Standard Operating Procedure
for

Chemical Handling and Storage

REVISION

Rev No.	DCN No.	Change Summary (Revised sections are in blue font.)	Release Date	DCN Initiator	Document Owner
4	DCN2230	Changes Made for updating nomenclature/branding, and removal of chemical storage cabinet inventory.	5-13-22	D. Brookhart	T. Diamond

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1. PURPOSE

1.1 To provide minimum requirements for the safe handling and storage of hazardous chemicals at the Albany Nanotech Complex.

2. SCOPE

2.1 This specification applies to the storage and handling of liquid and solid chemicals at the Albany Nanotech Complex. It does not apply to storage and handling of compressed gases (**EHS-00011**) or hazardous waste (**EHS-00009**).

2.2 This program applies to NY CREATES employees, SUNY Poly employees/students, tenant employees, contractors and sub-contractor who may be performing an activity or operation within the facility that involves the handling and/or storage of chemicals.

2.3 Tenant employees, contractors and sub-contractors may comply with their own organization's program provided that it meets and/or exceeds the minimum requirements set forth in this procedure.

2.4 NY CREATES employees, SUNY Poly employees /students, tenant employees, contractors and sub-contractors will be notified of the requirement to follow this program and are required to comply with the restrictions and limitations imposed upon them by NY CREATES / SUNY Poly during site activities.

3. DEFINITIONS

The following definitions apply to the various hazardous chemicals stored and handled at the Albany Nanotech Complex:

3.1 **Hazardous Chemical**, according to the Occupational Safety and Health Administration (OSHA) means any chemical which is a physical hazard or a health hazard.

3.2 **Physical Hazard** means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, an organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

3.3 **Health Hazard** means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed individuals. The term "health hazard" includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins,

agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

3.4 **Control Area:** Spaces within a building which are enclosed and bounded by exterior walls, fire walls, fire barriers and roofs, or a combination thereof, where quantities of hazardous materials not exceeding the maximum allowable quantities per control area are stored, dispensed, used or handled.

3.5 **Combustible Liquid.** A liquid having a closed cup flash point at or above 100°F (38 °C). Combustible liquids shall be subdivided as follows:

3.5.1 Class II. Liquids having a closed cup flash point at or above 100 °F (38 °C) and below 140°F (60 °C).

3.5.2 Class IIIA. Liquids having a closed cup flash point at or above 140 °F (60 °C) and below 200 °F (93 °C).

3.5.3 Class IIIB. Liquids having a closed cup flash point at or above 200 °F (93 °C).

3.6 **Flammable Liquid.** A liquid having a closed cup flash point below 100 °F (38 °C). Flammable liquids are further categorized into a group known as Class I liquids. The Class I category is subdivided as follows:

3.6.1 Class IA. Liquids having a flash point below 73 °F (23 °C) and having a boiling point below 100 °F (38 °C).

3.6.2 Class IB. Liquids having a flash point below 73 °F (23 °C) and having a boiling point at or above 100 °F (38 °C).

3.6.3 Class IC. Liquids having a flash point at or above 73 °F (23 °C) and below 100 °F (38 °C).

3.7 **Highly Toxic.** A material which produces a lethal dose or lethal concentration that falls within any of the following categories:

3.7.1 Ingestion. A chemical that has a medium lethal dose (LD_{50}) of 50 milligrams or less per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

3.7.2 Absorption. A chemical that has a median lethal dose (LD_{50}) of 200 milligrams or less per kilogram of body weight when administered by continuous contact 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.

3.7.3 Inhalation. A chemical that has a median lethal concentration (LC_{50}) in air of 200 parts per million by volume or less of gas or vapor, or 2

milligrams per liter or less of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

3.7.4 Mixtures of these materials with ordinary materials, such as water, might not warrant classification as highly toxic. While this system is basically simple in application, any hazard evaluation that is required for the precise categorization of this type of material shall be performed by experienced, technically competent persons.

3.8 **Oxidizer.** A material that readily yields oxygen or other oxidizing gas, or that readily reacts to promote or initiate combustion of combustible materials. Examples of other oxidizing gases include bromine, chlorine and fluorine.

3.8.1 Class 4. An oxidizer that can undergo an explosive reaction due to contamination or exposure to thermal or physical shock. In addition, the oxidizer will enhance the burning rate and can cause spontaneous ignition of combustibles.

3.8.2 Class 3. An oxidizer that will cause a severe increase in the burning rate of combustible materials with which it comes in contact or that will undergo vigorous self-sustained decomposition due to contamination or exposure to heat.

3.8.3 Class 2. An oxidizer that will cause a moderate increase in the burning rate or that causes spontaneous ignition of combustible materials with which it comes in contact.

3.8.4 Class 1. An oxidizer whose primary hazard is that it slightly increases the burning rate but which does not cause spontaneous ignition when it comes in contact with combustible materials.

3.9 **Toxic.** A chemical falling within any of the following categories:

3.9.1 Ingestion. A chemical that has a median lethal dose (LD_{50}) of more than 50 milligrams per kilogram, but no more than 500 milligrams per kilogram of body weight when administered orally to albino rats weighing between 200 and 300 grams each.

3.9.2 Absorption. A chemical that has a median lethal dose (LD_{50}) of more than 200 milligrams per kilogram but not more than 1,000 milligrams per kilogram of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between 2 and 3 kilograms each.

3.9.3 Inhalation. A chemical that has a median lethal concentration (LC_{50}) in air of more than 200 parts per million but not more than 2,000 parts per

million by volume of gas or vapor, or more than 2 milligrams per liter but not more than 20 milligrams per liter of mist, fume or dust, when administered by continuous inhalation for 1 hour (or less if death occurs within 1 hour) to albino rats weighing between 200 and 300 grams each.

3.10 **Water-reactive material.** A material that explodes; violently reacts; produces flammable, toxic or other hazardous gases; or evolves enough heat to cause self-ignition or ignition of nearby combustibles upon exposure to water or moisture. Water-reactive materials are subdivided as follows:

3.10.1 Class 3. Materials that react explosively with water without requiring heat or confinement.

3.10.2 Class 2. Materials that may form potentially explosive mixtures with water.

3.10.3 Class 1. Materials that may react with water with some release of energy, but not violently.

3.11 **Hazardous Material**. Any substance or material that could adversely affect the safety of the public, handlers, or carriers during transportation. This includes materials that are awaiting decontamination relocation or reuse that are not to be deemed waste.

4. RESPONSIBILITIES

4.1 It is the responsibility of each NY CREATES / SUNY Poly project manager, tenant (Tool Owner/operator) or individual who utilizes and/or stores chemicals at the Albany Nanotech Complex to ensure that the proper procedures, as detailed below, are followed for handling and storage of such chemicals. The individual using chemicals is also considered a hazardous waste generator and is responsible for properly characterizing, packaging and labeling the waste with the appropriate hazard information, as described in **EHS-00009** Hazardous Waste Management.

4.2 It is the responsibility of each NY CREATES / SUNY Poly Manager (host) who contracts the services of contractor/vendor personnel (contractor) to perform work at Albany Nanotech Complex property to ensure that the contractor is aware of the potential hazards associated with the required work and the proper procedures for handling and storage of the chemicals utilized in their activities.

4.3 It is the responsibility of the NY CREATES / SUNY Poly manager, tenant, Tool Owner/operator or individual ordering hazardous gases and chemicals to arrange for the safe and proper storage of those hazardous gases and chemicals when received onsite. Hazardous gases and

chemicals should not be delivered to and shall not be stored in office areas. They should be delivered to the Shipping and Receiving dock (NFN), where they can be stored temporarily until placed in bulk storage or delivered to the ultimate user. When delivered to a laboratory or cleanroom area, the chemicals should be placed into appropriate storage cabinets prior to use. Hazardous chemicals should only be stored in areas designed with adequate ventilation, spill control and fire protection systems.

4.4 It is the responsibility of the NY CREATES / SUNY Poly manager, tenant, Tool Owner/ operator, or individual ordering hazardous gases and chemicals to either provide individuals who have been properly trained in safe chemical handling and transportation or arrange to have the NY CREATES / SUNY Poly hazardous gas and chemical handling group properly handle and store the chemicals received at the Albany Nanotech Complex. The chemicals shall be stored within approved chemical storage rooms or cabinets and transported to the appropriate point of use locations (i.e., laboratories, clean rooms, equipment rooms, etc.) following safe handling practices, as detailed below.

