Title:	Policy on Laboratory use of Explosive and High Energy Materials
Approved by:	Envrionmental Health and Safety
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Relates to:	All of CWRU Community

Summary of this Policy:

This policy defines the protocol for the use of explosive or highly energetic materials (EoHE) as listed below in appendix A. Use of these chemicals require written consultation between the primary investigator and the student or staff who performs work with EoHE. The written plan must include the procedures for protection and be included in the laboratories' Chemical Hygiene Plan (CHP).

The EoHE committee and the dean of the school where the work will be done must first approve any grant that will use EoHE materials at, or above 100mg. This requirement is necessary so that adequate engineering controls and work locations can be found prior to a grant commitment.

Purpose of this Policy:

This policy's objective is to clarify the safety guidelines that must be followed when using EoHE while involved in general laboratory operations. It describes conduct, storage, heating and disposal procedures along with information on quantity permitted and signage use when handling all EoHE. This document goes into specific detail concerning the responsibilities of the EoHE committee.

Definitions:

a. CHP: Chemical Hygiene Plane

b. CWRU: Case Western Reserve University

c. DOE: Department of Energy

d. DOT: Department of Transportation

e. EHS: Environmental Health and Safety

f. EoHE: Explosive or highly energetic materials

g. EPS: Environmental Protection Agency

h. 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.

i. FDA: Food and Drug Administration

j. NFPA: National Fire Protection Association

k. OSHA: Occupational Safety and Health Administration

l. PI: Principal Investigator

m. TNT: Tri Nitro Toulene generally used as an explosive

n. WMD: Weapons of Mass Destruction

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

TRAINING REQUIRED

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

Procedure:

Good workmanship and laboratory practices shall be exercised in making and operating laboratory setups and configurations. Follow the guidelines as described in the Case Western Reserve 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 of taped.

c. Setups shall be geometrically and structurally stable.

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

Protection Procedures:

a. Laboratory operations shall be conducted in a manner that is consistent with good laboratory practices and complies with the specific CHP of each individual laboratory.

b. Laboratory personnel shall conduct work involving explosive materials only in accordance with the provisions of written operating procedures as defined in CHPs. These procedures shall comply with the requirements of the 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 limits defined in CHP.

d. 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.

e. 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.

f. 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 (WMD) must be stored in locked storage sufficient to prevent the removal of the material from the laboratory.

g. Open flames shall be prohibited in laboratories where explosives or flammable solvent vapors are or may be present unless allowed by an approved Environmental Health and Safety (EHS) assessment.

h. 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).

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

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

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

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

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 CHP.

Safety Quantities and Protective Equipment and Environment

a. Case Western Reserve University (CWRU) has deemed 100mg 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 performed remotely. Table I (above) lists shields that have been tested by the Department of Energy (DOE) and found to be acceptable for the indicated quantities of explosives.

c. 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.

d. Shields listed in Table I 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 wall is defined here as wall thickness to a diameter ratio greater than 0.01.)

e. 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.

f. 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 (Tri Nitro Toulene) equivalent.

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

h. When explosive 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.

Heating Procedures

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

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

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

c. If an experiment must be conducted behind a shield, any heating device shall be mounted so that temperatures 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 the design of the experiment in order to provide emergency cooling for the reaction vessel or its contents.

d. 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 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.

e. 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.

f. After explosives are in a diluted 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/explosive solution greater than 25 percent may also be similarly classified. The 100mg limit still holds for solutions.

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

The EoHE Committee

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

b. The EoHE committee and the dean of the school where the work will be done prior to submission must first approve any grant that will use EoHE materials at, or above 100mg, not exempt from this program. This requirement is necessary so that adequate engineering controls and work locations can be found prior to a grant commitment.

c. A maximum of 100mg of EoHE materials 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.

d. Any approved use of materials above 100mg requires an authorized 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 qualifications of local, state and federal regulations.

e. 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.

> Note: 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.

Appendix A: Substances defined as explosive

This list is defined by the ATF as of October 19, 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 op horite explosive
Amatex
Amatol
Ammonal
Ammonium nitrate exp losive mixtures (cap sensitive)
*Ammonium nitrate exp losive 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 isomorph housley 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- nitro acetoxy ethane]
Black powder
Black powder based explosive mixtures
*Blasting agents, nitro-carbo-nitrates, including non-cap sensitive slurry and water gel exp losives
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 exp losive mixture
Cellulose hexanitrate exp losive 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 [diamino trinitrobenzene]
DDNP [diazodinitrophenol]
DEGDN [diethylene glycol dinitrate]
Detonating cord
Detonators
Dimethylol dimethyl methane dinitrate composition
Dinitroethy leneurea
Dinitroglycerine [glycerol dinitrate]
Dinitrophenol
Dinitrophenol rates
Dinitrophenylhydrazine
Dinitroresorcinol
Dinitrotoluene-sodium nitrate explosive mixtures
DIPAM [dipicramide; diaminohexane nitrobiphenyl]
Dipicryl sulfone
Dipicry lamine
Display fireworks
DNPA [2,2-dinitro propyl acrylate]
DNPD [dinitrop entano nitrile]
Dynamite

E

EDDN [ethylene diamine dinitrate]
EDNA [ethylene dinitramine]
Ednatol
EDNP [ethyl 4,4-dinitrop ethanoate]
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

E (continued)

Explosive mixtures containing sensitized nitromethane
Explosive mixtures containing tetranitromethane (nitroform)
Explosive nitro compounds of aromatic hydrocarbons
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 [hexamethylene triperoxide diamine]
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 [lead trinitroresorcinate]
Liquid nitrate 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
Monopropellant

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 [ethyleneglycol dinitrate, EGDN]
Nitroguanidine explosives
Nitronium perchlorate propellant mixtures

N (continued)

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
Penthrinite composition
Pentolite
Perchlorate exp losive mixtures
Peroxide based exp losive mixtures
PETN [nitropentaerythrite, pentaerythrite tetranitrate, pentaerythritol tetranitrate
Picramic acid and its salts
Picramide
Picrate explosives
Picrate of potassium exp losive mixtures
Picrato
Picric acid (manufactured as an explosive)
Picryl chloride
Picryl fluoride
PLX [95% nitromethane, 5% ethylenediamine
Poly nitro aliphatic compounds
Poly olp olynitrate-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

S (continued)

Silver fulminate
Silver oxalate explosive mixtures
Silver styphnate
Silver tartrate exp losive mixtures
Silver tetrazene
Slurried exp losive 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 [triacetone triperoxide]
TEGDN [triethylene glycol dinitrate]
Tetranitrocarbazole
Tetrazene [tetracene, tetrazine, 1(5-tetrazoly l)-4-guanyl tetrazene hydrate]
Tetrazole explosives
Tetryl [2,4,6 tetranitro-N-methylaniline]
Tetrytol
Thickened inorganic oxidizer salt slurried explosive mixture
TM ETN [trimethylolethane trinitrate]
TNEF [trinitroethyl formal]
TNEOC [trinitroethyl orthocarbonate]
TNEOF [trinitroethylorthoformate]
TNT [trinitrotoluene, trotyl, trilite, triton]
Torpex
Tridite
Trimethylol ethyl methane trinitrate composition
Trimethylolethane trinitrate-nitrocellulose
Trimonite
Trinitroanisole
Trinitrobenzene
Trinitrobenzoic acid
Trinitrocresol

T (continued)

Trinitro-meta-cresol
Trinitronaphthalene
Trinitrophenetole
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 exp losive compositions

X

Xanthmonas hydrophilic colloid explosive mixture