FIRE DEPARTMENT • CITY OF NEW YORK

STUDY MATERIAL FOR THE EXAMINATION FOR

CERTIFICATE OF FITNESS TO SUPERVISE THE HANDLING AND USE Of CHEMICALS IN THE NYC K-12 SCHOOL LABORATORIES (Premises Related)

D-14

Important 1: The D-14 Certificate of Fitness only covers the handling and use of the chemicals.

Important 2: If you are also responsible for supervising the storage of hazardous materials at your school, you are required to obtain the D-15 Certificate of Fitness in addition to the D-14 Certificate of Fitness.

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NOTICE OF EXAMINATION

TITLE: Certificate of Fitness To Supervise the Handling and Use of Chemicals in the NYC K-12 School Laboratories (Premises Related) (D-14)

QUALIFICATION REQUIREMENTS

1. Applicants must be at least 18 years of age.
2. The Certificate of Fitness can **only be obtained by the Alternative Issuance Procedure (AIP)**
3. Applicants must have one of the following requirements:

   A. A NY State Permanent Certification as a Biology, Chemistry, Earth Science or Physics (7-12) Teacher **AND** A certificate or letter on the Department of Education's official letter head stating that the applicant has received, read the DOE Science Safety Manual.
   B. A NY State General Science 7-12 Teacher Extension Certification **AND** a certificate or letter on the Department of Education's official letter head stating that the applicant has received, read the DOE Science Safety Manual.

4. A recent photograph (2 x 2 head shot) in JPG or JPEG format.
5. The detail should be referred to the Alternative Issuance Procedure Document: http://www.nyc.gov/html/fdny/pdf/cof_study_material/d_14_aip_info.pdf

APPLICATION INFORMATION

Application Procedure: Future submittals of applications for **Alternate Issuance Procedure (AIP)** must be submitted online through NYC Business Express: https://www1.nyc.gov/nycbusiness/index#C
The detail could be referred to the following website:
http://www.nyc.gov/html/fdny/pdf/cof_study_material/d_14_aip_info.pdf

Application Fees: The $25 application fee has been waived for DOE employees.

RENEWAL REQUIREMENTS

This Certificate of Fitness must be renewed every ***THREE YEARS***. The $15 renewal fee has been waived for DOE employees. FDNY also reserves the right to require the applicants to take a re-examination upon submission of renewal applications.

You will receive a courtesy notice of renewal 90 days before the expiration date. However, it is your responsibility to renew your Certificate. Certificates expired over one year past expiration date will not be renewed. New exams will be required.

To change a mailing address:
- Submit a letter requesting the change of mailing address.

To change a work location:
- Submit a letter from your current employer (on company letterhead) confirming that you are an employee and stating your new work location.

To request a replacement certificate:
- Submit a driver's license or passport, social security number, mailing address.

The certificate can be renewed **by Mail** or **in Person**.

- **Renewal by mail**

Mail your Renewal Notice (if you did not receive a Renewal Notice, a copy of your certificate), along with your fee payment Personal or company check or money order (made payable to *the New York City Fire Department*)

For fee waivers submit: ***(Only government employees who will use their C of F for their work- related responsibilities are eligible for fee waivers.)***

- A letter requesting fee waiver on the Agency's official letterhead stating applicant full name, exam type and address of premises; ***AND***
- Copy of identification card issued by the agency

and if applicable, supporting documents to:

NYC Fire Department (FDNY)
Cashier's Unit
9 MetroTech Center, 1st Floor
Brooklyn, NY 11201

If all the requirements are met, the certificate of fitness will be mailed out within four to six weeks.

- **Renewal in person**

Submit your Renewal Notice (or if you did not receive a Renewal Notice, a copy of your certificate), along with your payment by one of the following methods:

- Cash
- Credit card (*American Express, Discover, MasterCard, or Visa*)
- Debit card (*MasterCard or Visa*)
- Personal or company check or money order (*made payable to the New York City Fire Department)*

For fee waivers submit: ***(Only government employees who will use their C of F for their work- related responsibilities are eligible for fee waivers.)***

- A letter requesting fee waiver on the Agency's official letterhead stating applicant full name, exam type and address of premises; ***AND***
- Copy of identification card issued by the agency

and if applicable, your supporting documents to:

NYC Fire Department (FDNY)
Cashier's Unit
9 MetroTech Center, 1st Floor
Brooklyn, NY 11201

If all the requirements are met, the certificate of fitness will be issued the same day.

STUDY MATERIAL

In addition to the general safety requirements addressed in the Science Safety Manual published by the DOE, this study material includes more safety regulations relating to the safe handling and use of hazardous materials required by the FDNY that you will be required to know as a NYC School D-14 Certificate of Fitness holder with respect to fire safety regulations in a chemical laboratory.

If the applicant is also responsible for supervising the storage of the hazardous material at his/her school, the applicant is required to obtain the D-15 Certificate of Fitness.

The Certificate of Fitness booklet was prepared in collaboration between the Department of Education (DOE) and the FDNY.

FOREWORD

New York City gives broad discretionary power to the Fire Commissioner to ensure the safety of persons and property in the City of New York. Certificates of Fitness are developed to ensure that individuals performing the functions of the Certificate holder are competent to fulfill the required duties.

The supervisor of chemical laboratories is to ensure **the handling and use of hazardous materials within non-production laboratories** are conducted with the safety of students and staff as the prime consideration, and in accordance with the Fire Code and the Fire Rules.

For teachers in science laboratories in New York City K-12 public schools, this D-14 Certificate documents that the holder understands the safety precautions required prior to experiments and demonstrations, that the holder has instructed the students in safe laboratory practices, and that the holder is aware the fire safety procedures to be followed should there be an incident. These individuals must demonstrate that they are knowledgeable of the requirements of all fire safety regulations and procedures required by the FDNY.

The Fire Commissioner understands the unique fire safety needs of K-12 schools, and the D-14 Certificate of Fitness for schools has been developed in conjunction with the Department of Education utilizing the requirements of the C-14 Certificate of Fitness and the Science Safety Manual to address key responsibilities of teachers in School Science Laboratories. Persons performing the duties for supervising the operation of a chemical laboratory in K-12 NYC schools must hold a D-14 Certificate of Fitness. Certificate of Fitness holders must maintain all qualifications and comply with all requirements applicable to such Certificate holders throughout the term of their certificate. D-14 Certificates of Fitness are premises-related and D-14 holders can work only at the school address listed on their Certificates of Fitness.

