









# Chemical Segregation and Storage Table



## Chemical Segregation

Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemical Types	Possible Reaction if Mixed/Health Concerns
<b>Corrosive Acids-Organic</b> 	Acetic Acid Glacial Acetic Acid Butyric Acid Trifluoroacetic Acid Picric Acid Propionic Acid Formic Acid	Store in ventilated corrosives cabinet on protected shelving using secondary containment, keep away from water sources *Do not store under the sink *Do not store acids on metal shelving	Flammable Liquids Flammable Solids Bases Oxidizers Inorganic Acids Cyanides Sulfides Poisons/Toxins	Heat Gas Generation Violent Reaction * DO NOT POUR WATER INTO ACID
<b>Corrosive Acids-Inorganic</b> 	Nitric Acid Sulfuric Acid Perchloric Acid Phosphoric Acid Hydrochloric Acid Chromic Acid Hydrofluoric Acid	Store concentrated Nitric acid (≥68%) and Sulfuric acid (≥93%) in a secondary container Store in a corrosive cabinet labeled “Acid” or on shelving using a secondary containment *Do not store under the sink *Do not store acids on metal shelving *Hydrofluoric acid should be stored in an area accessible only by authorized personnel; do not store in glass; use plastic containers and secondary containment	Flammable Liquids Flammable Solids Bases Oxidizers Organic Acids Cyanides Sulphides Poisons/Toxins	Heat Gas Generation Violent Reaction *DO NOT POUR WATER INTO ACID *Perchloric acid vapor can form explosive compounds within fume hood ducts *Hydrofluoric acid can result in severe burns to skin and lungs
<b>Corrosive Bases-Organic/Caustic</b> 	Hydroxylamine Tetramethylethylamine Diamine Triethylamine	Store in separate cabinet, preferably with ventilation, corrosive cabinet or storage area with a spill tray, away from potential water sources (DO NOT store under the sink)	Acids Oxidizers Flammable Liquids Flammable Solids Inorganic Bases Poisons/Toxins	Heat Gas Generation Violent Reaction
<b>Corrosive Bases-Inorganic/Caustics</b> 	Ammonium Hydroxide Potassium Hydroxide Sodium Hydroxide Calcium Hydroxide	Store in separate cabinet, preferably with ventilation, corrosive cabinet or storage area with a spill tray, away from potential water sources (DO NOT store under the sink); Store solutions of inorganic hydroxides in labeled polyethylene containers	Acids Oxidizers Flammable Liquids Flammable Solids Organic Bases Poisons/Toxins	Heat Gas Generation Violent Reaction







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Class of Chemicals	Common Chemical Examples	Additional Concerns and Storage Recommendations	Common Incompatible Chemicals Types	Possible Reaction if Mixed/Health Concerns
<b>Flammable Solids</b> 	Charcoal Carbon Paraformaldehyde Phosphorus Magnesium	Keep in a dry, cool area away from oxidizers and corrosives	Acids Bases Oxidizers Poisons/Toxins	Fire Hazard Violent Reaction
<b>Flammable Liquids</b> 	Ethanol, Ethyl Acetate, Methanol, Acetone, Benzene, Xylene, Toluene Diethyl Ether Tetrahydrofuran Acetonitrile Glacial Acetic Acid Acetone liquids with flashpoints < 100 F	Flammable storage cabinet or refrigerator rated for flammable/hazardous storage/explosion proof *Peroxide-forming chemicals must be dated upon delivery and opening (two dates)	Oxidizers Acids Bases Reactives Poisons/Toxins	Fire Hazard Heat Violet Reaction
<b>Poisons/Toxins</b> 	Chloroform Cyanides Heavy metal compounds (e.g. Cadmium, Mercury, Osmium, Oxalic Acid, Phenol, Formic Acid), Formamide, Carbon Tetrachloride, 2-Mercaptoethanol Phenol,  *Hydrofluoric Acid - Hydrofluoric Acid is a highly acute poison Acrylamide Ethidium Bromide Sodium Azide	Store in a dark, dry, ventilated, cool area in an unbreakable chemically resistant secondary container (polyethylene) * Store volatile toxins with evaporation rate above 1.0 - (ether =1.0) in flammable cabinet; Store non-volatile liquid poisons in a refrigerator or cabinet; amounts less than 1 liter can be stored in a cabinet above bench level, ONLY if the cabinet has sliding doors (not swinging)	Flammable liquids Acids Bases Reactives Oxidizers Corrosives Please consult Division of Environmental Protection (DEP) for assistance *Hydrofluoric Acid should be stored in an area accessible only by authorized personnel; do not store in glass; use plastic containers and secondary containment	Generation of Toxic and Flammable Gas Combustion Heat Fire Hazard Explosion Hazard Violent Reaction Chloroform explosively reacts with chemically-reactive metals (e.g., Aluminum or Magnesium powder, Sodium, and Lithium), Strong Oxidizers, Strong Caustics (e.g., Alkalis), and decomposes in sunlight
<b>Explosives</b> 	Picric Acid Ammonium Nitrate Nitro Urea Trinitroaniline Benzoyl Peroxide Trinitrobenzene Trinitrobenzoic Acid Trinitrotoluene Urea Nitrate Trinitrophenol Diazoisbutylnitrile	Store in a secure location away from other chemicals; store in an area away from friction or shock	Please consult the SDS and the DEP	Explosion Hazard Violent Reaction Heat Shock Friction



