on drying
Isosafrole	1/1/0	120	NA/NA	Oxidizing agents
Lithium	3/2/2	NA	NA/NA	Moisture, acids, oxidizers, oxygen, nitrogen, carbon dioxide
Lithium aluminum hydroxide	3/0/2	NA	NA/NA	Water
Magnesium turnings	0/1/1	NA	NA/NA	Oxygen, moisture, chlorinated solvents, methanol, hydrogen peroxide, oxidizing agents, sulfur compounds, metal oxides, metal cyanides, metal oxide salts, fluorine, carbonates, halogens, phosphates
Manganous carbonate	1/0/1	NA	NA/NA	Contact with acids may generate carbon dioxide gas; oxidizes toxic sulfur dioxide to the more toxic sulfur trioxide and causes violent decomposition of hydrogen peroxide
Manganous chloride	1/0/1	NA	NA/NA	Strong reducing agents, hydrogen peroxide, potassium, sodium, and zinc
Mercuric chloride	4/0/1	NA	NA/NA	Reacts violently with potassium and sodium; incompatible with many compounds: formates, sulfites, phosphates, albumin, ammonia, gelatin, carbonates, hypophosphites, sulfides, alkalis, alkaloid salts, lime water, antimony and arsenic, bromides, borax, reduced iron, copper, iron, lead, tannic acid and vegetable astringents

Mercury	3/0/0	NA	NA/NA	Acetylenes, ammonia, ethylene oxide, chlorine dioxide, azides, metal oxides, methyl silane, lithium, rubidium, oxygen, strong oxidants, metal carbonyls
Methanol	3/3/1	54	6%/36%	Strong oxidizing agents such as nitrates, perchlorates, or sulfuric acid; will attack some forms of plastics, rubber, and coatings; may react with metallic aluminum and generate hydrogen gas
Methylamine	3/3/0	39	4.9%/20.8%	Nitromethane, acids, oxidizing agents, chlorine, hypochlorite, halogenated agents, mercury, copper, copper alloys, zinc, zinc alloys, aluminum, perchlorates
Methylformamide	1/1/0	NA	NA/NA	Strong oxidizing agents, acids, bases, acid chlorides
Nitroethane	1/3/3	82	3.4%/NA	Amines; strong acids, alkalis, and oxidizers; hydrocarbons; combustibles; metal oxides
Norpseudoephedrine	1/0/0	NA	NA/NA	Oxidizing agents, direct light
Palladium sulfate	NA	NA	NA/NA	Strong oxidizing agents; protect from freezing
Perchloric acid	3/0/3	102	NA/NA	Incompatible with numerous materials, including combustible materials, organic chemicals, strong dehydrating agents, reducing and oxidizing agents; reacts violently with benzene, calcium hydride, wood, acetic acid, charcoal, olefins, ethanol, sulfur, and sulfuric acid; do not use perchloric acid in a hood designed for other purposes
Phenylacetic acid	2/0/0	168	NA/NA	NA
Phenylmagnesium bromide	NA	NA	NA/NA	Water
Phenylacetone	NA	NA	NA/NA	NA
Phosphorus (red)	0/2/2	NA	NA/NA	Halogens, halides, sulfur, oxidizing materials, and alkalis (forms phosphine)
Phosphorus pentachloride	3/0/2	NA	NA/NA	Reacts violently with water; alcohols, amines, aluminum, sodium, potassium acids
Piperonal	1/0/0	NA	NA/NA	Strong oxidizing agents
Piperidine	3/3/0	NA	NA/NA	Acids, acid chlorides, acid anhydrides, carbon dioxide, strong oxidizing agents, dicyanofurazan, <i>N</i> -nitrosoacetanilide, 1-perchlorylpiperidine