Science teachers are responsible to demonstrate chemical experiments safely, and to supervise the experiments performed by students who are under the age of 18 years. These students come from diverse backgrounds and have various levels of preparation. Most of them have no previous hands on training in handling chemicals or equipment.

D-14 Certificate of Fitness holders play the most important role in ensuring a safe and healthful learning environment for the students. D-14 Certificate of Fitness holders should implement the practices and procedures for students as described in the Science Safety Manual, and develop and implement safe practices and procedures for experiments and demonstrations not specifically covered in the Manual in order to ensure that all demonstrations and experiments address and incorporate the safety requirements for handling and use of hazardous materials.

The handling and use of hazardous materials must be under **personal supervision** of a D-14/C-14 Certificate of Fitness holder. **Any teacher/instructor who supervises the handling and use of any hazardous material must obtain the D-14/C-14 Certificate of Fitness to ensure the safe handling and use of the hazardous material, and that the procedures and practices are in compliance.** The handling

and use of any flammable/combustible liquids listed hazardous materials other than flammable/combustibles, and all demonstrations and experiments **MUST BE PROHIBITED in any laboratory without the presence of a person with a proper D-14/C-14 Certificate of Fitness.**

Operating any laboratory requiring a permit without a D-14/C-14 Certificate of Fitness holder's personal supervision is violating the law. The Fire Commissioner may order laboratory operations to stop until the Certificate of Fitness requirement is fulfilled.

The Certificate of Fitness holder is responsible to monitor the operation of such laboratories to help ensure compliance. For example**, the D-14 Certificate of Fitness holder should be aware of the experiments or demonstrations that are or will be performed in the laboratories that she/he supervises.** The D-14 Certificate of Fitness holders are responsible for **making sure that all fire safety regulations and procedures are fully observed. It is highly recommended that before each activity in the laboratories, the D-14 Certificate of Fitness holder weigh the potential risk factors against the educational value.** The holder should **understand all the potential hazards of the materials, the process, and the equipment involved in every laboratory activity and also inspect all related equipment/apparatus in the laboratory that are going to be used. All safety concerns and potential hazards related to the laboratory work should be addressed before starting the laboratory operation.**

D-14 Certificates of Fitness are valid for a maximum of three years from the date of issuance. At the end of this period, they expire unless the Fire Commissioner approves the renewals. Please be advised that Certificate of Fitness renewals shall be at the discretion of the Fire Commissioner in the interest of public safety. The FDNY may review the Certificate holder's qualifications and fitness to perform the duties of his/her position and may require a Certificate holder to complete a FDNY-approved continuing education program and/or provide other proof of the holder's continuing qualifications and fitness. A copy of the **FDNY permit shall be posted** in a conspicuous location within the laboratory and Certificates of Fitness shall be readily available on the premises for inspection by FDNY representatives.

In 2008, the DOE, published the safety guide *Science Safety Manual* to be used by all individuals who are responsible for implementing laboratory programs in their schools. It provides the guidelines for school staff the general safety information for the students. In addition, this FDNY D-14 study material focuses more on the fire safety regulations regulated by the Fire Code. It is to provide reasonable requirements and standards for fire and life safety and property protection. D-14 Certificate of Fitness holder must be familiar with the *Science Safety Manual* and this *D-14 study material* to supervise the operation of the non-production chemical laboratory in the NYC public school.

The operation of a non-production chemical laboratory is required to comply with the following FDNY code and rule sections:

- Non-production chemical laboratories: **[Fire Code Section 2706]**

- Standard on fire protection for laboratories using chemicals: **[NFPA 45, 2004 edition]**
- Flammable and combustible liquids: **[Fire Code Chapter 34]**
- Flammable gases: **[Fire Code Chapter 35]**
- Flammable solids systems and facilities: **[Fire Code Chapter 36]**
- Compressed gases: **[Fire Code Chapter 30]**
- Corrosive materials: **[Fire Code Chapter 31]**
- Cryogenic liquids : **[Fire Code Chapter 32]**
- Highly toxic and toxic materials systems and facilities: **[Fire Code Chapter 37]**
- Organic peroxides storage and facilities: **[Fire Code Chapter 39]**
- Oxidizer systems and facilities: **[Fire Code Chapter 40]**
- Pyrophoric materials systems and facilities: **[Fire Code Chapter 41]**
- Unstable (Reactive) materials systems and facilities: **[Fire Code Chapter 42]**
- Water-reactive solids and liquids systems and facilities: **[Fire Code Chapter 44]**
- Former laboratory rule for pre-existing laboratories **[Rule Section 4827-01(g)(1), 4827-01(g)(2)]**

1. DEFINITIONS

BASEMENT: A story partly below the grade plane and having less than one-half its clear height (measured from finished floor to finished ceiling) below the grade plane.

BOILING POINT: The temperature at which the vapor pressure of a liquid equals the atmospheric pressure of 14.7 pounds per square inch (psia) or 760 mm of mercury. Where a boiling point is unavailable for the material in question or for mixtures which do not have a constant boiling point, for the purposes of this classification, the 20-percent evaporated point of a distillation performed in accordance with ASTM D 86 shall be used as the boiling point of the liquid.

CHEMICAL: An element, chemical compound or mixture of elements or compounds or both.

CHEMICAL NAME: The scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC), the Chemical Abstracts Service rules of nomenclature, or a name that will clearly identify a chemical for the purpose of conducting an evaluation.

CLOSED CONTAINER: A container sealed by means of a lid or other device capable of preventing the escape of liquid, vapor or dusts in the ordinary course of storage, handling or use.

COMBUSTIBLE LIQUID: Any liquid that has a closed-cup flash point at or above 100°F, as determined by the standard test procedures.

CONTAINER: For solid and liquid hazardous materials, a vessel of 60 gallons or less in capacity used for storage or transportation. For compressed gases, a container, pressure vessel or tank designed for pressures greater than one atmosphere at 68°F. Pipes, piping systems, engines and engine fuel tanks associated with solid or liquid hazardous materials or compressed gases, shall not be deemed to be containers if in active use.