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<b>Oxidizers</b> 	Peroxides, Nitrates, Perchlorates Permanganates Sodium Hypochlorite Ethyl Acetate, Iodine, Benzoyl Peroxide Potassium Dichromate Chlorates, Bromates, and Superoxides, Ammonium Persulfate, Ferric chloride	Store in secondary containment separately from combustibles and flammable materials	Combustibles Flammables Organic Materials Reducing Agents	Fire Hazard Gas Generation Toxic Gas
<b>Peroxide Formers</b> 	Acrylonitrile Isopropyl Alcohol Ethers (e.g. Diethyl ether, Isopropyl Ether), Acetals and Ketals, especially Cyclic Ethers and those with primary and/or secondary Alkyl groups Aldehydes (e.g. Acetaldehyde, Benzaldehyde) Vinyl and Vinylidene compounds, Dienes Tetrahydrofuran Dioxane Butylated Hydroxytoluene (BHT) Isopropyl Ether	Store in airtight bottles, away from light and heat in a dark, cool dry area; avoid using containers with loose-fitting lids and ground glass stoppers; crystallization, discoloration, and formation or deposition of layers are signs a peroxide former may have become shock sensitive; do not use or move such containers: contact DEP; all bottles of peroxide-forming chemicals must have the received date marked on the container; when the bottle is first opened, the container must be marked with the date opened	Always consult the Safety Data Sheet (SDS) and the Division of Environmental Protection (DEP)	Explosion Hazard Violent Reaction Shock Sensitive Combustion (Exothermic Reaction)  If an old or expired container of a peroxide-forming chemical or reactive is found, do not move it. Contact the DEP at 301-496-4710 for assistance in disposing of the container
<b>Water Reactive</b>	Sodium Metals Lithium Metals Potassium Metals Sodium Borohydride Alkali Metal Hydrides	Store in a dry, cool area away from potential spray from fire sprinklers and other water sources (DO NOT store under the sink)  Label this area for water-reactive storage	Aqueous solutions Oxidizers Please consult the Safety Data Sheet (SDS) and the Division of Environmental Protection (DEP)	Heat Violent Reaction

