Safe Operating Procedure

(Revised 11/16)

COMPATIBLE CHEMICAL STORAGE

Purpose
The purpose of this Safe Operating Procedure (SOP) is to describe how to segregate chemicals by compatibility. There are different ways this can be done. The guidance below is based on the most common chemicals found in UNL laboratories.

Procedure
The simplest definition of chemical incompatibility is:

Two or more chemicals that, when mixed, react and create a hazard.

Examples of this include mixing strong acids and bases that create enough heat to shatter glass, organic compounds mixed with oxidizers that results in fires or explosions or combining some acids and metals that off-gas flammable gases.

One method for simplifying how to store chemicals compatibly is to focus on those chemicals known to cause problems. Compared to the universe of chemicals, this list is relatively short.

Inorganic acids (I)

Common - hydrochloric, sulfuric, and nitric. Less common – phosphoric, perchloric and chromic.

Organic acids (II)

Common – acetic. Less common – propionic, valeric, isovaleric, lactic and butyric. Note: peracetic acid is an organic acid. It is also an oxidizer.

Lots of chemicals have the word ‘acid’ in their name. Citric acid and boric acids are two examples. Other chemicals are described as hydrogen chloride salts such as tetracycline hydrochloride. With few exceptions, these chemicals are weak acids at best; not highly reactive.

Bases (III)

It is easiest to remember these chemicals by their 'last names;' (i.e. the anion fraction of the salt). These are the hydroxides and less commonly the oxides. Common - sodium hydroxide, potassium hydroxide, and ammonium hydroxide. Less common - calcium hydroxide and calcium oxide.

Oxidizers (IV)

It is also easiest to remember these chemicals by their last names. The most common are the nitrates. Lots of cations can join with them. Sodium for example creates sodium nitrate and potassium creates potassium nitrate. Other last names to remember are nitrites, chlorates, chlorites, hypochlorites, perchlorates, and bromates. Inorganic peroxides such as hydrogen peroxide and sodium peroxide will have 'peroxide' in the name. Three other stand-alone chemicals that are common are sodium persulfate, potassium permanganate and iodine.

Organic Peroxides (V)

Almost all organic peroxides will say 'peroxide' in the name. Methyl ethyl ketone peroxide is an example. Some organic peroxides go by a trade name such as Luperox (di tert butyl peroxide) so it may be necessary to look up the trade name to determine what the chemical is.

Strong Reducing Agents (VI)

This is a small group consisting mainly of hydrides such as aluminum hydride and sodium borohydride. Also in this group are the alkali metals such as sodium.

Everything Else (VII)

If the chemical name is something other than what has been mentioned above, it is likely that the chemical is generally compatible with others of the 'everything else' class. This class consists of salts inorganic chemicals such as potassium chloride, magnesium sulfate, and calcium bicarbonate and organic compounds like sucrose, alanine, chloroform and hexane.

These classes are summarized in the table on the next page.

Class	Chemical Classification	Examples	Incompatibility Examples
I	Inorganic Acids	Sulfuric, hydrochloric, nitric, phosphoric, perchloric	Metals – heat; flammable gases Organics – heat/fire/explosion Bases – heat
II	Organic Acids	Acetic, formic, propionic, butyric, valeric, isovaleric	Inorganic acids - heat/fire/explosion Bases – heat Oxidizers – heat/fire/explosion
III	Bases	Hydroxides of ammonium, sodium, potassium, calcium, etc. Oxides of calcium	Acids – heat Some metals – flammable gases
IV	Oxidizers	Nitrate, nitrite, chlorate, hypochlorate, hypochlorite, perchlorate and bromate salts (i.e. sodium, potassium, calcium, iron, etc.). Potassium permanganate, sodium persulfate, iodine. Inorganic peroxides (i.e. hydrogen peroxide)	Organics – heat/fire/explosion Reducing agents – heat/explosion
V	Organic Peroxides	Methyl ethyl ketone peroxide, di tert-butyl peroxide	Any other class - heat/fire/explosion
VI	Strong Reducing Agents	Lithium aluminum hydride and other hydrides, sodium borohydride, sodium and other alkali metals	Acids – heat and gas generation Organics – heat/explosion, gas generation Oxidizers – heat/explosion
VII	Everything Else	Inorganic chemicals such as potassium chloride, magnesium sulfate, and calcium bicarbonate and organic compounds like sucrose, alanine, chloroform and hexane	Varies widely but can be everything from heat to explosions to generating toxic or flammable gases

Thus there are seven classes of chemicals that need to be separated by trays or distance. Considering how infrequent organic peroxides and strong reducing agents are found in labs, the classes reduce to five (I-IV and VII) for many UNL locations.

The table above is **only** for chemical compatibility. It does not address other storage needs such as flammable liquids cabinets for solvents, that pyrophorics and water-reactives be kept away from air and water, that some organic peroxides and self-reactives need refrigeration, etc.

The table also only describes incompatibilities in general. It does not address all potential incompatibilities. For example, amines such a triethanolamine are incompatible with halogenated organics such as methylene chloride. Given that amines are not common in laboratories; they weren't included in the table. Also, generally speaking organic chemicals are incompatible with oxidizers. However, benzene, an organic chemical, can be mixed with nitric acid which is an oxidizer. The same is true of acids. Non-oxidizing inorganic acids such as hydrochloric acid and phosphoric acid are compatible with organic acids. They are grouped as inorganic acids out of simplicity.