CORROSIVE MATERIALS: A liquid, solid, or gas that causes permanent injury ("full thickness destruction") to human skin at a rate specified by the Department of Transportation (DOT) regulations. Or a liquid that can corrode ¼ inch of steel or aluminum within the course of a year.

DESIGN PRESSURE: The maximum gauge pressure that a pressure vessel, device, component or system is designed to withstand safely under the temperature and conditions of use.

DISPENSING: The pouring or transferring by other means of any material from a container, tank or similar vessel, which would release dusts, fumes, mists, vapors or gases to the atmosphere, unless such release is prevented by a device, equipment or system designed for that purpose.

EXCESS FLOW CONTROL: A fail-safe system or other approved device, equipment or system designed to shut off flow caused by a rupture in a pressurized piping system.

EXHAUSTED ENCLOSURE: A device, typically consisting of a hood equipped with a fan that serves to capture and exhaust fumes, mist, vapors and gases generated at a workstation or other local environment. An exhausted enclosure does not include a room provided with general ventilation.

EXPLOSION; An effect produced by the sudden violent expansion of gases, whether or not accompanied by a shock wave or disruption, of enclosing materials, including the effects of the following sources of explosion:

1. Chemical changes such as rapid oxidation, deflagration or detonation, decomposition of molecules and runaway polymerization (usually detonations).
2. Physical changes such as pressure tank ruptures.
3. Atomic changes (nuclear fission or fusion).

FACE VELOCITY: The rate of flow or velocity of air moving into the chemical fume hood entrance or face, as measured at the plane of the chemical fume hood face.

FIRE SEPARATION: A horizontal or vertical fire resistance-rated assembly of materials that have protected openings and are designed to restrict the spread of fire.

FLAMMABLE GAS: Any substance that exists in the gaseous state at normal atmospheric temperature and pressure and is capable of being ignited and burned when mixed with the proper proportions of air, oxygen, or other oxidizers.

FLAMMABLE LIQUID: Any liquid that has a closed-cup flash point below 100°F, as determined by the standard test procedures.

FLAMMABLE SOLID: A solid, other than a blasting agent or other explosive, whether in elemental or alloy form, that is capable of causing fire through friction, absorption of moisture, spontaneous chemical change, or heat retained from manufacturing or processing, or which has an ignition temperature below 212°F or which burns so vigorously and persistently when ignited as to create a serious hazard. Examples include Aluminum powder, Camphor, Magnesium, Matches, Naphthalene, Nitrocellulose, Phosphorus, Sulfur and Picric Acid (wetted with not less than 10% water).

FLAMMABLE VAPORS OR FUMES: The concentration of flammable constituents in air that exceeds 25 percent of their lower flammable limit (LFL).

FLASH POINT: The minimum temperature in degrees Fahrenheit at which a liquid will give off sufficient vapors to form an ignitable mixture with air near the surface or in the container, but will not sustain combustion. The flash point of a liquid shall be determined by appropriate test procedure and apparatus as specified in ASTM D 56, ASTM D 93 or ASTM D 3278.

GAS CABINET: A fully enclosed, noncombustible enclosure used to provide an isolated environment for compressed gas containers in storage or use, including any doors and access ports for exchanging containers and accessing pressure-regulating controls.

GENERAL SUPERVISION: Supervision by the holder of any certificate of fitness who is responsible for performing the duties set forth in the Fire Code but need not be personally present on the premises at all times. The storage of any hazardous material in quantities requiring a permit shall be under the general supervision of a certificate of fitness holder.

HANDLING: The movement of a material in its container, the removal of the material from its container, or any other action or process that may affect the material, other than its storage or use.

HAZARDOUS LOCATIONS CLASSIFICATIONS DESCRIPTIONS FOR CLASS 1 DIVISION 2: Where ignitable concentrations of flammable gases, vapors, or liquids are present within the atmosphere under abnormal operating conditions.

HAZARDOUS MATERIALS: Those chemicals or substances that are physical hazards or health hazards as defined and classified in this definition section, whether the materials are in usable or waste condition.

HAZARDOUS WASTES: Those chemicals or substances in waste condition that are physical hazards or health hazards as defined and classified in this definition section.

HEALTH HAZARD: A classification of a chemical for which there is statistically significant evidence that acute or chronic health effects are capable of occurring in exposed persons. The term “health hazard” includes chemicals that are toxic, highly toxic and corrosive.

IMPAIRMENT COORDINATOR: The person designated by the owner who is responsible for ensuring that proper notification and safety precautions are taken when a fire protection system is out of service. The role of impairment coordinator in schools will always be assigned to either the Custodian Engineer or the Building Manager if they are on the premises. There may be a limited number of locations where the landlord has the responsibility to designate the impairment coordinator.

INCOMPATIBLE MATERIALS: Materials that, if mixed or combined, could explode, generate heat, gases or other byproducts, or react in a way hazardous to life or property.

LABORATORY CHEMICAL: A material with a health, flammability and/or instability (reactivity) hazard ranking of 2, 3 or 4 as defined in NFPA 704.

LABORATORY UNIT: An enclosed space of a minimum one-hour fire rated construction, designed or used as a non-production laboratory. Laboratory units may include one or more separate laboratory work areas, and accessory storage rooms or spaces within or contiguous with the laboratory unit, such as offices and lavatories.

LABORATORY WORK AREA: a room of space for testing, analysis, research, instruction, or similar activities that involve the use of chemicals.

LC50: LC stands for "Lethal Concentration". A LC50 value is the amount of a gas, dust or mists that it takes to kill 50% of test animals (for example, mice or rats) in one dose. Like LD50 various tests and animals may be utilized. In addition the duration of exposure may vary. For the purposes of the Fire Code this is a one hour test utilizing rats.

LD50: LD stands for "Lethal Dose". A LD50 value is the amount of a solid or liquid material that it takes to kill 50% of test animals (for example, mice or rats) in one dose. It is a standard measurement of the short-term poisoning potential (acute toxicity) of a solid or liquid material. LD50 values are expressed in terms of the tests and animal used (i.e. LD50 (oral, rat), LD50 (skin, mouse)) other animals (dogs, hamsters, cats, guinea-pigs, rabbits, and monkeys) are sometimes utilized but the Fire Code is very specific regarding test species (oral-rats and skin-rabbets). The LD50 value is expressed as the weight of chemical administered per kilogram body weight of the animal, the test animal used and route of exposure. So, the example "LD50 (oral, rat) 5 mg/kg" means that 5 milligrams of that chemical for every 1 kilogram body weight of the rat, when administered in one dose by mouth, causes the death of 50% of the test group.