5. ASSOCIATED DOCUMENTS

5.1 Building and Fire Codes of New York State.

5.2 **EHS-00002** –Hazard Communication Program

5.3 **EHS-00009** – Hazardous Waste Management

5.4 **EHS-00010** – Personal Protective Equipment

5.5 **EHS-00011** – Gas Cylinder Handling Procedure

5.6 **EHS-00005-F1** – Flammable Liquids Cabinet Inventory and Inspection Form

6. BULK STORAGE AREAS

6.1 Areas and rooms in which chemicals are stored, in excess of the short-term, in-use quantities, shall be designed and maintained in accordance with New York State Building and Fire Codes, National Fire Protection Association Codes (NFPA) and federal Occupational Health and Safety Administration (OSHA) Regulations. The Facilities Operations Group (FOG) is responsible for the design construction and general maintenance of these areas. The Cleanroom/Laboratory Manager and Gas & Chemical handling group are responsible for the safe operation of these areas. The EHS Department shall be contacted for interpretation and application of the appropriate codes.

6.2 General Requirements for Bulk Storage Areas

6.2.1 When the area is less than 300 square feet of storage the area must consist of minimum one-hour fire resistive construction.

6.2.2 When greater than 300 square feet of storage the area must consist of minimum two-hour fire resistive construction.

6.2.3 Floors shall be non-combustible and liquid tight.

6.2.4 Spill containment shall be provided through the use of sills, sumps and/or drains.

6.2.5 Exhaust ventilation at the rate of one cubic foot per minute per square foot of floor area, or six air changes per hour, whichever is greater, and arranged such that exhaust is taken within 12” of the floor.

6.2.6 Exhaust ventilation shall not be re-circulated within the room or building.

6.2.7 Electrical wiring and equipment shall be installed in accordance with the National Electric Code (NEC). In areas where flammables are stored, electrical equipment and wiring shall be approved for Class I, Division 1, hazardous locations.

6.2.8 When there is the possibility of an explosive environment, storage rooms shall be located on the outer perimeter of the building and provided with explosion venting.

6.2.9 Non-compatible chemicals shall be separated by a noncombustible solid partition extending 18 inches above and to the sides of the stored material, or separated by a distance of not less than 20 feet, or stored in approved hazardous material storage cabinets (see Appendix A - Figure 1). For solids and liquids which are labeled as poisons or toxics, secondary hazard labels (for example, Hydrogen Fluoride – Corrosive (Acid)/Poison) shall be referred to in order to determine compatibility.

6.2.10 Categories requiring separation are flammables, acids, bases and oxidizers. Appendix B - Figure 2 lists common chemicals utilized in research laboratories with examples of incompatibles.

6.2.11 Self-contained breathing apparatus (SCBA), minimum of two, shall be installed in an immediately accessible location outside of the room. For responding to the Central Utility Building (CUB) bulk chemical storage areas, the nearest SCBAs are in the NanoFab South (NFS) dock or the NanoFab South Annex (NFSX) dock.

6.2.12 Emergency eyewash and showers shall be readily available with a maximum travel distance from any point in the room to the shower is 25 feet or less or 10 seconds or less.

6.2.13 Emergency communication shall be provided and monitored at a remote location at all times when someone may be working in the area alone.

6.2.14 Any chemical or gas that has been identified as expired or “out of specification” that cannot be used in the laboratory or on cleanroom tools must be "RED TAGGED" by the shipping and receiving department or the gas and chemical handling firm’s personnel upon delivery, or the responsible chemical user if discovered during storage or use. The material container must be tagged on all sides (cylinders require only 1 tag). If the “out of specification” material is in a laboratory or in a cleanroom, it should be either stored in an appropriate cabinet for return to the supplier or moved to the chemical storage rooms by the gas and chemical handling firm. Expired material, if determined to be unusable, should be sent for disposal as a waste chemical through the NY CREATES's gas and chemical handlers.

7. IN-USE STORAGE

7.1 For the purpose of this specification, in-use storage refers to those chemicals which have been removed from the bulk storage areas and/or are being stored in or near the laboratory, cleanroom or maintenance areas where they will be used.

7.2 General Requirements for In-Use Storage

7.2.1 No chemicals or gases shall be stored in office areas, with the exception of small quantities of chemical containing office products such as printer/ copier toner, white board cleaners, or other cleaning products, which are exempt from these requirements.

7.2.2 Chemical containers should have the date received and first opened for use noted on them to aid in determining shelf life and product quality. Many chemicals degrade after exposure to moisture in the air and some, such as ethyl ether and tetrahydrofuran, form peroxides as a result, which are unstable and may cause a fire or explosion upon opening the container.

7.2.3 The storage of hazardous chemicals shall be within fully enclosed storage cabinets and/or in cabinets under lab hoods and wet benches.

7.2.4 No chemical storage cabinets shall be located within exit corridors.

7.2.5 No chemical storage cabinets shall be located within fume hoods.

7.2.6 Metal chemical storage cabinets must be of approved double-walled construction and minimum 18 gauge steel.

7.2.6.1 Corrosives cabinets (especially those used for storing nitric and/or sulfuric acids) are exempted from this provision. HDPE or similar engineered plastic materials provide better resistance to corrosion in the event of a spill of those materials.

7.2.7 All wiring within flammable cabinets or explosion proof refrigerators must be in accordance with the NEC.

7.2.8 Specific Chemical hazard labels for each chemical must be attached to the exterior of the cabinet. If a number of different chemicals are stored in a cabinet, a listing of the current inventory on a removable sheet that can be updated regularly is acceptable. The list shall be updated when each new chemical is added or the use of a listed chemical is discontinued. Separation of incompatible materials must be maintained.

7.2.9 The bottoms of cabinets utilized for the storage of liquids shall be liquid-tight to a minimum height of 2 inches.

7.2.10 No mechanical or electrical equipment shall be stored on top of or inside chemical storage cabinets.

7.2.11 No HPM or corrosive chemicals shall be stored above eye level in a cabinet or lab hood, or on the floor in any laboratory, cleanroom or maintenance area.

7.2.12 All chemical storage cabinets on site shall be inspected, cleaned out and wiped down with a suitable cleaning agent at a minimum annually.

- The cabinet owner must maintain a record of the date that the annual inspection and wipe down was completed.
- This shall be coordinated by the individuals responsible for the storage cabinet.
- The maximum weight capacity per cabinet shelf must not be exceeded.
- All chemicals in storage for over a year should be carefully reviewed by the cabinet owner for chemical purity and continued need.
    - If chemical is determined to be of no use, then dispose of as hazardous waste.

IMPORTANT: All chemical storage cabinets shall have signage posted on the front of each cabinet stating the cabinet owner and contact information in case of emergency.

7.3 **Exceptions to Section 7.2**

7.3.1.1 Chemicals may be stored on chemical carts in the NFSX chemical transfer areas provided that they are either in the process of being used, or properly stored within the same shift.

7.3.1.2 A maximum of one squeeze bottle containing each specific type of chemical is allowed at their “point of use" provided that they are in use during that shift.

7.3.1.3 A maximum of one tub containing pre-soaked alcohol wipes is allowed at their "point of use" provided that they are in use during that shift.

Explosion-proof refrigerators that contain chemicals shall have chemical specific labels on their exterior and labels prohibiting the storage of food. Chemicals shall be stored in secondary containment trays, tubs, or over pack containers inside the refrigerator to avoid mixing of incompatible materials.

NOTE: Flammable liquids and solids must be stored in explosion-proof refrigerators, if temperature–sensitive.

8. SEPARATION CLASSIFICATION

8.1 The following are the five general classes of chemicals that must not be intermingled in the same storage cabinet:

- Flammables (including combustibles)
- Acids
- Bases
- Oxidizers
- Miscellaneous hazards (e.g., phosphorous oxychloride ($POCl_3$); Perchloric Acid; Tetrahydrofuran (THF); boron tribromide (BBr_3).

8.2 **Exceptions to General Separation/ Classification Rules**

8.2.1 Inert materials may be intermingled with other materials.

8.2.2 When approved by EHS, some Oxidizers may be stored with Bases.

8.2.3 Strong mineral acids, which are also oxidizers (e.g., fuming Nitric acid), must never be stored with organic acids or bases, unless segregated

within the cabinet in separate spill containment trays capable of holding 110% of the largest container of each material stored.

8.3 Flammables/Combustibles

8.3.1 Flammable liquids/solids may be stored only within approved metal flammable storage cabinets.

8.3.2 A maximum total of 120 gallons of Class I, Class II, and Class III liquids may be stored. Of this total, no more than 60 gallons total may be Class I and Class II liquids (See definitions Sec 3.1, 3.2) may be stored in each cabinet.

