Case Western Reserve University
Policy on Laboratory use of
Explosive and High Energy Materials

Partially Adapted from
Department of Energy (DOE) Explosives Safety Manual
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1.0 Policies

All work with explosive or highly energetic materials (EoHE) as listed in appendix A requires written consultation between the primary investigator and the student or staff perform work with EoHE materials. The written plan must include the procedures to be taken for protection and be included in the laboratories Chemical Hygiene Plan.

EoHE Committee

The EoHE committee approves use of EoHE materials above 100mg and shall be comprised, at a minimum, of the primary investigator, two additional peers, and a representative from Environmental Health and Safety (EHS). The committee will evaluate the work plan proposed by the primary investigator and work to achieve a suitable process for carrying out the work.

Any grant that will use EoHE materials at or above 100mg not exempted from this program must first be approved by the EoHE committee and the Dean of the School were the work will be done prior to submission. This requirement is necessary so that adequate engineering controls and work locations can be found prior to a grant commitment.

A maximum of 100mg of EoHE material may be prepared, stored, or handled in a reaction at any one time unless an additional work plan has been established and presented to the EoHE committee for approval.

Any approved use of materials above 100mg requires an approved location for the work that contains the required engineering controls needed to contain a blast should it occur. This engineered space shall meet all the requirements of local, state, and federal regulations.

Use of EoHE materials above 1g requires an emergency action plan be established. The emergency action plan must be comprehensive and sufficiently detailed to address the worst case scenario.

Training

All faculty, staff, and students working with EoHE materials shall be trained in accordance with the prepared work plan and the elements of this document before working with EoHE materials. Documentation of training shall include an outline of the training accompanied by a sign in sheet. These documents will then be included in the Chemical Hygiene Plan along with the work plan.

Exemptions

Picric acid and Sodium Azide are utilized in biological research. Hydrated materials do not require additional protection and are exempt from the 100mg limit. In order to take advantage of this exemption, a log demonstrating a visual check of hydration must be kept. The materials should be checked no less than once every four months.

1.1 General

a. Safety guidelines presented here are applicable to general laboratory operations involving explosive and high energy materials. Laboratory operations shall be conducted in a manner that is consistent with good laboratory practices and complies with the individual chemical hygiene plan of each individual laboratory.

b. Laboratory personnel shall conduct work involving explosives materials only in accordance with the provisions of written operating procedures as defined in chemical hygiene plans. These procedures shall comply with the requirements of National Fire Protection Association (NFPA) 45: Standard on Fire Protection for Laboratories Using Chemicals.

c. The quantity of explosives and high energy materials present in a laboratory shall be the minimum required for the operations and should be at or below the limits defined in the chemical hygiene plan.

Storage of stable material is permitted provided the material is secured when the laboratory is unoccupied. Storage of unstable material or material that may become unstable is discouraged and should be detailed in the work plan.

Once an EoHE has been produced, if it has the potential for destabilization by exposure to air, light, temperature or other factors, the products should be made and used as soon as possible. If materials must be stored, they should be protected to reduce the possibility of adverse reactions and destabilization.

If a product cannot be used when made, it must be placed in a locked and labeled munitions safe such as those used to store gunpowder.

Any material, and its precursors with the potential for misappropriation, or material that is listed as a weapon of mass destruction, or WMD, must be stored in locked storage sufficient to prevent the removal of the material from the laboratory.

d. Open flames shall be prohibited in laboratories where explosives or flammable solvent vapors are or may be present unless allowed by an approved EHS assessment.

e. Disposal of explosives through laboratory drains shall be forbidden. Special care should be exercised to prevent entrance of compounds into drains that may react with iron or rust to form sensitive salts (e.g., picrates, azides, and picric acid).

f. Solvents or other flammable substances shall be protected against electrical sparks, heat, and open flames.

g. Suitable guards for all glass or fragile equipment that must withstand reduced or elevated pressure must be present All glass ware should be examined for cracks and wrapped in tape as necessary to minimize the travel of glass shards should and explosion or implosion occur.

h. All work with EoHE materials shall be isolated from other laboratory experiments to the extent required for isolation in the event of an unexpected reaction.

i. Signs shall be placed on the entrance of areas where EoHE work will be conducted that state the names of materials in use, emergency contact information, and the quantity in use.