LECTURE BOTTLE: A small compressed gas container up to a size of approximately 2 in. X 13 in.

LIQUID: A material having a melting point that is equal to or less than 68°F and a boiling point that is greater than 68°F at 14.7 psia. When not otherwise identified, the term “liquid” includes both flammable and combustible liquids.

LOWER EXPLOSIVE LIMIT (LEL): See “Lower flammable limit.”

LOWER FLAMMABLE LIMIT (LFL): The minimum concentration of vapor in air at which propagation of flame will occur in the presence of an ignition source. The LFL is sometimes referred to as LEL or lower explosive limit.

MATERIAL SAFETY DATA SHEET (MSDS): A document prepared in accordance with the regulations of the United States Department of Labor, as set forth in 29 CFR Part 1910.1200 or a federally approved state OSHA plan which sets forth information concerning a hazardous material.

NON-PRODUCTION LABORATORY: A building or portion thereof wherein chemicals or gases are stored, handled or used on a non-production basis for testing, research, experimental, instructional or educational purposes.

NORMAL TEMPERATURE AND PRESSURE (NTP): A temperature of 70°F and a pressure of 1 atmosphere.

ORGANIC PEROXIDE: An organic compound having a double oxygen or peroxy (-O-O-) in its chemical structure. Organic peroxides can present an explosion hazard (detonation or deflagration), can be shock sensitive, can be susceptible to decomposition into various unstable compounds over an extended period of time. The materials are divided in to six classes from Classes I through V and unclassified detonable class, with decreasing levels of hazard from Class I through Class V.

OUT OF SERVICE SYSTEM: This is a fire protection system that is not fully functional; or whose operation is impaired or is otherwise not in good working order.

OXIDIZER: A material that readily yields oxygen or other oxidizing gas, such as bromine, chlorine and fluorine, or that readily reacts to promote or initiate combustion of combustible materials. The materials are divided in to 4 classes, with increasing level of hazard from Classes 1 through 4.

PERSONAL SUPERVISION: Supervision by the holder of any certificate of fitness who is required to be personally present on the premises, or other proximate location acceptable to the Fire Department, while performing the duties for which the certificate is required.

PHYSICAL HAZARD: A chemical for which there is evidence that it is a combustible or flammable liquid; a flammable solid or gas; an explosive; an organic peroxide; an oxidizer; a pyrophoric material; an unstable (reactive) material; a water-reactive solid or liquid; or a cryogenic liquid.

PRE-EXISTING LABORATORY: Non-production laboratories approved by the Fire Department prior to July 1, 2008 do not have to, and in some case could not, comply the design and installation requirements of the 2008 Fire Code. Such laboratories are considered to be "pre-existing laboratories" and are required to comply with the design and installation requirements in effect at the time the laboratory was established. Throughout this study material you will see references and requirements that are applicable to "pre-existing laboratories". It is important that you understand what this means. Generally, original permits for laboratories issued by Fire Department prior to July 1 2008 would be subjected to compliance with the former rule requirement. Generally, original permits for laboratories issued after July 1 2008 would be subject to compliance with the new fire code. Therefore, it is possible that there can be two different kinds of non-production chemical laboratories in the same building, both supervised by one certificate of fitness holder. The certificate of fitness holder will have the responsibility of distinguishing and ensuring compliance with the different code requirements.

On the other hand, both new and pre-existing laboratories are required to comply with the operational and maintenance requirements of the 2008 Fire Code. Operational and maintenance requirements include such things as permits, certificate of fitness, signage, housekeeping, periodic testing and portable fire extinguishers.

PYROPHORIC MATERIAL: A material that is so chemically unstable that it may ignite spontaneously at a temperature at or below 130˚F.

REDUCED FLOW VALVE: A valve equipped with a restricted flow orifice and inserted into a compressed gas container that is designed to reduce the maximum flow from the valve under full-flow conditions. The maximum flow rate from the valve is determined with the valve allowed to flow to atmosphere with no other piping or fittings attached.

SAFETY CAN: An approved container with a capacity of not more than 5-gallons and equipped with a spring-closing lid and spout cover designed to relieve internal pressure when exposed to fire.

SASH: A movable panel or panels set in the hood entrance.

SOLID: A material that has a melting point and decomposes or sublimates at a temperature greater than 68°F.

STANDARD CUBIC FEET (SCF): Cubic feet of gas at normal temperature and pressure (NTP).

STORAGE CABINET: A cabinet for the storage of flammable and combustible liquids constructed in accordance with section 6.3 of NFPA 30.

UNSTABLE(REACTIVE) MATERIAL: A material, other than an explosive, that will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with incompatible materials. The materials are divided in to 4 classes, with increasing level of hazard from Classes 1 through 4.

WATER-REACTIVE MATERIAL: A material (solid, liquid, or gas) that has a dangerous chemical reaction when reacting with water. Upon coming in contact with water, a water reactive material may explode, violently react, produce flammable, toxic, or other hazardous gases, and/or generate enough heat to cause ignition of the material or nearby materials. Water-reactive materials are divided in to Classes 1 through 3, with increasing levels of hazard from Class 1 to Class 3.

2. PREVENT LABORATORY FIRE/EXPLOSION ACCIDENTS

Although most school laboratory accidents do not involve fires and/or explosions (as compared to cuts from broken glass, chemical spills and exposure to hazardous materials) those accidents resulting from the mishandling and/or mislabeling of hazardous materials can be catastrophic, resulting in multiple injuries to students and teachers, many causing permanent disfigurement, property damage to the school building, with millions of dollars in payouts from ensuing lawsuits

There are some flammable liquids which have the potential to be particularly dangerous unless specific precautions are taken. The United States Chemical Safety Board (CSB) knows of at least 12 methanol-related fires in science demonstrations since 2000, four of which have occurred this year.

01/02/2014 Rainbow fire experiment incident, New York, NY
Two students at a public high school were badly burned when the teacher was demonstrating a "rainbow experiment". The rainbow experiment involves burning various metal flakes to create multicolored flames. The rainbow experiment also injured children in Ohio in 2006.