8.3.3 No more than three (3) 60 gallon flammable storage cabinets are allowed within any area, unless they are separated from the next nearest group of three cabinets by at least 100 feet. Multiple combinations of storage cabinet types are allowed provided that no more than 180 gallons of flammable liquids are stored within the flammable storage cabinets in a given room.

8.3.4 The cabinet must be conspicuously labeled in red letters on a contrasting background, "Flammable - Keep Fire Away".

8.3.5 All flammable chemical storage cabinets shall be grounded.

8.3.6 When it is necessary to dispense flammable or combustible liquids utilizing pressure:

- The canister shall be made of stainless steel.
- The canister shall be less than five gallons.
- Only an inert gas such as nitrogen or CDA may be used to pressurize the canister.
- The canister may be pressurized to a maximum of 3 psi less than the rating for the canister.
- The canister shall be grounded.
- If dispensed by pressurized lines they shall be at a pressure of <15 psi, and shall utilize double contained piping with teflon or braided stainless steel outer piping.

8.4 Acids

8.4.1 May be stored only within blue acid storage cabinets or acid wet station cabinets.

8.4.2 Storage cabinets shall be labeled as "ACIDS-CORROSIVE".

8.4.3 The cabinet shelves and its bottom must be constructed or covered with polyethylene, polypropylene, or similar acid resistant material, with molded "traps" to catch acid spills.

8.4.4 Solid corrosive acids, used in laboratories, may be stored as general chemicals and it's not necessary to have spill containment for solids.

8.4.5 Inorganic mineral acids (nitric, sulfuric, hydrochloric) and organic acids (acetic, lactic) shall not be stored in the same cabinet unless segregated within the cabinet in separate spill containment trays capable of holding 110% of the largest container of each material stored.

8.5 **Bases**

8.5.1 May be stored only within blue base storage cabinets or base wet station cabinets.

8.5.2 Storage cabinets shall be labeled as "BASE - CORROSIVE".

8.5.3 Cabinet construction shall be the same as for acid cabinets.

8.5.4 Solid corrosive bases, used in laboratories, may be stored as general chemicals and it's not necessary to have spill containment for solids.

8.6 **Oxidizers**

8.6.1 May be stored in blue oxidizer storage cabinets or oxidizer wet station cabinets.

8.6.2 When approved by EHS, oxidizers may be stored with some bases but shall never be stored in same cabinet or spill containment area as organic acids or flammable organics.

8.6.3 Cabinets shall be labeled as "Oxidizer".

8.6.4 Construction shall be the same as an acid cabinets.

8.7 **Miscellaneous**

8.7.1 Phosphorous oxychloride ($POCl_3$), perchloric acid ($HClO_4$) and boron tribromide (BBr_3) must be stored in separate storage cabinets, away from other corrosives, due to their high reactivity.

8.7.2 The cabinets must be blue and labeled with their contents, and hazards.

8.7.3 The cabinets shall be of the same construction as acid cabinets.

8.8 General Chemical Storage

8.8.1 Chemicals, and in particular flammable liquids or water reactive solids or liquids, should not be stored in basement areas.

8.8.2 Non-hazardous liquids should be stored in cabinets or on shelves in such a manner as to limit contact with incompatible materials, and to prevent their entry into floor or sink drains in the event of a leak from a container.

8.8.3 It is not necessary to provide spill containment for non-hazardous solids.

8.9 Maximum Chemical Quantities

8.9.1 The maximum quantity of hazardous chemicals within a single production area (such as the NFS or NFSX cleanroom areas), both stored and in-use, shall not exceed the quantities listed in Appendix C.

8.9.2 The average density of hazardous chemicals within a workstation within a fabrication area shall not exceed that listed in Appendix D.

8.9.3 The average density of hazardous chemicals within a single control area or laboratory shall not exceed that listed in Table III. The design and number of control areas in any given building shall comply with the requirements set forth in New York State Fire Code Table 2703.8.3.2 - Appendix G.

9. PERCHLORIC ACID

9.1 Perchloric acid ≥73% forms highly explosive and unstable compounds with many combustible materials and with metals. Unstable perchlorate compounds may collect in the duct work of improperly installed fume hoods and cause fire or violent explosions.

9.2 Perchloric acid should be used with extreme caution and only in a fume hood designed for its use.

9.3 Perchloric acid hood has corrosion-resistant ductwork and wash-down facilities.

9.4 Containers of perchloric acid should be kept on trays of glass, ceramic, or polyethylene materials of sufficient capacity to hold all of the acid in the event of a leak.

9.5 Only minimum quantities should be kept, with no more than a one pound bottle in the laboratory at any time. No flammables or organic solvents should be used in a perchloric acid hood.

9.6 Perchloric acid should not be kept for more than a year since explosive crystals may form. To verify adherence to this rule the requestor must place a date on the bottle of perchloric acid as soon as it is received.

9.7 Discolored perchloric acid should not be touched, it is most likely contaminated and could be dangerous. Contact EHS for proper disposal.

9.8 It is recommended that concentrations <73% follow the same protocol outlined above with the exception of the wash-down facilities in the designated perchloric acid hood.

10. MATERIALS LIABLE TO FORM PEROXIDES IN STORAGE

10.1 A number of both organic and inorganic compounds are susceptible for the formation of peroxide compounds by reaction with atmospheric oxygen. Such compounds include:

- Aldehydes
- Ethers, especially cyclic ethers and those containing primary and secondary alcohol groups
- Compounds containing benzylic hydrogen atoms (particularly if the hydrogens are on tertiary carbon atoms)
- Compounds containing the allylic structure, including most alkenes.
- Vinyl and vinylidene compounds.

10.2 Among the more widely-used compounds which may form peroxides in storage are:

- acetal
- cumene
- cyclohexene
- cyclooctene
- decahydronaphthalene
- decalin
- diacetylene
- dicyclopentadiene
- diethyl ether
- diethylene glycol
- diisopropyl ether
- dimethyl ether
- dioxane
- divinyl acetylene
- ethylene glycol dimethyl ether (glyme)
- isopropyl ether
- methyl acetylene
- sodium amide
- tetrahydrofuran (THF)
- tetrahydronaphthalene
- tetralin
- vinyl acetate
- vinylidene chloride

10.3 Peroxide compounds are very reactive and often highly unstable.

10.4 Formation of peroxide compounds pose a number of safety hazards with the potential for very serious injury and damage to property. These safety hazards include:

10.4.1 Explosive Decomposition Reactions, and

10.4.2 Violent, possibly explosive, auto-polymerization of certain unsaturated compounds, initiated by formation of peroxides.

10.5 Labeling of Incoming Material Requirements

10.5.1 On arrival to the laboratory, the labels on containers of materials susceptible to peroxide formation must be:

10.5.1.1 Inspected to determine whether they include the warning “Peroxide Former” or “Peroxidizable”. This information must be added, if not already present.

10.5.1.2 Labeled with the date (MM/DD/YY) on which the material was received and the identity of a responsible employee, group or department.

10.6 **Storage Requirements**

10.6.1 Peroxidizable materials must be stored in compliance with supplier SDS recommendations.

10.6.2 If possible, the original supplier's container should be used. Otherwise, use containers that strictly conform to manufacturers recommendations.

10.6.3 Containers should be kept tightly sealed to prevent both ingress of additional atmospheric oxygen and also to prevent evaporation of volatile compounds.

10.7 **Handling and Use Requirements Before using a Container of Peroxidizable Material**

10.7.1 Ensure that the material is within its approved storage / disposal limits.

10.7.2 Examine the condition of the container. If a viscous condensate, crystals or other solids are discovered in any peroxidizable material container (even one that is otherwise empty), DO NOT TOUCH OR MOVE THE CONTAINER. Post a warning sign, keep others away and immediately contact the Emergency Response Team (ERT) (#78600 or 514-437-8600).

10.7.3 Once a container is opened the chemical should be tested for peroxides not less frequently than once every month and dispose of after six months.

10.7.4 Unopened containers if not used disposed of after 12 months.

11. PYROPHORIC CHEMICALS

11.1 Storage

11.1.1 Pyrophoric liquids in quantities greater than 0.4 gallons shall be stored in an approved flammable storage cabinet or exhausted enclosure that is constructed of at least 18-gauge steel and is equipped with a highly sensitive smoke detection device (e.g., VESDA).

11.1.2 If used, the highly sensitive smoke detector shall be tied into the fire alarm control panel which will page the ERT directly.

11.1.3 Accept delivery from the shipping department and transfer immediately to the storage location. Unpack vessel from the shipping packaging.