1.2 Definitions of explosive and high energy materials

a. An explosive substance is a solid or liquid substance (or mixture of substances) which is, in itself, capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.

b. A list of known and documented explosives and high energy materials are listed in Appendix A (attached) as defined by the Bureau of Alcohol, Tobacco, Firearms and Explosives. This list should not be seen as comprehensive list, but rather a strong, guiding framework for determining if substances being worked with in the laboratory are potentially explosive.

1.3 Safe Quantities and Protective Equipment and Environment

a. CWRU has deemed 100 mg to be the upper limit for working with explosive or high energy compounds without prior approval. If it becomes necessary to work with larger quantities, an approved protocol will need to be developed in conjunction with EHS.

b. If a laboratory operation involves an explosion hazard, personnel should be protected by appropriate engineering controls, personal protective equipment, and safety shields or the operation should be performed remotely. Table I lists shields that have been tested by the Department of Energy and found acceptable for the indicated quantities of explosive.

NOTE: CWRU laboratories are not generally equipped with the appropriate blast walls, such as infrangible panels and ceilings, required for use of EoHE above 100mg. If larger amounts of material above 100mg are approved, a suitable work area will need to be located or built.

NOTE: Shields listed in Table I, below, were not tested for metal-fragment penetration (unless specifically indicated) and thus may not offer effective protection when the explosive is closely confined in a heavy-walled metal container. ("Heavy-walled" is defined here as wall thickness to diameter ratio greater than 0.01.)

c. If an experiment poses a metal-fragment hazard (as opposed to a glass-fragment hazard) and the experiment cannot be conducted remotely, the proposed reaction conditions should be designed in consultation with EHS.

d. The shield shall be anchored to the hood frame or bench top when it is being used for protection against more than 5 g of TNT equivalent.

f. Work in confined areas is forbidden unless engineered and approved by an architect for such use.

g. When explosives operations require personnel to reach around a shield to manipulate equipment, exposure shall be minimized and the use of distancing devices shall be employed whenever possible. For example, a stick or other device can be used to distance the worker from the potential hazard.

Table I. Safety Shields for Explosive Laboratory Operations*

Shield	Minimum distance from explosive (cm)	Explosives limit
Leather gloves, jackets, or coats, and plastic face shields	----	100 mg
3 mm tempered glass	8	100 mg
7 mm Lucite/equivalent material	15	2.5 g
20 mm Lucite/equivalent material	15	10 g
15 mm laminated resistant glass	20	20 g
25.4 mm Lexan/Lexguard	30	50 g

* When proposing reactions that utilize or produce more than 100 mg of explosive or high energy material, a committee approved written plan must be filed with EHS and included in the individual laboratory's chemical hygiene plan.

1.4 Heating Operations

a. During synthesis, formulation, or experimental work, heat may be applied to initiate or maintain reaction, to increase solubility, etc., if the principles below are followed:

(1) Heat shall be applied indirectly using steam, a water bath, oil bath, or an approved laboratory electrical heating device, such as a mantle.

(2) Utmost caution shall be exercised to ensure that reactive materials do not come into direct contact with the heating elements.

(3) If an experiment must be conducted behind a shield, any heating device shall be mounted so that temperature can be controlled from the operator side of the shield. The heating device should be mounted so it can be separated quickly from the reaction vessel without operator exposure. Consideration should be given during design of the experiment to providing emergency cooling for the reaction vessel or its contents.