09/03/2014 Fire tornado experiment incident, Reno, NV
Thirteen people, mostly children, were burned by a methanol-fueled flash fire during a science demonstration called the "Fire Tornado" at a museum in Reno. A green-colored "Fire Tornado" results from a methanol flame near boric acid, a common ant and roach killer.

09/03/2014 Lab fire incident, Denver, CO
Four students were injured during a chemistry-class demonstration at a charter high school. The teacher added methanol from a large container to a small flame — which flashed back into the container and then out about 12 feet, striking a student in the chest.

10/20/2014 Chemical explosion, Raymond, IL
Three Cub Scouts and an adult were injured when a parent poured methanol onto boric acid near an open flame.

Lessons to be learned from the four incidents:
In the words of American Chemical Society (ACS) safety experts, "The 'Rainbow' demonstration performed **on an open bench using a flammable solvent is a high risk operation**."

The recent incidents of methanol fires in schools are just one example of what can happen when lab demonstrations are adopted and used – with the best of educational intentions – but without **a thorough review of the hazards and the development of robust safety procedures.**

All schools and science educators should discontinue any use of bulk methanol – or other similar flammables – in lab demonstrations that involve combustion, open flames, or ignition sources.

In addition, as noted in the January 14, 2014 edition of *Principals' Weekly*, **the NYCDOE suspended the use of the "rainbow experiment".** Principals of schools serving grades 9-12 were also notified about this decision separately in an email from Deputy Chancellor Kathleen Grimm sent on January 10, 2014. Furthermore, the New York State Education Department (NYSED) provided additional information in an email to all principals across the State on January 14. Furthermore, the New York State Education Department (NYSED) provided additional information in an email to all principals across the State on January 14, 2014. In accordance with those prior decisions and based upon recent recommendations from the United States Chemical Safety Board, the NYC public school teachers and staff must comply with the following directives:

- **The rainbow experiment is suspended indefinitely** –staff should not use the experiment in schools;
- **All schools cannot store bulk quantities** (two liters or more) **of methanol** or other similar flammables;
- All schools must use metal cabinets that are appropriate for storing flammable materials; and
- No staff is permitted to remove or dispose of methanol or other similar flammables without being supervised by a D-14/D-15/C-14 Certificate of Fitness holder.

If you have questions regarding the safe removal of bulk quantities of methanol or other similar flammables, contact Bernie Orlan.

There are safer alternative ways to demonstrate the same scientific phenomena, and many teachers are already using them. **Any other use of methanol or other flammables should be either avoided completely or restricted to minimal amounts,** which have been safely dispensed at remote locations. **Bulk containers of flammable liquids must never be positioned or handled near viewing audiences,** especially when there are potential ignition sources present. There are well-known safer alternatives to the rainbow demonstration where no methanol is used, if you would like guidance regarding alternative demonstrations and experiments, contact Dr. Denise McNamara. **Safety must be the absolute priority in all demonstrations.**

What should we do to prevent chemical fire/explosion accidents?

(1) Review the demonstration and lab activity scheduled for the day with particular attention to all recommended safety precautions.
(2) Follow all procedures and precautions noted in the DOE approved Science Safety Manual.
(3) Avoid any high risk open flame experiment or demonstration. If it is required, the instructor must keep students away from the demonstration table as far as possible (e.g. 10 feet to 15 feet). A safety shield is recommended to be placed between the students, teacher, and the demonstration. Make sure students are wearing the appropriate personal protective equipment (i.e., chemical splash goggles, laboratory aprons or coats, and gloves).
(4) Know the location of and how to use all safety and emergency equipment (i.e., safety shower, eyewash, first-aid kit, fire blanket, fire extinguishers and mercury spill kits).

(5) Make sure no flammable/combustible solvents are in the surrounding area when lighting a flame.
(6) Use fume hoods or snorkels whenever possible
(7) Never allow the containers storing flammable or combustible liquids to be left open. The vapors can escape from the container and may exceed 25 percent of the lower flammable limit. The accumulation of the vapor will be easily ignited. Always cap the containers to reduce the vapors.
(8) Identify any malfunctioning safety equipment, never use defective equipment
(9) Only that amount of hazardous material required for a specific experiment should be brought into a laboratory or demonstration room.
(10) Never heat a flammable liquid with a flame. Extremely harmful fires happen when additional flammable solvent is added to a hot vessel over a flame during a flame test.
(11) Avoid the use of open flames where flammable or combustible materials will be involved. The flammable or combustible materials should be kept at least 20 feet away.
(12) Do not store chemicals on the lab bench, on the floor, or in the laboratory chemical hood.
(13) Use hot plates instead of Bunsen burners for most basic lab procedures that require heating. If Bunsen burners are used, exercise extreme caution. Always check Bunsen burners and other gas emitting equipment for leaks and cracks. Know where the master switch is to turn off all the gas to the room.
(14) A well-ventilated room can greatly reduce the risk of explosion.
(15) Do not allow the introduction of hazardous materials which would exceed quantities requiring a permit into demonstration labs without arranging for an inspection by the FDNY and receiving a permit from the FDNY.