11.1.1 Upon receipt of a pyrophoric liquid the ampoule and inner metal container should be checked that it is labeled with the name and hazard classification. If such a label is not present then a GHS or NFPA label must be attached to identify the name and hazards associated with the chemical.

11.1.2 Also upon receipt the receiver must attach a ‘status tag’ to the outside of the ampoule and inner metal container to identify its current state of ‘full, in-use or empty’.

11.1.3 Place the container in the designated flammable storage cabinet.

11.1.4 In the case of a spill or emergency contact ERT immediately. Those handling emergencies associated with this material should follow the guidelines, equipment and PPE specified in the ERT SOP (**EHS-00019**).

11.1.5 Emergency response PPE and spill equipment shall be located near the storage cabinet to allow for immediate emergency response.

11.2 Delivery

11.2.1 Pyrophoric liquids shall be transported on a cart with the ampoule inside a metal container/housing.

11.2.2 Pyrophoric liquids can only be delivered to the NFN chemical pass-through between the hours of 9:00am-3:00pm, Monday-Friday and handed off directly to the person using them. Once received, this material shall be transported directly to the cabinet and loaded immediately.

11.3 Loading/Unloading/Handling

11.3.1 Once received, the pyrophoric liquids shall continue to be transported inside the cleanroom on a cart with the ampoule inside the metal container/housing.

11.3.2 Wearing the PPE specified in **EHS-00010** and only if qualified to do so, the person loading or unloading the material shall ensure that the area around them is barricaded.

11.3.3 Loading or unloading of such a material shall be limited to the hours of 9:00am-3:00pm, Monday-Friday and shall be done as a buddy system.

11.3.4 Once loaded the status tag on the ampoule shall be marked as 'in use' and when removed shall be marked as 'empty'.

11.3.5 Please note that the quantity of pyrophoric liquids at any one workstation shall be limited to 0.5 gallons.

11.4 Spill or Emergency

11.4.1 In the case of a spill or emergency, contact immediately. Those handling emergencies associated with this material should follow the guidelines, equipment and PPE specified in the ERT Standard Operating Procedure **EHS-00019**.

11.4.2 Emergency response PPE and spill equipment shall be located near the storage cabinet to allow for immediate emergency response.

11.5 Packaging Liquid Pyrophorics for Return to Supplier

11.5.1 Retrieve shipping packaging that corresponds to the container to be shipped from storage.

11.5.2 Remove the in use / empty labels from the vessel before packing.

11.5.3 Place the vessel in the packing. Seal and label, as required. Bring the complete package to the shipping location.

12. HAZARDOUS MATERIALS

12.1 Storage/Labeling

12.1.1 Hazardous materials shall be stored in yellow, hazardous-materials bag with legible and clear information at a minimum containing the following:

- An appropriate GHS label,

- The source of the material (i.e., tool, system the material is from),
- A contact name and number and,
- The date on which the bag was created

12.1.2 The bags may not contain any free liquid or produce any odor.

12.1.3 Hazardous material bags once properly labeled can be stored either in the fab/subfab or in a designated storage area.

12.1.4 Bags left in the fab/subfab and not in a designated storage area should not be more than 6 months old. After 6 months the contact on the bag will be contacted and either asked to remove the bag and place it in a storage area or deem the bag waste and have it removed as hazardous waste.

13. CHEMICAL RECEIPT PROCESS

13.1 After receiving a chemical, the Shipping and Receiving (S&R) department, in accordance with **EHS-00002** - Hazard Communication Program, verifies that such a material is on the approved chemical list. If the material is not on the approved chemical list S&R will send a note to the EHS department to check if the material is in the approval progress. If the material is not in the approval process, S&R must send a note to the requestor telling them that the material needs to be approved by the EHS department before being delivered.

13.2 If the material is on the approved chemical list, S&R will contact the Chemical and Gas handling firm telling them that the chemical has arrived and ask that they place it into storage. In the event that the material needs to be placed into storage before it is approved by the EHS department, S&R must place a ‘jailed/quarantined’ note on the container and/or outer packaging.

14. CHEMICAL DELIVERY PROCESS

14.1 When the requestor is ready to use the chemical that they ordered, they must contact Chemical and Gas handling firm in writing requesting that the material be delivered and provide at least the following:

Name of requestor:
Name of the material:
Location to be stored or delivered to:
Hex ID of the tool that will use the chemical:
Approved by EHS: (Y / N)

Date requested:
Date delivered:
Delivered by:

14.2 The requestor should allow at least 12-24 hours for the material to be delivered. In the event that the material needs to be approved by the EHS department, the requestor should allow 5-10 business days before the material can be approved and thereafter delivered.

14.3 In the event that the material requested is a precursor/bubbler, Chemical and Gas handling firm should contact the EHS to verify that the requestor and/or tool have been approved to use such a precursor/bubbler.

14.4 Chemicals, if delivered to an area that is not a chemical storage cabinet, should not remain in this location for more than one work shift or 12 hours whichever is less. Chemicals that remain in such an area for >12 hours will be returned to their storage location and the requestor will have to go through the process again.

15. HANDLING

15.1 General

15.1.1 The required Personal Protective Equipment (PPE) must be worn when using, handling, transferring or transporting chemicals (See **EHS-00010**).

15.1.2 Ensure all containers, baths, holding tanks, storage cabinets, etc., are properly labeled. If a chemical is transferred into smaller container or secondary container, the chemical identification and its associated hazards must be clearly labeled. Labels can be obtained from label centers located throughout the facility. Chemical label centers are located in: each of the clean room gowning rooms; are generally available in the CESTM labs; and can also be obtained from the EHS office.

15.1.3 A supply of spill clean-up materials shall be readily available in high chemical use, transfer and storage areas for use in spill situations.

15.1.4 As with storage, transportation of chemicals shall be done in a manner to prevent against accidental contact of incompatible materials.

15.1.5 All stocked chemicals should be staged to affect a First-In, First-Out (FIFO) stock rotation process to ensure that oldest chemicals are used first. This should avoid having chemicals in storage that exceed the manufacturer’s expiration dates and should also serve to minimize the generation of hazardous waste due to raw chemicals exceeding listed expiration dates.

15.2 Bulk Chemical Handling

15.2.1 When powered industrial lift trucks are necessary, only trained and authorized operators are allowed to drive a powered industrial truck to transport chemicals.

15.2.2 When bulk chemicals are transported, only compatible chemicals may be transported on the same pallet (See Appendix A - Figure 1 for Compatibility / Separation Matrix).

15.2.3 All boxes on a pallet must be secured before being transported via motorized or manual pallet movers (e.g., shrink wrap, tie downs, utilization of tension belts, strapping, or similar means).

15.2.4 When new chemicals are received, every effort must be made to place them within their proper storage area immediately. In no instance shall chemicals remain outside of the storage area beyond one shift.

15.2.5 When chemicals are pulled for clean room or laboratory use, they shall be brought directly to the research area. Those which are not immediately transferred to the clean room or laboratory area must be stored within the appropriate chemical cabinets or returned back to the appropriate storage room.

15.2.6 Dumbwaiters or freight elevators shall never be used as a storage location, not even on a temporary basis.

15.2.7 Once emptied, boxes shall be broken down and removed to the designated trash dumpster. In no instance shall empty boxes remain beyond one shift nor shall chemicals be stored inside in a box and inside the storage cabinet.

15.2.8 Special shipping containers, such as those used for shipping highly toxic or flammable precursor materials, should be labeled “Hold for return shipment”. A request should be made to Shipping and Receiving or the Clean room or Laboratory manager for temporary storage of the container in the chemical storage area.

15.3 Chemical Container Handling

15.3.1 <u>Bottles/Containers (up to one gallon)</u>

15.3.1.1 Chemicals should never be transported on a passenger elevator except as noted in Section 20. Individuals transporting single containers should use a chemical bottle carrier and use the stairs.

15.3.1.2 Dumbwaiters and freight elevators can be used for transport of chemicals, but shall NEVER be used as a chemical storage location, not even on a temporary basis.

15.3.1.3 When carrying a one gallon size bottle, it shall be supported by one hand at the neck of the bottle and one under the bottom. The use of chemical carriers to move individual bottles is strongly recommended.

15.3.1.4 Multiple small containers (e.g., 20-100 ml or cc, 0.7-3.4 oz.) can be carried in a chemical carrier or an over pack container of suitable size as long as chemically compatible.

15.3.1.5 At no time shall either full or empty chemical bottles be transported without its cover firmly fastened.

15.3.1.6 Empty bottles shall be handled and disposed of in accordance with the hazardous waste procedures.

15.3.1.7 When two or more gallon size bottles are transported, it shall be by means of a cart which is constructed of a chemical resistant material.