# Chemical Segregation

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<b>Flammable Compressed Gases</b>  	Methane Acetylene Butane Propane Hydrogen Silane Ethane Arsine Germane	Handle flammable compressed gases in a chemical fume hood  Store in well-ventilated areas; store away from oxidizers, open flames, sparks, and other sources of heat ignition; post NO SMOKING signs around storage area(s) or entrance(s) to storage room(s); flammable gases stored outdoors where ambient temperatures exceed 125 deg F (51.7 deg C) shall be protected from direct sunlight  Use a spark proof wrench to attach regulators and make other connections; install a flame/flash arrestor at the regulator outlet flow valve	Oxidizers Toxic Compressed Gases	Fire Hazard Explosion Hazard
<b>Oxidizing Compressed Gases</b>  	Oxygen Chlorine Fluorine Nitrogen oxides Gas mixtures containing Oxygen higher than atmospheric concentrations	Store oxidizers separately from flammable gas containers or combustible materials; minimum separation requirement from these materials is 20 ft or a 5 ft noncombustible barrier with a fire resistance rating of at least 30 minutes  Clean equipment used for oxygen and nitrous oxide with oxygen-compatible materials free from oils, greases, and other contaminants  Fluorine shall be handled in specially passivated containers and associated equipment	Flammable Compressed Gases Toxic Compressed Gases	Fire Hazard Explosion Hazard
<b>Toxic Compressed Gases</b>  	Carbon Monoxide Hydrogen Chloride Hydrogen Sulfide Nitrogen Dioxide	Handle toxic compressed gases in a chemical fume hood  Indoor storage or use of toxic compressed gases shall be provided with a gas cabinet, exhausted enclosure, or gas room  Refer to the SDS information for additional guidance on the storage and compatibility requirements	Flammable Compressed Gases Oxidizing Compressed Gases	Release of Toxic Gas Hydrogen Sulfide is a colorless, flammable, extremely hazardous gas with a “rotten egg” smell; Prolonged exposure may cause nausea, tearing of the eyes, headaches or loss of sleep, airway problems (bronchial constriction) in some asthma patients; possible fatigue, loss of appetite, headache, irritability, poor memory, dizziness and slight conjunctivitis
		Contact DOHS to determine if a fail-safe valve and/or continuous monitoring for toxic gas may be required during use		

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<b>Strong Reducing Agents</b>	Acetyl Chloride Thionyl Chloride Maleic Anhydride Ferrous Sulfide	Store in cool, dry, well-ventilated location Water reactive Segregate from all other chemicals	Please consult the specific SDS and DEP	Please consult the specific SDS and DEP
<b>Carcinogens</b> 	Benzidine Beta-Naphthylamine Benzene Methylene Chloride Beta-Propiolactone Carbon Tetrachloride	Label all containers as "Cancer Suspect Agents" or the equivalent. Store according to the hazardous nature of the chemical, using appropriate security when necessary	Please consult the specific SDS and DEP	Please consult the specific SDS and DEP
<b>Teratogens</b> 	Lead Compounds Mercury Compounds Benzene Aniline	Label all containers as "Suspect Reproductive Hazard" or "Reproductive Effector"  Store according to the hazardous nature of the chemical, using appropriate security when necessary	Aniline incompatible with Nitric Acid and hHdrogen Peroxide Please consult the specific SDS and DEP	Please consult the specific SDS and DEP
<b>General Stock Chemicals</b>	Sodium Bicarbonate Sodium Chloride Agar Salt buffer Most non-reactive salts	Store on shelves, or laboratory benches or shelving preferably behind glass doors and below eye level with like chemicals	Please consult the SDS and DEP	Please consult the specific SDS and DEP

Adapted from Prudent Practices in the Laboratory: Handling and Disposal of Chemicals, National Research Council, 1995, University of Texas/Health Science at Houston and Boston University Environmental Health & Safety.

## INCOMPATIBILITY OF COMMON LABORATORY CHEMICALS

When certain hazardous chemicals are stored or mixed together, violent reactions may occur because the chemicals are unsuitable for mixing, or are *incompatible*. Classes of incompatible chemicals should be segregated from each other during storage, according to hazard class. Use the following general guidelines for hazard class storage:

- Flammable/Combustible Liquids and Organic Acids
- Flammable Solids
- Mineral Acids
- Caustics
- Oxidizers
- Perchloric Acid
- Compressed Gases