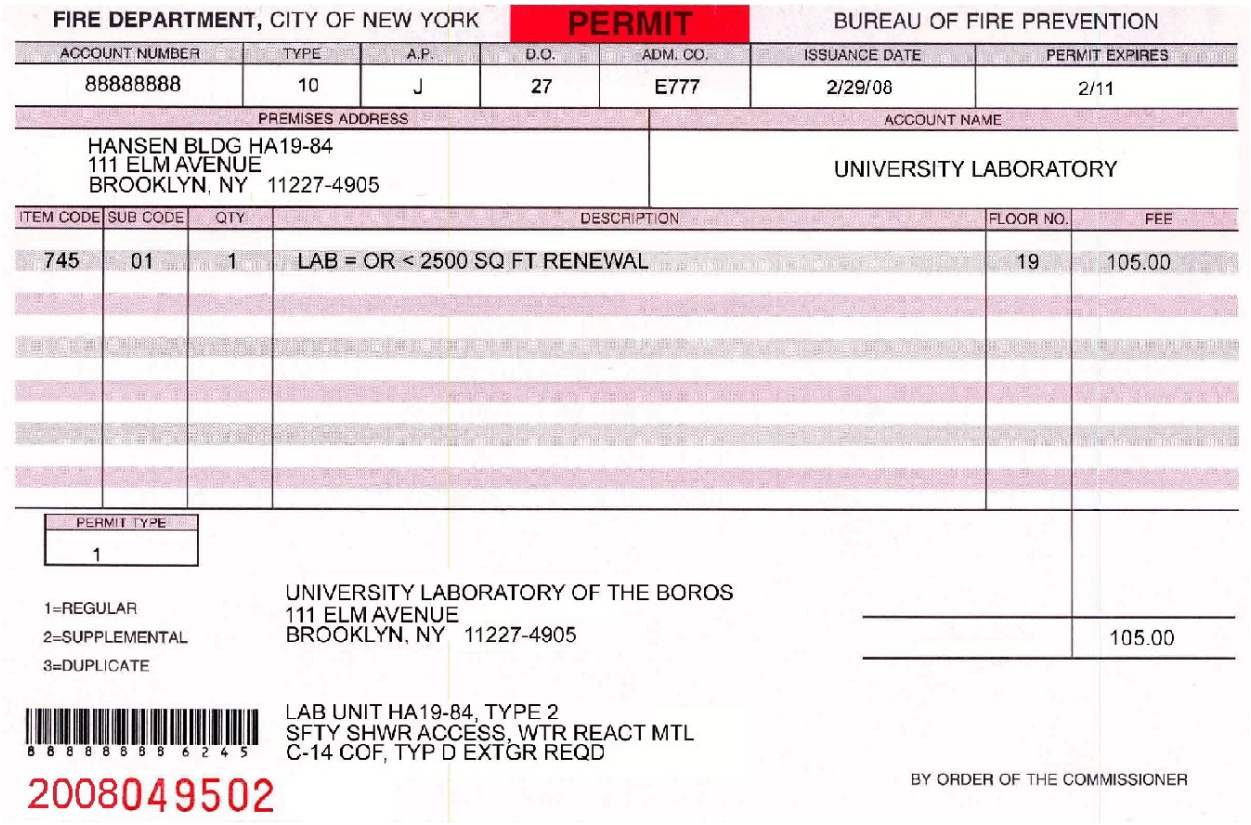
3. FIRE DEPARTMENT PERMIT

A permit is required to maintain or operate a non-production chemical laboratory in which more than **1 gallon of flammable or combustible liquid** or **75 SCF of flammable gas** are handled or used in testing, research, experimental or instructional work. This permit will be issued by the Fire Commissioner after the location has been inspected and approved as acceptable for such practices.

A copy of the FDNY permit must be posted in every laboratory requiring a permit. The Certificate of Fitness holder is responsible for ensuring that all required permits are posted in visible locations. The holder is responsible for complying with the requirements of the Fire code. **The Certificate of Fitness holder MUST NOT handle or use any flammable/combustible liquid exceeding 1 gallon or flammable gas exceeding 75 SCF in any laboratory without FDNY permit** (for example, many science demo rooms do not have FDNY permit).

Permits are valid for 12 months only. Every permit or renewal shall require an inspection and shall expire after twelve months. Permits are not transferable and any change in occupancy, operation, tenancy or ownership shall require that a new permit be issued. Current permits (or a legible copy) shall be readily available for inspection by any representative of the Fire Department.

Fire Department Permit Sample:



FIRE DEPARTMENT, CITY OF NEW YORK — PERMIT — BUREAU OF FIRE PREVENTION

ACCOUNT NUMBER	TYPE	A.P.	D.O.	ADM. CO.	ISSUANCE DATE	PERMIT EXPIRES
88888888	10	J	27	E777	2/29/08	2/11

PREMISES ADDRESS	ACCOUNT NAME
HANSEN BLDG HA19-84 111 ELM AVENUE BROOKLYN, NY 11227-4905	UNIVERSITY LABORATORY

ITEM CODE	SUB CODE	QTY	DESCRIPTION	FLOOR NO.	FEE
745	01	1	LAB = OR < 2500 SQ FT RENEWAL	19	105.00

PERMIT TYPE: 1

1=REGULAR
2=SUPPLEMENTAL
3=DUPLICATE

UNIVERSITY LABORATORY OF THE BOROS
111 ELM AVENUE
BROOKLYN, NY 11227-4905

105.00

88888888 6245

LAB UNIT HA19-84, TYPE 2
SFTY SHWR ACCESS, WTR REACT MTL
C-14 COF, TYP D EXTGR REQD

2008049502

BY ORDER OF THE COMMISSIONER

Permit demonstrates to the satisfaction of the Fire Department that the design, installation, operation and maintenance of the laboratory have been complied with the Fire Code. In addition to the requirements of Fire Code, all applicants for a permit must meet the requirements of the Department of Buildings. Other agencies such as NYCDOH, NYCDEP, NYSDEC, OSHA, and USEPA may have additional requirements.

4. PORTABLE FIRE EXTINGUISHERS

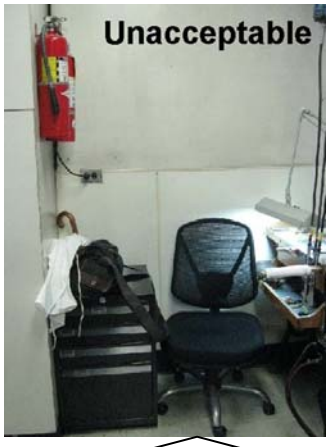
Fire extinguishers must be provided in each laboratory and storage area. The Certificate of Fitness holder should verify that the required fire extinguisher:

(1) is in good working order
   a. it is fully charged and operable
   b. it has not been actuated or tampered with
   c. there is no obvious or physical damage

(2) is located in conspicuous, unobstructed, readily accessible location (it is highly recommended that there is an extra fire extinguisher to be placed on the teacher's demonstration table before starting a laboratory class).

Generally, dry-chemical extinguishers are installed in laboratories and storage areas. These extinguishers or extinguishers suitable for more than one class of fire are most effective when they are discharged at the base of the fire. However, the Fire Commissioner may require other types of extinguishers depending on the nature of the chemicals used in the laboratory.