15.3.1.8 The carts shall provide a means of restraining containers against accidental dislodgment and breakage, and shall be capable of containing the volume of the largest bottle, should it break.

15.3.1.9 The length or width of the cart shall not exceed 48 inches.

15.3.1.10 No more than 48 gallons shall be transported on one cart.

15.3.1.11 Non-compatible chemicals shall not be transported within the same cart, dumbwaiter, or freight elevator at the same time.

15.3.1.12 Bulk storage of cases of chemicals is limited to a stacking height of four cases. The cases should be stacked on a spill containment skid or on shelves located within a spill containment area.

15.3.2 Five-Gallon Drums

15.3.2.1 Five-gallon drums shall be transported by means of cart or hand truck designed for the load.

15.3.2.2 Five-gallon drums may be stacked up to three drums high, provided that the drums are designed for stacking, while they are in bulk storage. No stacking of drums is allowed for In-Use storage.

15.3.3 Greater Than Five-Gallon Drums

15.3.3.1 Larger drums shall be transported by means of a hand truck of tripod style and designed for the load.

15.3.3.2 Drums shall be transported in the upright position with their bungs/tops secured. This section, applies to all drums to include full, in-service, and empty drums.

15.3.3.3 Once emptied, drums shall have an "EMPTY" label affixed, and be treated as still having the chemical hazard associated with the original chemical until they have been triple rinsed.

15.3.3.4 Full drums of 30 gallon or greater capacity shall not be stacked.

15.3.3.5 Empty drums may be stacked on their sides with both ends secured. They should only be stored in designated storage areas, and if outside, not subject to storm water runoff. The stacking of empty drums is limited to three rows high.

15.3.4 Transferring Chemicals by Hand

15.3.4.1 NY CREATES EHS's preferred technique for chemical transfers is based on minimizing employee exposures to chemicals, in order of effectiveness:

1) Designed engineering controls, such as bulk-fed delivery systems
2) Local engineering controls, such as an articulating arm with snorkel exhaust,
3) Lastly, having the employee pour chemicals by hand while wearing PPE.

15.3.4.2 NY CREATES recognizes that in an R&D environment, it may not always be feasible to bulk feed smaller amounts of chemicals, therefore, we allow the transfer of chemicals by hand with the following requirements:

- All hand pouring of an HPM requires local exhaust, such as a fume hood or an articulating arm with snorkel exhaust to minimize employee exposures, odor issues, and HEPA filter risks.
- No more than 1.3 gallons (5L) of liquids with a hazard ranking of 4 may be hand poured at a single time and must be dispensed to and from approved containers.
- No more than 5 gallons of liquids with a hazard ranking of 3 or less may be hand poured at a single time and must be dispensed to and from approved containers.

- The maximum amount of any one hazardous chemical that can be poured in a week is 20 gallons.
- If a tool needs more than 55 gallons of a single chemical in a two-week period, it must be bulk supplied.
- Job-specific training must be given to all employees performing the hand pouring task. This should include proper use of PPE and spill emergency and clean-up procedures.
- All hand pouring/dispensing of an HPM requires secondary containment such as spill trays.
- Spill clean-up kits must be prepared and available in the work area.

15.3.5 Exceptions

15.3.5.1 The requirements for transferring chemicals by hand do not apply to canister change-outs or Nowpaks which have quick-disconnect ports.

15.3.5.2 Special circumstances that do not meet this specification must be authorized by the NY CREATES EHS Department.

16. EMERGENCY SHOWER AND EYEWASH

16.1 Emergency Shower and Eyewash stations are and shall be installed in areas where the eyes or body of any person may be exposed to corrosive chemicals. The EHS Department should be consulted for the additional emergency shower and eye wash needs for other hazardous chemicals.

16.1.1 The stations shall be installed within 25 feet of any hazardous chemical location or within 10 seconds of travel, must be unobstructed at all times and have a continuous water supply.

16.1.2 Signs indicating “Emergency Shower and/or Eyewash” shall be posted at each installation.

16.1.3 They shall be inspected monthly and flushed monthly by Facilities personnel, and the attached inspection record label shall be completed.

16.1.4 They shall be located away from electrical sources.

17. CHEMICAL SPILLS AND LEAKS

17.1 All chemical spills must be cleaned up immediately by qualified individuals.

17.1.1 Small chemical spills of known materials (i.e., less than one quart) of low to moderately hazardous materials can be cleaned up by qualified laboratory personnel. Larger spills should be cleaned up by ERT, since larger quantities of spill supplies than typically stored in a laboratory will be required. In addition, special precautions such as use of PPE may be needed based on the type and volume of material spilled.

17.1.2 Call 437-8600 or 7-8600 to report chemical spills

17.2 All chemical leaks must be contained immediately upon discovery, and the leak source repaired and cleaned up as soon afterward as business conditions allow. At no time shall a leak be allowed to continue uncontained.

17.2.1 Only persons who have been deemed qualified shall contain chemical leaks.

17.2.2 Call 437-8600 or 7-8600 to report chemical leaks.

17.2.3 Leaking chemical containers should be clearly labeled to indicate that they are leaking, and should not be moved without adequate spill containment Damaged or leaking chemical containers are contained and over-packed if necessary by the ERT and placed in designated storage areas. If the leaking container is deemed unfit for use and declared waste, it should be labeled according to **EHS-00009**.

18. CHEMICAL WORK STATION DESIGN REQUIREMENTS

18.1 General chemical work station (including wet benches) design requirements shall include the following:

18.1.1 Exhaust manometer, magnahelic, or photohelic to provide a visible indication of ventilation operation.

18.1.2 Emergency power-off switch (red mushroom “panic” button) controlling all power to the work station.

18.1.3 Station/equipment power controlled by a ground fault circuit interrupter.

18.1.4 Minimum hood face capture velocity shall be 100 fpm and for wet benches, sinks and hoods which utilize slots in the freeboard area above the liquid level of the bath shall have minimum slot velocities of 750 fpm and a minimum capture velocity, 9" above the liquid level at the center of the chemical bath, of 125 fpm.

18.2 Flammable/Combustible Solvent Work Station Design

18.2.1 Work stations shall be all metal (18-gauge stainless steel minimum) construction, or Factory Mutual Flame retardant plastic meeting 4910 performance standard.

18.2.2 All stations shall have point of use (in station or directly above) extinguishing system, either water or Halon/CO_2 system. If Halon/CO_2 system, both manual and automatic, utilizing UV/IR detectors (not powered by the emergency off switch).

18.2.3 There must be a means for electrically grounding the hood or work station to prevent static accumulation.

18.2.4 Electrical equipment & wiring, including lighting inside the hood, shall be rated for flammable atmospheres, Class I, Division II; or shall be located in a separate nitrogen-purged area of the work station. The nitrogen purge must have a flow indicator.

18.3 Heated Work Station Design

18.3.1 Heaters, or heated work stations must have a primary temperature control, and an independent over temperature detector tied to the heater power cut-off. This shall also apply to hotplates used in lab hoods or on lab bench tops. Power must auto shut off if temperature exceeds 15 degrees C above the process temperature.

18.3.2 A low liquid level indicator must be interlocked to the heater power. An optical or nitrogen bubbler type level detector is preferred over floats because floats may corrode. A bubbler type shall have a nitrogen flow indicator.

18.3.3 Any heating element which transfers heat by passing fluid through the heating element must have an appropriate pressure or flow sensor capable of removing power from the heating element, should flow fall below a specified limit.

18.3.4 An automatic timer should be connected to the heater or hot plate, to prevent overheating if left unattended for any length of time.

18.3.5 No immersion type heaters shall be used unless it is absolutely necessary. Applications involving immersion type heaters shall be reviewed with the EHS Manager.

18.4 **Corrosive Liquids Work Stations**

Stations should be of metal (18-gauge stainless steel minimum) construction, with corrosion resistant coating, or flame-retardant plastic meeting Factory Mutual 4910 performance standard.

19. CHEMICAL TRANSPORT

19.1.1 Only materials that are on the approved chemical list shall be permitted to be picked up from S&R and transported.

19.2 **Placarding**

19.2.1 Packages or containers shall be transported in the original Department of Transportation (DOT) packaging as the DOT requires that all packages containing hazardous materials be constructed of particular types of material and be placarded on the outside to alert the carrier of the hazard contained within.

19.2.2 In the event that a package does not have a placard, the S&R department will place the appropriate placard on the outside of the package before allowing the HPM to be transported.