(4) Heating of explosives with devices without proper controls is prohibited unless approved in writing by EHS. If the operator must leave for any reason, the heating device should be turned off. Heating systems that will be operated unattended shall have dual controls, an override shutoff, or some other protection against failure of the primary heating control. Systems capable of totally containing the effects of an explosion may be exempted from these requirements.

b. Periodic checks should be made to ensure that an experiment is proceeding satisfactorily and that the apparatus is not boiling dry, malfunctioning, etc. In the case of remotely controlled operations, provisions shall be made for observation, using mirrors, television monitors, etc.

1.5 Laboratory Setups

Good workmanship and laboratory practice shall be exercised in making and operating laboratory setups. Follow the guidelines described in the CWRU Safety Manuals and Prudent Practices. In particular, the following guidelines apply:

a. Equipment and apparatus shall be clean, in good condition, and in good working order.

b. All glassware and apparatus shall be inspected for cracks, defects, etc., before use. Defective or damaged equipment shall be removed from service. Where appropriate, glassware should be wrapped or taped.

c. Setups shall be geometrically and structurally stable.

d. Work areas should be as neat and uncluttered as possible.

1.6 Low Concentration of Explosives in Solution

a. After explosives are in dilute solution (less than 25 percent explosives by weight), the primary hazard shall be considered as that associated with the solvent and not the explosive. Where supported by technical data, a solvent/explosives solution greater

than 25 percent may also be similarly classified. The 100mg limit still holds for solutions.

b. If the explosive recrystallizes or precipitates out of solution, safety guidelines for pure explosives shall apply.

Appendix A: Substances defined as explosive

This list is defined by the Bureau of Alcohol, Tobacco, Firearms and Explosives as of October 19th 2011(Federal Register / Vol. 76, No. 202).

NOTE: This list should not be considered comprehensive.

A
Acetylides of heavy metals.
Aluminum containing polymeric propellant.
Aluminum ophorite explosive.
Amatex.
Amatol.
Ammonal.
Ammonium nitrate explosive mixtures (cap sensitive).
* Ammonium nitrate explosive mixtures (non-cap sensitive).
Ammonium perchlorate having particle size less than 15 microns.
Ammonium perchlorate explosive mixtures (excluding ammonium perchlorate composite propellant (APCP)).
Ammonium picrate [picrate of ammonia, Explosive D].
Ammonium salt lattice with isomorphously substituted inorganic salts.
* ANFO [ammonium nitrate-fuel oil].
Aromatic nitro-compound explosive mixtures.
Azide explosives.

B
Baranol.
Baratol.
BEAF [1, 2-bis (2, 2-difluoro-2- nitroacetoxyethane)].
Black powder.
Black powder based explosive mixtures.
* Blasting agents, nitro-carbo-nitrates, including non-cap sensitive slurry and water gel explosives.
Blasting caps.
Blasting gelatin.
Blasting powder.
BTNEC [bis (trinitroethyl) carbonate].
BTNEN [bis (trinitroethyl) nitramine].
BTTN [1,2,4 butanetriol trinitrate].
Bulk salutes.
Butyl tetryl.

C
Calcium nitrate explosive mixture.
Cellulose hexanitrate explosive mixture.
Chlorate explosive mixtures.
Composition A and variations.

C (continued)
Composition B and variations.
Composition C and variations.
Copper acetylide.
Cyanuric triazide.
Cyclonite [RDX].
Cyclotetramethylenetetranitramine [HMX].
Cyclotol.
Cyclotrimethylenetrinitramine [RDX].

D
DATB [diaminotrinitrobenzene].
DDNP [diazodinitrophenol].
DEGDN [diethyleneglycol dinitrate].
Detonating cord.
Detonators.
Dimethylol dimethyl methane dinitrate composition.
Dinitroethyleneurea.
Dinitroglycerine [glycerol dinitrate].
Dinitrophenol.
Dinitrophenolates.
Dinitrophenyl hydrazine.
Dinitroresorcinol.
Dinitrotoluene-sodium nitrate explosive mixtures.
DIPAM [dipicramide;diaminohexanitrobiphenyl].
Dipicryl sulfone.
Dipicrylamine.
Display fireworks.
DNPA [2,2-dinitropropyl acrylate].
DNPD [dinitropentano nitrile]. Dynamite.