Chemical	Hazards (NFPA Rating: H/F/R)	Flash Point (°F)	Explosive Limit (Lower/Upper)	Incompatibilities
Platinum	NA	NA	NA/NA	Aluminum, acetone, arsenic, ethane, hydrazine, hydrogen peroxide, lithium, phosphorus, selenium, tellurium, various fluorides
Platinum chloride	NA	1076	NA/NA	Strong oxidizing agents
Platinum oxide	2/0/0	NA	NA/NA	Oxidizing agents
Potassium carbonate	2/0/1	NA	NA/NA	Acids, chlorine trifluoride, magnesium; an explosion occurred after mixing sodium hydrosulfite, aluminum powder, potassium carbonate, and benzaldehyde
Potassium cyanide	4/0/0	NA	NA/NA	Violent reactions can occur with oxidizing agents such as nitric acid, nitrates, and peroxides; contact with acids liberates extremely toxic and flammable hydrogen cyanide gas; hydrogen cyanide may form by a reaction with carbon dioxide and moisture when this material is in prolonged contact with air in a closed system
Potassium hydroxide	3/0/2	NA	NA/NA	Contact with water, acids, flammable liquids, and organic halogen compounds, especially trichloroethylene, may cause fire or explosion; contact with nitromethane and other similar nitro compounds causes formation of shock-sensitive salts; contact with metals such as aluminum, tin, and zinc causes formation of flammable hydrogen gas
Pumice	NA	NA	NA/NA	NA
Pyridine	2/3/0	68	1.8%/12.4%	Strong oxidizers, strong acids
Raney nickel	NA	NA	NA/NA	NA
Sodium	3/3/3	NA	NA/NA	Water, oxygen, carbon dioxide, carbon tetrachloride, halogens, acetylene, metal halides, ammonium salts, oxides, oxidizing agents, acids, alcohols, chlorinated organic compounds, many other substances



Sodium acetate	3/0/1	NA	NA/NA	Nitric acid, fluoride, potassium nitrate, strong oxidizers, and diketene
Sodium bisulfate	IRR	NA	NA/NA	Strong bases, strong oxidizing agents, strong reducing agents
Sodium hydroxide	3/0/2	NA	NA/NA	Metals, acids, nitro compounds, halogenated organics (e.g., dibromoethane, hexachlorobenzene, methyl chloride, trichloroethylene), nitromethane, flammable liquids
Sodium sulfate	1/0/0	NA	NA/NA	Strong oxidizing agents, aluminum, magnesium, potassium, mercury, lead, calcium, silver, barium, ammonium ions, strontium
Sulfuric acid	3/0/3	NA	NA/NA	Water, potassium chlorate, potassium perchlorate, potassium permanganate, sodium, lithium, bases, organic material, halogens, metal acetylides, oxides and hydrides, metals (yields hydrogen gas), strong oxidizing and reducing agents, and many other reactive substances
Thionyl chloride	4/0/2	NA	NA/NA	Water, ammonia, chloryl perchlorate, dimethyl sulfoxide, linseed oil, quinoline, sodium, 2,4-hexadiyn-1–6-diol, <i>o</i> -nitrobenzoyl acetic acid, and <i>o</i> -nitrophenylacetic acid
Thorium nitrate	NA	NA	NA/NA	Strong oxidizers

*Continued.*

## Key to NFPA ratings

Health (H) Hazard — The Left Quadrant (Blue)	Fire (F) Hazard — The Top Quadrant (Red)	Reactivity (R) Hazard — The Right Quadrant (Yellow)	Important Messages — The Bottom Quadrant (White)
4. DANGER: May be fatal on short exposure. Specialized protective equipment required.	4. DANGER: Flammable gas or extremely flammable liquid.	4. DANGER: Explosive material at room temperature.	W — Avoid use of water COR — Corrosive LAS — Laser electrical hazard AZK — Alkali ACID — Acid OXY — Oxidizing chemicals RED — Dangerous reducing agent/metal hydride
3. WARNING: Corrosive or toxic. Avoid skin contact or inhalation.	3. WARNING: Flammable liquid. Flash point below 100°F.	3. DANGER: May be explosive if shocked, heated under confinement, or mixed with water.	
2. WARNING: May be harmful if inhaled or absorbed.	2. CAUTION: Combustible liquid. Flash point of 100 to 200°F.	2. WARNING: Unstable, or may react if heated or if mixed with water.	
1. CAUTION: May cause irritation.	1. Combustible if heated.	1. CAUTION: May react if heated or mixed with water.	
0. No unusual hazard.	0. Not combustible.	0. Stable. Not reactive when mixed with water.	