19.3 **Transport Cart**

19.4 Chemicals or hazardous waste transport shall only be done within an approved cart.

19.5 The transport cart must be clearly marked and designated for transporting compatible materials (e.g., corrosive; flammable).

19.6 Incompatible materials shall not be transported or carried at the same time.

19.7 Chemical containers must be secured/locked on cart before entering the corridor and shall remain secured/locked during transport.

19.8 Transport carts transporting HPMs above excepted quantities must be compliant with 2703.10.3 of the NYSFC.

19.9 **Emergency Procedures**

19.9.1 The transport cart shall be equipped with spill pads for containing and cleaning up spills of less than a pint.

19.9.2 The transporter shall have knowledge of NY CREATES ERT and the phone number to activate the team should there be a spill of greater than a pint.

19.9.3 The transporter shall be aware of pull stations and use one in the event that a situation occurs that is beyond their control, such as a material that is fuming, smoking or otherwise reacting.

20. CHEMICAL & HAZARDOUS WASTE TRANSPORT IN HALLS AND ELEVATORS

20.1 The required PPE must be worn when transporting chemicals.

20.2 Chemical carts should be loaded and staged the day prior to expected delivery. The staging should take place in CUB, HPM Storage building or NFN receiving area

20.3 While transporting the chemical cart into the building and down hallways the lead person shall assists with doors and any obstructions while the second person steers the cart.

20.4 No one is allowed to travel inside ANY elevator while transporting HPM chemicals.

20.5 Two qualified persons are required for transporting HPM chemicals in elevators.

20.5.1 A qualified person is one who has been trained in Chemical Handling, PPE and Emergency Spill Response Procedures.

20.6 The elevator sequence is as follows:

1. One person stays at the elevator loading floor and the second is in position at the off-loading floor level.

2. The chemical cart is loaded into the elevator. No one travels inside the elevator with chemicals. A sign shall be hung on the front of the cart that reads “Hazardous Materials/Waste in Transport. DO NOT BOARD’.

3. The person at the off-loading floor calls for the elevator and receives the cart.

4. The person at the off-loading floor shall wait until the second qualified person is present to proceed with transportation down hallways.

20.7 **HPM Transport**

20.7.1 HPM Chemicals cannot be transported through emergency egress exits except in special circumstances as approved by EHS.

20.7.2 HPM Chemicals shall be transported using chemical elevators or dumbwaiters with the exception of the following buildings that do not contain chemical elevators:

- NFS
- NFE
- CESTM

20.7.3 Passenger elevators should never be used to transport HPMs in buildings where chemical elevators are available (NFN, NFX, and NFC). If the freight elevator is unavailable, EHS must review and approve each alternate transport request on a case-by-case basis.

20.7.4 HPMs shall not be transported in corridors that have a width of less than 44 inches.

20.8 **Safe Transport of Chemicals and Waste using the NFS/NFE/CESTM Passenger Elevator**

20.8.1 Corridors being used cannot have dead ends and must be equipped with smoke detection devices, pull stations, and fire alarm horns/strobes.

20.9 Chemicals can be transported into NFS labs within an approved cart in the NFS passenger elevator between 5:00am and 7:00 am only on Tuesdays and Thursdays.

20.10 Chemicals can be disposed of or removed from NFS labs within an approved cart in the NFS elevator only between 5:00am and 7.00am on Wednesdays and Fridays.

20.11 Hazardous Waste removal follows the same process as for chemical transport.

20.11.1 Chemicals delivered to the NFN loading dock shall be transferred from the NFN loading dock to the NFE loading dock within one day of delivery.

20.11.2 Chemicals cannot be transported until receipt of delivery to the NFE loading dock has been confirmed. Chemicals transported to NFE shall be done so by the Chemical and Gas handling firm using a powered industrial truck.

20.11.3 Chemicals and waste delivered to the NFE loading dock that will not immediately be transferred to their final destination must be secured in a flammable or corrosive staging cabinet.

20.11.4 Chemicals delivered to the NFN loading dock shall be transferred from the NFN loading dock to the CESTM labs within one day of delivery.

20.12 Chemicals can be transported to or waste removed from the NFE/CESTM labs within an approved cart using the building's passenger elevator.

20.12.1 HPMs shall be transported from Shipping and Receiving dock on the second floor of NFN to the second floor CESTM labs.

20.12.2 If chemicals need to be transported to the first or third floor CESTM labs, the transporter shall use the elevators located in CESTM.

20.13 Hazardous Waste removal from labs in NFE/CESTM follows the same route and process as outlined for chemical transportation.

20.14 Biosafety materials delivered to the NFN loading dock shall be placed in refrigerated/freezer storage awaiting pick up and transported directly to the designated lab(s) in NFE/CESTM.

20.14.1 Biosafety waste shall be picked up from each biosafety lab and transported by a qualified NY CREATES / SUNY Poly employee, in a labeled cardboard shipping box, directly to the designated biosafety waste storage area in the CUB.

21. RECORDS

21.1 Chemical and gas inventory records shall be maintained by the cleanroom maintenance support group or laboratory manager.

21.2 Facilities Operation shall maintain an inventory of Flammable Storage Cabinets in use at the Albany Nanotech Complex.

21.3 EHS shall maintain records of training for individuals required to handle and store chemicals, or clean up chemical spills or leaks.

NOTE: Those individuals handling or storing chemicals must attend training upon initial assignment, annually or more frequent if an incident occurs that deems retraining is necessary. Persons qualified to transport chemicals have had EHS training in Chemical Handling, PPE, and Small Spill Response.

22. APPENDICES

22.1 **Appendix A** - Figure 1: HPM Separation Matrix

22.2 **Appendix B** - Figure 2: List of Incompatible Chemicals

22.3 **Appendix C** - Table I: Maximum Chemical Quantities Stored in a Single Fabrication Area or Laboratory

22.4 **Appendix D** - Table II: Maximum Quantities of HPM at a Workstation

22.5 **Appendix E** - Table III (A): Maximum Quantity of Hazardous Materials Posing a “Physical” Hazard

22.6 **Appendix F** - Table III (B): Maximum Quantity of Hazardous Materials Posing a “Health” Hazard

22.7 **Appendix G** - Table IV: Design and Number of Control Areas

Appendix A - Figure 1: Minimum Separation of HPM[a,b]

Materials	Highly Toxic	Toxic	Acid	Base	Flammable	Oxidizer	Water Reactive	Pyrophoric	Unstable Reactive	Organic Peroxide
Highly Toxic	—	NR	1 hr.	1 hr.	1 hr.	1 hr.	1 hr.	1 hr.	1 hr.	1 hr.
Toxic	NR	—	S	S	S	S	S	S	S	S
Acid	1 hr.	S	—	S	S[c]	S	S	S[c]	S	S
Base	1 hr.	S	S	—	S	S	S	S	S	S
Flammable	1 hr.	S	S[C]	S	—	S	R	S	S	S
Oxidizers	1 hr.	S	S	S	S	—	S	S[c]	S	S
Water Reactives	1 hr.	S	S	S	R	S	—	S	S	S
Pyrophoric	1 hr.	S	S[C]	S	S	S[c]	S	—	S	S

NOTES:

For SI: 1 Foot = 304.8mm

a. NR = Not Required
S = Separation by a partial noncombustible partition
R = Separate Rooms
1 hr. = 1-hour fire-barrier construction

b. Hazardous production material gas shall be separated from HPM liquids and solids by a 1-hour fire-barrier or shall be kept in approved gas cabinets.

c. Separation by not less than 20 feet is allowed in lieu of a noncombustible partition.

Appendix B - Figure 2: Partial List of Incompatible Chemicals

The following list of chemicals in the left-hand column should be transported, stored, used, and disposed of in such a manner that they do not accidentally come in contact with the corresponding chemicals in the right–hand column. These chemicals could react violently if allowed to come in accidental contact with each other, resulting in an explosion, or may produce highly toxic and/or flammable gases or vapors. However, it should be remembered that this list is not in any way complete, but is to serve only as a guide for the commonly used chemicals.