**Before mixing any chemicals, refer to this partial list and the chemicals' MSDS's**

CHEMICAL	INCOMPATIBLE CHEMICAL(S)
Acetic acid	aldehyde, bases, carbonates, hydroxides, metals, oxidizers, peroxides, phosphates, xylene
Acetylene	halogens (chlorine, fluorine, etc.), mercury, potassium, oxidizers, silver
Acetone	acids, amines, oxidizers, plastics
Alkali and alkaline earth metals	acids, chromium, ethylene, halogens, hydrogen, mercury, nitrogen, oxidizers, plastics, sodium chloride, sulfur
Ammonia	acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, sulfur
Ammonium nitrate	acids, alkalis, chloride salts, combustible materials, metals, organic materials, phosphorous, reducing agents, urea
Aniline	acids, aluminum, dibenzoyl peroxide, oxidizers, plastics
Azides	acids, heavy metals, oxidizers
Bromine	acetaldehyde, alcohols, alkalis, amines, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.), metals, sulfur
Calcium oxide	acids, ethanol, fluorine, organic materials
Carbon (activated)	alkali metals, calcium hypochlorite, halogens, oxidizers

<b>Carbon tetrachloride</b>	benzoyl peroxide, ethylene, fluorine, metals, oxygen, plastics, silanes
<b>Chlorates</b>	powdered metals, sulfur, finely divided organic or combustible materials
<b>Chromic acid</b>	acetone, alcohols, alkalis, ammonia, bases
<b>Chromium trioxide</b>	benzene, combustible materials, hydrocarbons, metals, organic materials, phosphorous, plastics
<b>Chlorine</b>	alcohol's, ammonia, benzene, combustible materials, flammable compounds (hydrazine), hydrocarbons (acetylene, ethylene, etc.), hydrogen peroxide, iodine, metals, nitrogen, oxygen, sodium hydroxide
<b>Chlorine dioxide</b>	hydrogen, mercury, organic materials, phosphorous, potassium hydroxide, sulfur
<b>Copper</b>	calcium, hydrocarbons, oxidizers
<b>Hydroperoxide</b>	reducing agents
<b>Cyanides</b>	acids, alkaloids, aluminum, iodine, oxidizers, strong bases
<b>Flammable liquids</b>	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
<b>Fluorine</b>	alcohol's, aldehydes, ammonia, combustible materials, halocarbons, halogens, hydrocarbons, ketones, metals, organic acids
<b>Hydrocarbons (Such as butane, propane benzene, turpentine, etc.)</b>	acids, bases, oxidizers, plastics
<b>Hydrofluoric acid</b>	metals, organic materials, plastics, silica (glass), (anhydrous) sodium
<b>Hydrogen peroxide</b>	acetaldehyde, acetic acid, acetone, alcohol's carboxylic acid, combustible materials, metals, nitric acid, organic compounds, phosphorous, sulfuric acid, sodium, aniline
<b>Hydrogen sulfide</b>	acetaldehyde, metals, oxidizers, sodium
<b>Hypochlorites</b>	acids, activated carbon
<b>Iodine</b>	acetaldehyde, acetylene, ammonia, metals, sodium
<b>Mercury</b>	acetylene, aluminum, amines, ammonia, calcium, fulminic acid, lithium, oxidizers, sodium
<b>Nitrates</b>	acids, nitrites, metals, sulfur, sulfuric acid
<b>Nitric acid</b>	acetic acid, acetonitrile, alcohol's, amines, (concentrated) ammonia, aniline, bases, benzene, cumene, formic acid, ketones, metals, organic materials, plastics, sodium, toluene