E
EDDN [ethylene diamine dinitrate].
EDNA [ethylenedinitramine].
Ednatol.
EDNP [ethyl 4,4-dinitropentanoate].
EGDN [ethylene glycol dinitrate].
Erythritol tetranitrate explosives.
Esters of nitro-substituted alcohols.
Ethyl-tetryl.
Explosive conitrates.
Explosive gelatins.
Explosive liquids.
Explosive mixtures containing oxygen- releasing inorganic salts and hydrocarbons.
Explosive mixtures containing oxygen- releasing inorganic salts and nitro bodies.
Explosive mixtures containing oxygen- releasing inorganic salts and water insoluble fuels.
Explosive mixtures containing oxygen- releasing inorganic salts and water soluble fuels.
Explosive mixtures containing sensitized nitromethane.
Explosive mixtures containing tetranitromethane (nitroform).
Explosive nitro compounds of aromatic hydrocarbons.

E (continued)
Explosive organic nitrate mixtures.
Explosive powders.

F
Flash powder.
Fulminate of mercury.
Fulminate of silver.
Fulminating gold.
Fulminating mercury.
Fulminating platinum.
Fulminating silver.

G
Gelatinized nitrocellulose.
Gem-dinitro aliphatic explosive mixtures.
Guanyl nitrosamino guanyl tetrazene.
Guanyl nitrosamino guanylidene hydrazine.
Guncotton.

H
Heavy metal azides.
Hexanite.
Hexanitrodiphenylamine.
Hexanitrostilbene.
Hexogen [RDX].
Hexogene or octogene and a nitrated N- methylaniline.
Hexolites.
HMTD [hexamethylenetriperoxidediamine].
HMX [cyclo-1,3,5,7-tetramethylene 2,4,6,8-tetranitramine; Octogen].
Hydrazinium nitrate/hydrazine/aluminum explosive system.
Hydrazoic acid.

I
Igniter cord. Igniters.
Initiating tube systems.

K
KDNBF [potassium dinitrobenzo-furoxane].

L
Lead azide.
Lead mannite.
Lead mononitroresorcinate.
Lead picrate.
Lead salts, explosive.
Lead styphnate [styphnate of lead, lead trinitroresorcinate].
Liquid nitrated polyol and trimethylolethane.
Liquid oxygen explosives.

M
Magnesium ophorite explosives.
Mannitol hexanitrate.
MDNP [methyl 4,4-dinitropentanoate].
MEAN [monoethanolamine nitrate].
Mercuric fulminate.
Mercury oxalate.
Mercury tartrate.
Metriol trinitrate.
Minol-2 [40% TNT, 40% ammonium nitrate, 20% aluminum].
MMAN [monomethylamine nitrate];methylamine nitrate.
Mononitrotoluene-nitroglycerin mixture.
Monopropellants.

N
NIBTN [nitroisobutametriol trinitrate].
Nitrate explosive mixtures.
Nitrate sensitized with gelled nitroparaffin.
Nitrated carbohydrate explosive.
Nitrated glucoside explosive.
Nitrated polyhydric alcohol explosives.
Nitric acid and a nitro aromatic compound explosive.
Nitric acid and carboxylic fuel explosive.
Nitric acid explosive mixtures.
Nitro aromatic explosive mixtures.
Nitro compounds of furane explosive
mixtures.
Nitrocellulose explosive.
Nitroderivative of urea explosive mixture.
Nitrogelatin explosive.
Nitrogen trichloride.
Nitrogen tri-iodide.
Nitroglycerine [NG, RNG, nitro, glyceryl trinitrate, trinitroglycerine].
Nitroglycide.
Nitroglycol [ethylene glycol dinitrate, EGDN].
Nitroguanidine explosives.
Nitronium perchlorate propellant mixtures.
Nitroparaffins Explosive Grade and ammonium nitrate mixtures.
Nitrostarch.
Nitro-substituted carboxylic acids.
Nitrourea.