Primary Chemical	Incompatible with
Acetic acid	Chromic acid, ethylene glycol, hydroxyl-containing compounds, nitric acid, perchloric acid, permanganates and peroxides.
Acetone	Bromine, chlorine, nitric acid, and sulfuric acid.
Acetylene	Bromine, chlorine, copper, mercury, and silver.
Alkaline and alkaline earth metals such as calcium, cesium, lithium, magnesium, potassium and sodium.	Carbon dioxide, chlorinated hydrocarbons, and water.
Aluminum and its alloys (as powders)	Acid or alkaline solutions, ammonium persulfate and water, chlorates, chlorinated compounds, nitrates, and organic compounds in nitrate/nitrite salt baths.
Ammonia (anhydrous)	Bromine, calcium hypochlorite, chlorine, hydrofluoric acid, iodine, mercury, and silver.
Ammonium perchlorate, permanganate, or persulfate.	Combustible materials, oxidizing materials such as acids, chlorates, and nitrates.
Ammonium nitrate	Acids, chlorates, lead, metallic nitrates, metal powders, finely divided organics or combustibles, sulfur and zinc.
Aniline	Hydrogen peroxide or nitric acid.
Barium peroxide	Combustible organics, oxidizable materials, and water.
Barium rhodanide	Sodium nitrate.
Bismuth and its alloys	Perchloric acid
Bromine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, metal powders, sodium carbide, and turpentine.
Calcium or sodium carbide	Moisture (in air) or water.
Calcium hypochlorite	Ammonia or carbon (Activated)
Chlorates or perchlorates	Acids, aluminum, ammonium salts, cyanides, phosphorous, metal powders, oxidizable organics or other combustibles, sugar, sulfides and sulfur.
Chlorine	Acetone, acetylene, ammonia, benzene, butadiene, butane and other petroleum gases, hydrogen, metal powders, sodium carbide, and turpentine.
Chlorine dioxide	Ammonia, hydrogen sulfide, methane, and phosphine.
Chromic acid	Acetic acid (glacial), acetic anhydride, alcohols, combustible materials, flammable liquids, glycerine, naphthalene, nitric acid, sulfur, and turpentine.
Cumene Hydroperoxide	Acids (mineral or organic).
Cyanides	Acids or alkalines.
Fluorine	Most materials.
Hydrocarbons such as benzene, butane, gasoline, propane, turpentine, etc.	Bromine, chlorine, chromic acid, fluorine, hydrogen peroxide, and sodium peroxide.

Primary Chemical	Incompatible with
Hydrofluoric acid or anhydrous hydrogen fluoride	Ammonia (anhydrous or aqueous).
Hydrocyanic acid or hydrogen cyanide	Alkalis and nitric acid.
Hydrogen peroxide, 3%	Chromium, copper, iron, most metals or their salts.
Hydrogen peroxide, 30% to 90%	Same as Hydrogen peroxide 3% (above), plus aniline, any flammable liquids, combustible materials, nitromethane, and all other organic matter.
Hydrogen sulfide	Fuming nitric acid or oxidizing gases.
Iodine	Acetylene, ammonia, (anhydrous or aqueous), and hydrogen.
Lithium	Acids, moisture in air, and water.
Lithium aluminum hydride	Air, chlorinated hydrocarbons, carbon dioxide, ethyl acetate, and water.
Magnesium (particularly powder)	Carbonates, chlorates, heavy metal oxylates or oxides, nitrates, perchlorates, peroxides, phosphates, and sulfates.
Mercuric oxide	Sulfur
Mercury	Acetylene, alkali metals, ammonia, nitric acid with ethanol, and oxalic acid.
Nitrates	Combustible materials, esters, phosphorous, sodium acetate, stannous chloride, water, and zinc powder.
Nitric Acid (Conc.)	Acetic acid, aniline, chromic acid, flammable gases and liquids, hydrocyanic acid, hydrogen sulfide, and nitratable substances.
Nitric acid	Alcohols, and other oxidizable organic material, hydoiodic acid (hydrogen iodide), magnesium or other metals, phosphorous, and thiophene.
Nitrites	Potassium or sodium cyanide.
Nitro paraffin's	Inorganic alkalis.
Oxalic acid	Mercury or silver.
Oxygen (liquid or enriched air)	Flammable gases, liquids or solids such as acetone, acetylene, grease, hydrogen, oils, and phosphorous.
Perchloric acid	Acetic anhydride, alcohols, bismuth and its alloys, grease, oils, or any organic materials, and reducing agents.
Peroxides (organic)	Acids (mineral or organic).
Phosphorous	Chlorates and perchlorates, nitrates and nitric acid.
Phosphorous pentoxide	Organic compounds or water.
Phosphorous (Red)	Oxidizing materials.
Phosphorous (White)	Air (oxygen) or other oxidizing materials.
Picric acid	Ammonia heated with oxides or salts of heavy metals and friction with oxidizing agents.
Potassium	Air (moisture and/or oxygen) or water.
Potassium chlorate or perchlorate	Acids or their vapors, combustible materials, especially organic solvents, phosphorous, and sulfur.
Potassium permanganate	Benzaldehyde, ethylene glycol, glycerin, and sulfuric acid.
Silver	Acetylene, ammonium compounds, nitric acid with ethanol, oxalic acid, and tartaric acid.
Sodium amide	Air (moisture and oxygen) or water.
Sodium chlorate	Acids, ammonium salts, oxidizable materials and sulfur.
Sodium hydrosulfite	Air (moisture) or combustible materials.
Sodium nitrite	Ammonia compounds, ammonium nitrate, or other ammonium salts.

Primary Chemical	Incompatible with
Sodium peroxide	Acetic acid (glacial), acetic anhydride, alcohols, benzaldehyde, carbon disulfide, ethyl acetate, ethylene glycol, furfural, glycerine, methyl acetate, and other oxidizable substances.
Sulfur	Any oxidizable substance.
Sulfuric acid	Chlorates, perchlorates, and permanganates.
Water	Acetyl chloride, alkaline and alkaline earth metals, their hydrides and oxides, barium peroxide, carbides, chromic acid, phosphorous oxychloride, phosphorous pentachloride, phosphorous pentoxide, sulfuric acid, and sulfur trioxide, etc.
Zinc chlorate	Acids or organic materials.

Appendix C - Table I: (TABLE 1804.2.1) Maximum Chemical Quantities Stored in a Single Fabrication Area

Hazard Category	Solid (Lbs. /sq. ft.)	Liquids (Lbs. /sq. ft.)	Gases (Cu ft @ NTP / sq. ft.)
Physical - Hazard Materials			
Combustible Fiber Loose Baled	 100 cu ft. 1000 cu ft.	 Not Applicable	 Not Applicable
Combustible Liquid Class II Class IIIA Class IIIB Combination – Class I, II, IIIA	 Not Applicable	 0.01 0.02 Not Limited 0.04	 Not Applicable
Cryogenic gas Flammable Oxidizing	 Not Applicable	 Not Applicable	 Note c 1.25
Explosives	Note b	Note b	Note b
Flammable Gas Gaseous Liquefied	 Not Applicable	 Not Applicable	 Note c Note c
Flammable Liquid Class IA Class IB Class IC Combination Class IA, IB, and IC Combination Class I, II, and IIIA	 Not Applicable	 0.0025 0.025 0.025 0.025 0.04	 Not Applicable
Flammable Solid	0.01	Not Applicable	Not Applicable
Organic Peroxide Unclassified detonable Class I Class II Class III Class IV Class V	 Note b Note b 0.025 0.1 Not Limited Not Limited	 Not Applicable	 Not Applicable
Oxidizing Gas Gaseous Liquefied Combination of Gaseous and Liquefied	 Not Applicable	 Not Applicable	 1.25 1.25 1.25
Oxidizer Class 4 Class 3 Class 2 Class 1 Combination Oxidizer Class 1,2,3	 Note b 0.003 0.003 0.003 0.003	 Note b 0.03 0.03 0.03 0.03	 Not Applicable	
Pyrophoric	Note b	0.00125	Notes c and d
Unstable reactive Class 4 Class 3 Class 2 Class 1	 Note b 0.025 0.1 Not Limited	 Note b 0.025 0.1 Not Limited	 Note b Note b Note b Not Limited
Water reactive Class 3 Class 2 Class 1	 Note b 0.025 Not Limited	 0.00125 0,025 Not Limited	 Not Applicable
Health – Hazard Materials			
Corrosives	Not Limited	Not Limited	Not Limited
Highly Toxics	Not Limited	Not Limited	Note c
Toxics	Not Limited	Not Limited	Note c

This is Table 1804.2.1 from the Fire Code of New York State, specific to semiconductor fabrication facilities in Group H-5.

NOTES:

a. Hazardous materials within piping shall not be included in the calculated quantities.
b. Quantity of hazardous materials in a single fabrication area shall not exceed exempt amounts in Table 2703.1(1) and 2703.1.1(2) in the Fire Code of New York State.
c. The aggregate quantity of flammable, pyrophoric, toxic and highly toxic gases shall not exceed 9,000 cubic feet at normal temperature and pressure (NTP).
d. The aggregate quantity of pyrophoric gases in the building shall not exceed the amounts set forth in Tables 2703.1(1) and 2703.8.2 in the Fire Code of New York State.