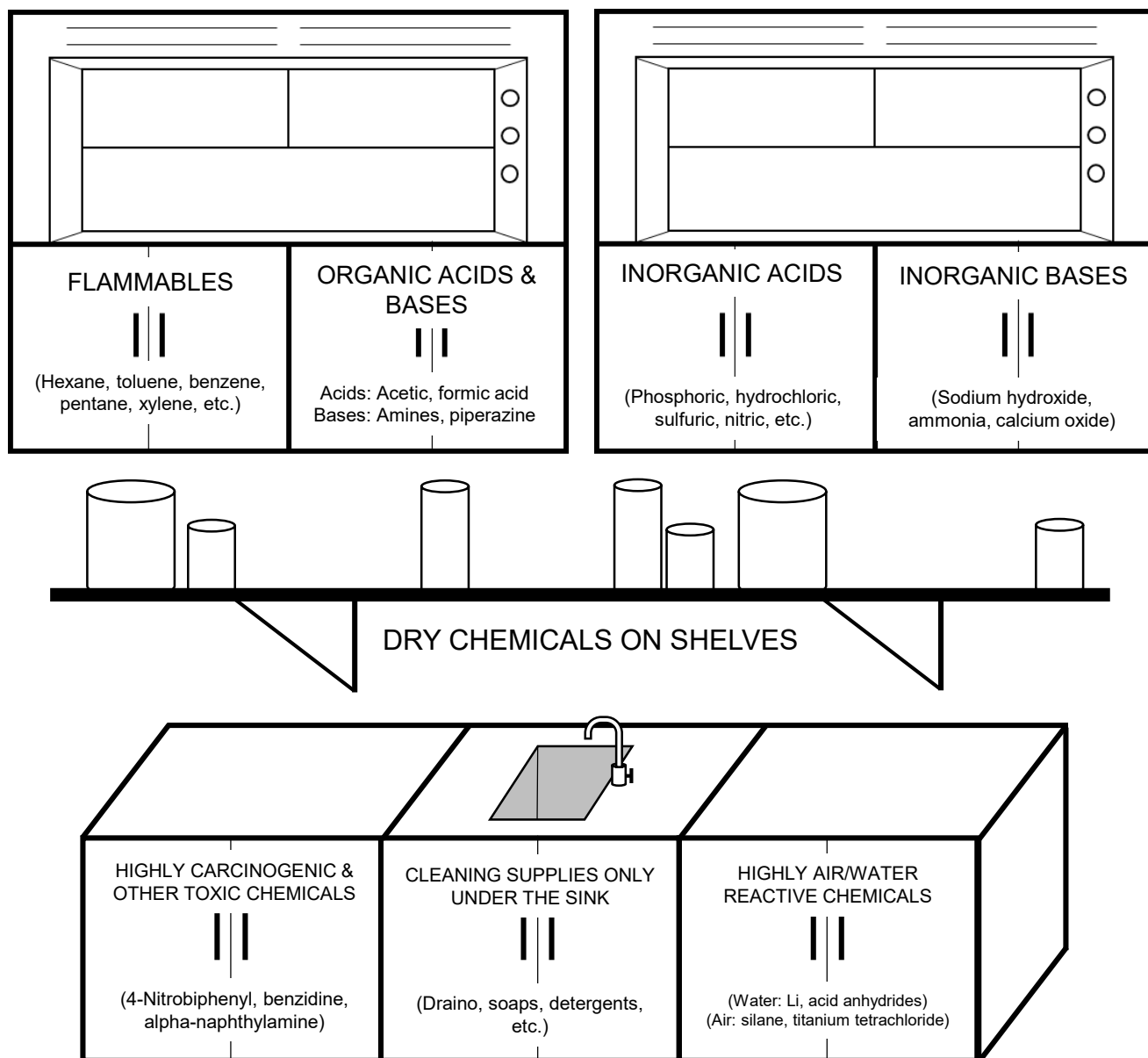
<b>Oxalic acid</b>	oxidizers, silver, sodium chlorite
<b>Oxygen</b>	acetaldehyde, secondary alcohol's, alkalis and alkalines, ammonia, carbon monoxide, combustible materials, ethers, flammable materials, hydrocarbons, metals, phosphorous, polymers
<b>Perchloric acid</b>	acetic acid, alcohols, aniline, combustible materials, dehydrating agents, ethyl benzene, hydriotic acid, hydrochloric acid, iodides, ketones, organic material, oxidizers, pyridine
<b>Peroxides, organic</b>	acids (organic or mineral)
<b>Phosphorus (white)</b>	oxygen (pure and in air), alkalis
<b>Potassium</b>	acetylene, acids, alcohols, halogens, hydrazine, mercury, oxidizers, selenium, sulfur
<b>Potassium chlorate</b>	acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic materials, sugars
<b>Potassium perchlorate (also see chlorates)</b>	alcohols, combustible materials, fluorine, hydrazine, metals, organic matter, reducing agents, sulfuric acid
<b>Potassium permanganate</b>	benzaldehyde, ethylene glycol, glycerol, sulfuric acid
<b>Silver</b>	acetylene, ammonia, oxidizers, ozonides, peroxyformic acid
<b>Sodium</b>	acids, hydrazine, metals, oxidizers, water
<b>Sodium nitrate</b>	acetic anhydride, acids, metals, organic matter, peroxyformic acid, reducing agents
<b>Sodium peroxide</b>	acetic acid, benzene, hydrogen sulfide metals, oxidizers, peroxyformic acid, phosphorous, reducers, sugars, water
<b>Sulfides</b>	acids
<b>Sulfuric acid</b>	potassium chlorates, potassium perchlorate, potassium permanganate