Fire extinguishers must be located in conspicuous locations where they will be readily accessible and immediately available for use. These locations must be along normal paths of travel. Fire extinguishers having a gross weight 40 pounds or less must be installed so that the top of the extinguisher is not more than 5 ft above the floor. Hand-held fire extinguishers having a gross weight exceeding 40 pounds shall be installed so that their tops are not more than 3.5 feet above the floor. The clearance between the floor and the bottom of installed hand-held extinguishers shall not be less than 4 inches. In other words, **no fire extinguisher is allowed to be on the floor.**



(1) For the fire extinguisher having 40 pounds or less, its top must not be more than 5 ft above the floor
(2) The fire extinguishers must be accessible and unobstructed.

(1) The bottom of the fire extinguisher must be at least 4 in above the floor.
(2) The fire extinguisher must be properly mounted.

In the event of a fire extinguisher has been discharged, a fully charged replacement is required before work can resume. Portable fire extinguishers are important in preventing a small fire from growing into a catastrophic fire, however, they are not intended to fight large or spreading fires. **By the time the fire has spread, fire extinguishers, even if used properly, will not be adequate to extinguish the fire. Such fires should be extinguished by the building fire extinguishing systems or** trained firefighters only.

In case of fire, 911 must be called. Fire extinguishers must be used in accordance with the instructions painted on the side of the extinguisher. They clearly describe how to use the extinguisher in case of an emergency. The Certificate of Fitness holder should be familiar with the use of portable fire extinguishers. When it comes to using a fire-extinguisher just remember the acronym P.A.S.S. to help make sure you use it properly. P.A.S.S. stands for Pull, Aim, Squeeze, Sweep. An example of these instructions is depicted in the picture.

The Certificate of Fitness holder must be familiar with the different types of fire extinguishers that are present. He/she must know how to operate the extinguishers in a safe and efficient manner. He/she must know the difference between the various types of extinguishers and when they should be used. A description of the five classes of fires and the appropriate extinguishers are described below.

Class A fires occur when ordinary combustible materials are ignited. For example, wood, cardboard, and most plastics fires are Class A fires. Water type extinguishers

should be used to extinguish these fires. The water type extinguishers cool the fire while quenching the flame.

Class B fires occur when flammable liquids such as gasoline, kerosene, grease and oil are ignited. These fires must extinguished by smothering the flame. The flame may be smothered using CO_2, dry chemical or foam extinguishers. Water type extinguishers should not be used for class B fires. However, personnel should be aware that CO_2 and dry chemical extinguishers are likely to be ineffective against oxidizer-based (e.g. oxidizer or organic peroxide) fires. All laboratories are required to have the minimum fire extinguisher rating of 20-B with maximum travel distance of 50 ft.

Class C fires occur when electrical equipment catches fire. These fires must be fought with fire extinguishers that do not conduct electricity. Fire extinguishers for the protection of delicate electronic chemical extinguishers must be used to extinguish electrical fires. Foam and water type extinguishers must not be used to extinguish electrical fires. After shutting off the electrical equipment, extinguishers for Class A or B fires may be used. As a result, the fire extinguisher shall be sized and located on the basis of the anticipated either Class A or Class B hazard.

Class D fires occur when they involve combustible metals, such as magnesium, titanium, potassium, sodium, and lithium. For metallic or pyrophoric material fires, do not use water, foam or carbon dioxide as an extinguishing agent. Dousing metallic fires with inappropriate extinguisher may generate flammable gas, an extremely dangerous explosion hazard, particularly if fire is in a confined environment. Use extinguishers designed for class D fires only.

The use of the markings to identify a fire extinguisher's suitability is particularly important: the marking are shown in the table below.

Markings to Indicate Extinguisher Suitability According to Class of Fire:

	Letter-Shaped Symbol Markings	Recommended Marking System
Class A: Ordinary Combustibles		
Class B: Flammable Liquids		
Class C: Electrical Fires		
Class D: Combustible Metals		

Symbols may also be painted on the extinguisher. The symbols with the shaded background and the slash indicate that the extinguisher must not be used for that type of fire. Examples of these symbols are shown on the following picture. The Certificate of Fitness holder must understand these symbols.

Examples of fire extinguishers

Class BC fire extinguisher	Class ABC fire extinguisher	Class D fire extinguisher
		

Note: Do not use an ammonium based dry chemical fire extinguisher on chlorine-based oxidizers. The reaction between the chlorine, the oxidizer and the ammonium salts in the fire extinguishing agent may produce an explosive compound (NCL_3). Generally, operation instructions are clearly painted on the side of the fire extinguisher. They clearly describe how to use the extinguisher in case of an emergency. An example of these instructions is shown below.

Portable fire extinguishers must be kept in good working order at all times. The extinguishers are required to be inspected monthly. The Department of Education site based custodial staff is responsible to perform a monthly inspection of fire extinguishers. This inspection is a "quick check" that a fire extinguisher is available and will operate. It is intended to give reasonable assurance that the fire extinguisher is fully charged and operable. This is done by verifying that it is in its designated place, that it has not been actuated or tampered with, and that there is no obvious or physical damage or condition to prevent its operation. The information of the monthly inspection record must include the date the inspection was performed, the person performing the inspection, and those portable fire extinguishers found to require corrective action. Such recordkeeping must be either attached to the extinguisher or on an inspection checklist maintained on file. Labels or markings indicating fire extinguisher use or classification or both shall be placed on the front of the fire extinguisher.

In addition, the required annual servicing tag shall include (1) the name and Certificate of Fitness number of the person who serviced the extinguisher; (2) The month and year the extinguisher was serviced; (3) The name, street address and telephone number of the extinguisher servicing company, if any, servicing the extinguisher.

Annual servicing tag.

Monthly inspection tag.

5. EMERGENCY PLANNING AND PREPAREDNESS

A. Emergency Procedures

(1) Fire notification

In case of fire, immediate notification to the emergency operator (911) is required. The New York City Fire Department will respond. No supervisor or other person shall issue any directive or take any action to prevent or delay the reporting of a fire or other emergency to the Fire Department. You should also notify the Custodian Engineer or designee, who is the fire safety person familiar with the building and who will meet the responding emergency units upon their arrival, and direct them quickly to the fire area.

The Certificate of Fitness holder must know the locations of manual fire alarm system pull stations and portable fire extinguishers and how to operate them. In addition to calling 911, you should also activate the fire alarm system manual pull station. Activation of the manual pull station will sound the alarm in the building and typically will notify the Fire Department.