Appendix D - Table II: (TABLE 1805.2.1) Maximum Quantities of HPM at a Work Station[e]

HPM Classification	Physical State	Maximum Quantity
Flammable, highly toxic, pyrophoric and toxic combined	Gas	3 cylinders
Flammable	Liquid Solid	15 gallons [a,b,c] 5 pounds [b,c]
Corrosive	Gas Liquid Solid	3 cylinders 25 gallons [a,b,c] 20 pounds [b,c]
Highly toxic	Liquid Solid	15 gallons [a,b] 5 pounds [b]
Oxidizer	Gas Liquid Solid	3 cylinders 12 gallons [a,b,c] 20 pounds [b,c]
Pyrophoric	Liquid Solid	0.5 gallon [d] See Table 1804.2.1
Toxic	Liquid Solid	15 gallons [a,b,c] 5 pounds [b,c]
Unstable reactive Class 3	Liquid Solid	0.5 gallon [b,c] 5 pounds [b,c]
Water reactive Class 3	Liquid Solid	0.5 gallon [d] See Table 1804.2.1

Table 1805.2.1 from the Fire Code of New York State, Chapter 18 – Semiconductor Fabrication Facilities.

NOTES:

a. DOT shipping containers with a capacity of greater than 5.3 gallons shall not be located within a workstation.

b. Maximum allowable quantities shall be increased 100 percent for use-closed systems operations. When Note c also applies, the increase for both notes shall be allowed.

c. Quantities shall be allowed to be increased 100 percent when workstations are internally protected with an approved automatic fire-extinguishing or suppression system complying with Chapter 9. When note b also applies, the increase for both notes shall be allowed.

d. Allowed only in workstations that are internally protected with an approved automatic fire-extinguishing or suppression system complying with Chapter 9.

e. The quantity limits apply only to materials classified as HPM.

Appendix E - Table III (A): (TABLE F2703.1.1(1)) Maximum Allowable Quantity per Control Area of Hazardous Materials Posing a "Physical" Hazard [a,j,m]

Hazard Category	Solid pounds (cubic feet)	Liquids gallons (pounds)	Gas (cubic feet)
Combustible Liquid[c, i]			
Class II		120[d,e]	
Class IIIA	Not Applicable	330[d,e]	Not Applicable
Class IIIB		13,200[e,f]	
Combustible Fiber	(100)		
	(1000)	Not Applicable	Not Applicable
Cryogenic			
Flammable	Not Applicable	45[d]	Not Applicable
Cryogenic			
Oxidizing	Not Applicable	45[d]	Not Applicable
Explosives	Note b	Note b	Note b
Flammable Gas			
Gaseous	Not Applicable	Not Applicable	1000[d,e]
Liquefied		30[d,e]	Not Applicable
Flammable Liquid[c]			
Class IA		30[d,e]	
Class IB	Not Applicable	60[d,e]	Not Applicable
Class IC		90[d,e]	
Combination Flammable Liquid			
(I-A, I-B, I-C)	Not Applicable	120[d,e,h]	Not Applicable
Flammable Solid	125[d,e]	Not Applicable	Not Applicable
Organic Peroxide			
Unclassified detonable	1[e,g]	(1)[e,g]	
Class I	5[d,e]	(5)[d,e]	
Class II	50 [d,e]	(50) [d,e]	Not Applicable
Class III	125 [d,e]	(125) [d,e]	
Class IV	Not Limited	Not Limited	
Class V	Not Limited	Not Limited	
Oxidizing Gas			
Gaseous	Not Applicable	Not Applicable	1,500 [d,e]
Liquefied		15 [d,e]	Not Applicable
Oxidizer			
Class 4	1[e,g]	(1)[e,g]	
Class 3	10[d,e]	(10)[d,e]	Not Applicable
Class 2	250 [d,e]	(250) [d,e]	
Class 1	4,000 [e,f]	(4,000) [e,f]	
Pyrophoric	4[e,g]	(4)[e,g]	50[e,g]
Unstable reactive			
Class 4	1[e,g]	(1)[e,g]	10[e,g]
Class 3	5[d,e]	(5)[d,e]	50[d,e]
Class 2	50 [d,e]	(50) [d,e]	250 [d,e]
Class 1	Not Limited	Not Limited	Not Limited
Water reactive			
Class 3	5[d,e]	(5)[d,e]	Not Applicable
Class 2	50 [d,e]	(50) [d,e]	
Class 1	Not Limited	Not Limited	

NOTES:

a. For use of control areas, see §F2703.8.2.
b. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
c. The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.3 gallons.

d. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with §F903.3.1.1. Where Note e also applies, the increase for both notes shall be applied accumulatively.
e. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, or exhausted enclosures. Where Note d also applies, the increase for both notes shall be applied accumulatively.
f. Quantities shall not be limited in a building equipped throughout with an approved automatic sprinkler system.
g. Allowed only in buildings equipped throughout with an approved automatic sprinkler system.
h. Containing not more than the maximum allowable quantity per control area of Class IA, Class IB or Class IC flammable liquids.
i. Inside a building, the maximum capacity of a combustible liquid storage system that is connected to a fuel-oil piping system shall be 660 gallons provided such system conforms to this code.
j. Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.
k. A maximum quantity of 200 pounds of solid or 20 gallons of liquid Class 3 oxidizers is allowed when such materials are necessary for maintenance purposes, operation or sanitation of equipment when the storage containers and the manner of storage are approved.
l. Net weight of pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks including packaging shall be used.
m. For gallons of liquids, divide the amount in pounds by 10 in accordance with §F2703.1.2.

Appendix F - Table III (B): (TABLE F2703.1.1 (1)) Maximum Allowable Quantity per Control Area of Hazardous Materials Posing a "Health" Hazard [a,b,c,j]

Hazard Category	Solid pounds [e,f]	Liquids gallons (pounds) [e,f]	Gas cubic feet[e]
Health – Hazard Materials			
Corrosives	5,000	500	810[g]
Highly Toxics	10	(10)[i]	20[h]
Toxics	500	(500)[i]	810[f]

NOTES:

a. For use of control areas, see §F2703.8.3.
b. In retail and wholesale sales occupancies, the quantities of medicines, foodstuffs consumer or industrial products, and cosmetics, containing not more than 50 percent by volume of water-miscible liquids and with the remainder of the solutions not being flammable, shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.3 gallons.
c. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with §F2703.11, see Table F2703.11.1.
d. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
e. Maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with §F903.3.1.1. Where Note f also applies, the increase for both notes shall be applied accumulatively.
f. Maximum allowable quantities shall be increased 100 percent when stored in approved storage cabinets, gas cabinets, or exhausted enclosures. Where Note e also applies, the increase for both notes shall be applied accumulatively.
g. A single cylinder containing 150 pounds or less of anhydrous ammonia in a single control area in a non-sprinklered building shall be considered a maximum allowable quantity. Two cylinders, each containing 150 pounds or less in a single control area shall be considered a maximum allowable quantity provided the building is equipped throughout with an automatic sprinkler system in accordance with §F903.3.1.1.
h. Allowed only when stored in approved exhausted gas cabinets or exhausted enclosures.
i. Quantities in parenthesis indicate quantity units in parenthesis at the head of each column.
j. For gallons of liquids, divide the amount in pounds by 10 in accordance with §F2703.1.2.

Appendix G - Table IV: (TABLE F2703.8.3.2) Design and Number of Control Areas

Floor	Level	Percentage Of The Maximum Allowable Quantity Per Control Area[a]	Number Of Control Areas Per Floor[b]	Fire-Resistance Rating For Fire Barriers In Hours[c]
Above grade	Higher Than 9	5	1	2
	7-9	5	2	2
	6	12.5	2	2
	5	12.5	2	2
	4	12.5	2	2
	3	50	2	1
	2	75	3	1
	1	100	4	1
Below grade	1	75	3	1
	2	50	2	1
	Lower than 2	Not Applicable	Not Applicable	Not Applicable

NOTES:

a. Percentages shall be of the maximum allowable quantity per control area shown in Table F2703.1.1(1) and Table F2703.1.1(2), with all increases allowed in the footnotes of those tables.
b. There shall be a maximum of two control areas per floor in Group M occupancies and in buildings or portions of buildings having Group S occupancies with storage conditions and quantities in accordance with §F2703.11.
c. Fire barriers shall include walls and floors as necessary to provide separation from other portions of the building.