#### References:

Material Safety Data Sheets, various chemical companies.



## LABORATORY COMPATIBLE CHEMICAL STORAGE GROUPS 2



### Major Chemical Storage Groups with Examples:

#### Storage Group

#### Examples

<i>Organic Acids:</i>	propionic acid, trichloroacetic acid, acetic anhydride, acetyl bromide
<i>Organic Bases:</i>	hydroxylamine, ethylimine, tetramethylethylenediamine, triethylamine
<i>Inorganic Acids:</i>	hydrobromic acid, chlorosulfonic acid, sulfuryl chloride, hydriodic acid
<i>Inorganic Bases:</i>	hydrazine, sodium hydroxide and potassium hydroxide solutions
<i>Oxidizers:</i>	nitrates, persulfate, peroxides, iodates, nitric acid, chlorates, ozone, nitrites
<i>Flammables:</i>	methanol, tetrahydrofuran, ethyl ether, ethyl acetate, heptane, ethanol, acetone
<i>Water Reactive:</i>	alkali metals such as Li, Na, K; lithium aluminum hydride; calcium hydride
<i>Air Reactive:</i>	silane, silicon tetrachloride, white or yellow phosphorus
<i>Carcinogens:</i>	2-acetylaminofluorene, benzene, chloroform, methylene chloride, formaldehyde
<i>Peroxide Formers:</i>	isopropyl ether, p-dioxane, tetrahydrofuran, ethyl ether

## GUIDELINES FOR STORAGE & USE OF FLAMMABLE LIQUIDS IN LABS

[ALL VALUES ARE PER CONTROL AREA,]

MAXIMUM AMOUNT ALLOWED TO BE PRESENT IN A CONTROL AREA:

### In a Flammable Storage Cabinet

IA	60 gal
IB	120 gal
IC	180 gal
*Combination	240 gal

***\*NONE of the limits may be exceeded in the combination amount.***

Class IA - Flash point < 73EF, Boiling point < 100EF

Class IB - Flashpoint < 73EF, Boiling Point  $\geq$  100EF

Class IC - Flash Point  $\geq$  73EF, & < 100EF

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INCLUDED IN THE ABOVE LIMITS, ARE CHEMICALS ACTIVELY BEING USED IN **OPEN** FORM (EXPOSED TO ATMOSPHERE) WHICH ARE LIMITED TO:

IA	10 gal
IB	15 gal
IC	20 gal
*Combination	30 gal

NOTE: these amounts include waste solvents.

***\*NONE of the limits may be exceeded in the combination amount.***

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ALSO INCLUDED IN THE CONTROL AREA LIMITATIONS, ARE CHEMICALS ACTIVELY BEING USED IN **CLOSED** FORM (NOT EXPOSED TO ATMOSPHERE) WHICH ARE ALSO LIMITED TO:

IA	10 gal
IB	15 gal
IC	20 gal
*Combination	30 gal

NOTE: these amounts include waste solvents.

NOTE: Distillation apparatus that is vapor tight and totally enclosed is considered **closed** form.

***\*NONE of the limits may be exceeded in the combination amount.***