O
Octogen [HMX].
Octol [75 percent HMX, 25 percent TNT].
Organic amine nitrates.
Organic nitramines.

P
PBX [plastic bonded explosives].
Pellet powder.

P (continued)
Penthrinite composition.
Pentolite.
Perchlorate explosive mixtures.
Peroxide based explosive mixtures.
PETN [nitropentaerythrite, pentaerythrite tetranitrate, pentaerythritol tetranitrate].
Picramic acid and its salts.
Picramide.
Picrate explosives.
Picrate of potassium explosive mixtures.
Picratol.
Picric acid (manufactured as an explosive). Picryl chloride.
Picryl fluoride.
PLX [95% nitromethane, 5%
ethylenediamine].
Polynitro aliphatic compounds.
Polyolpolynitrate-nitrocellulose explosive gels.
Potassium chlorate and lead sulfocyanate explosive.
Potassium nitrate explosive mixtures. Potassium nitroaminotetrazole. Pyrotechnic compositions.
PYX [2,6-bis(picrylamino)] 3,5- dinitropyridine.

R
RDX [cyclonite, hexogen, T4, cyclo-1,3,5,- trimethylene-2,4,6,-trinitramine; hexahydro-1,3,5-trinitro-S-triazine].

S
Safety fuse.
Salts of organic amino sulfonic acid explosive mixture.
Salutes (bulk).
Silver acetylide.
Silver azide.
Silver fulminate.
Silver oxalate explosive mixtures.
Silver styphnate.
Silver tartrate explosive mixtures.
Silver tetrazene.
Slurried explosive mixtures of water, inorganic oxidizing salt, gelling agent, fuel, and sensitizer (cap sensitive).
Smokeless powder.
Sodatol.
Sodium amatol.
Sodium azide explosive mixture.
Sodium dinitro-ortho-cresolate.
Sodium nitrate explosive mixtures.
Sodium nitrate-potassium nitrate explosive mixture.
Sodium picramate.
Special fireworks.
Squibs.
Styphnic acid explosives.

T
Tacot [tetranitro-2,3,5,6-dibenzo-1,3a,4,6a tetrazapentalene].
TATB [triaminotrinitrobenzene].
TATP [triacetonetriperoxide].
TEGDN [triethylene glycol dinitrate].
Tetranitrocarbazole.
Tetrazene [tetracene, tetrazine, 1(5- tetrazolyl)-4-guanyl tetrazene hydrate].
Tetrazole explosives.
Tetryl [2,4,6 tetranitro-N-methylaniline].
Tetrytol.
Thickened inorganic oxidizer salt slurried explosive mixture.
TMETN [trimethylolethane trinitrate].
TNEF [trinitroethyl formal].
TNEOC [trinitroethylorthocarbonate].
TNEOF [trinitroethylorthoformate].
TNT [trinitrotoluene, trotyl, trilite, triton].
Torpex.
Tridite.
Trimethylol ethyl methane trinitrate composition.
Trimethylolthane trinitrate-nitrocellulose.
Trimonite.
Trinitroanisole.
Trinitrobenzene.
Trinitrobenzoic acid.
Trinitrocresol.
Trinitro-meta-cresol.
Trinitronaphthalene.
Trinitrophenetol.
Trinitrophloroglucinol.
Trinitroresorcinol.
Tritonal.

U
Urea nitrate.

W
Water-bearing explosives having salts of oxidizing acids and nitrogen bases, sulfates, or sulfamates (cap sensitive).
Water-in-oil emulsion explosive compositions.

X
Xanthamonas hydrophilic colloid explosive mixture.