The Certificate of Fitness holder should know how to respond when an individual's clothing has caught fire. The most important instruction for the case of clothing fires: immediately drop to the floor and roll. If the person is panicking and running, other people in the area should immediately knock that person to the floor and roll that person around to smother the flames. Most non-production laboratories are also required to have installed a safety shower. If the safety shower is near, the use of this shower would also be an effective way to smother the flames. If after smothering the fire, if the clothing that caught fire can be removed, remove it. If the clothes are burnt onto your skin, do not remove the clothes but soak with water and keep cool. In all cases, immediately seek medical attention.

(2) Spill notification

In case of a major spill, the Certificate of Fitness holder must notify the Fire Department by phone immediately. The Certificate of Fitness holder must know the telephone number of the Fire Department Borough Communication Office. The borough phone numbers are listed below. These phone numbers must be posted near the phones most likely to be used in case of an emergency.

Manhattan	212-570-4300
Bronx	718-430-0200
Brooklyn	718-965-8300
Queens	718-476-6200
Staten Island	718-494-4296

B. Penalties for Non-compliance with Fire Code

All applicants and certificate holders are required to promptly notify the Fire Department and the Department of Education of any change in the applicant's or certificate holder's residence address, any change in work location when such location is required for and/or indicated on such certificate or permit and such other information as the Fire Department may require. Certificate of Fitness holders and

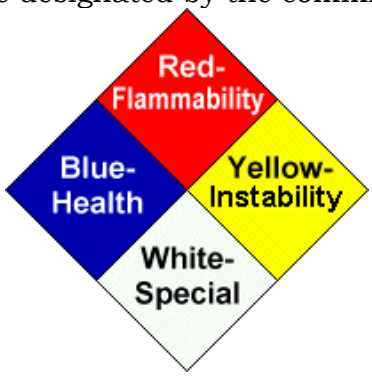
permit holders must ensure that all requirements of the Fire Code and Fire Department Rules are met. Failure to comply with these provisions may subject Certificate of Fitness holder and/or permit holders to enforcement action, including violations. Generally, violation orders will go to the school principal, while Notices of Violation will be sent to the Department of Education. **The Certificate of Fitness may be revoked if the C of F holder is negligent in failing to comply with the requirements of the NYC Fire Code and Rules**.

6. LABORATORY UNIT DESIGN AND EQUIPMENTS

A. Signs Requirements.

(1) NFPA 704 Diamond Sign

It is highly recommended that in addition to identify the lab; hazard diamond signs should be posted. These signs should be conspicuously affixed at entrances to locations where hazardous materials are handled, including dispensing, in quantities requiring a permit, including locations where such materials are dispensed, and at such other locations as may be designated by the commissioner.



The NFPA National Fire Protection Association (www.nfpa.org), a private, non-profit organization that produces technical data related to fire protection and prevention, including the widely used NFPA diamond containing codes representing chemical hazards. 704 diamond (sometimes called the "fire diamond") is a standard placard used to quickly identify a chemical's level of hazard. The diamond sign is divided into 4 quadrants:

- Within the blue, red, and yellow quadrants a number from 0 to 4 indicates the degree of risk associated with the chemical. The higher the number, the higher the risk.
- For some chemicals, the white quadrant contains symbols indicating special hazards.

The meaning of each code number and symbol is shown on the following page.

Where more than one chemical is present in a building or specific area, professional judgment shall be exercised to indicate ratings using the following methods:

- Composite Method. Where many chemicals are present, a single sign shall **summarize the maximum ratings contributed by the material(s) in each category and the special hazard category for the building and/or the area**. That is, it shows the highest value in each hazard category for any chemical at that location. **It may be that one chemical poses the highest health hazard, while another poses the highest flammability hazard**.

- Individual Method. Where only a few chemicals are present or where only a few chemicals are of concern to emergency responders (taking into account factors including physical form, hazard rating, and quantity), individual signs shall be displayed. The chemical name shall be displayed below each sign.

- Composite–Individual Combined Method. A single sign shall be used to summarize the ratings via the Composite Method for buildings or other areas containing numerous chemicals. Signs based on the Individual Method shall be used for rooms or smaller areas within the building containing small numbers of chemicals.

Interpreting NFPA 704 Codes

Quadrant	Code	Meaning
Health Hazard	4	Materials that, under emergency conditions, can be lethal.
	3	Materials that, under emergency conditions, can cause serious or permanent injury.
	2	Materials that, under emergency conditions, can cause temporary incapacitation or residual injury.
	1	Materials that, under emergency conditions, can cause significant irritation.
	0	Materials that, under emergency conditions, would offer no hazard beyond that of ordinary combustible materials
Flammability Hazard	4	Materials that rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air and burn readily.
	3	Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions.
	2	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating could release vapor in sufficient quantities to produce hazardous atmospheres with air.
	1	Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur.
	0	Materials that will not burn under typical fire conditions, including intrinsically noncombustible materials such as concrete, stone, and sand.
Instability (Reactivity) Hazard	4	Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures.
	3	Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction but that require a strong initiating source or must be heated under confinement before initiation.

Quadrant	Code	Meaning
	2	Materials that readily undergo violent chemical change at elevated temperatures and pressures.
	1	Materials that in themselves are normally stable but that can become unstable at elevated temperatures and pressures.
	0	Materials that in themselves are normally stable, even under fire conditions.
Special Hazard	"**W**"	The materials that react violently or explosively with water (water reactivity rating of 2 or 3).
	"**OX**"	The materials that possess oxidizing properties. The severity of the hazard posed by an oxidizer can be divided in to 4 classes from Classes 1 through 4. The adding of the quantification of the oxidation helps to better define the hazard. For example, for the material categorized as a Class 2 oxidizer (e.g. calcium chlorite) can be marked "**OX 2**" to better define the hazard.

(2) "No Smoking" sign.

"No Smoking" signs when provided shall be in English as a primary language and conspicuously posted in the following locations:
a.) In rooms or areas where hazardous materials are stored.
b.) Within 25 feet of outdoor hazardous material storage and handling areas, including dispensing areas.
c.) Facilities or areas within facilities in which smoking has been entirely prohibited.

The Fire Department has published an approved "No Smoking" sign. It is set forth in Fire Department rule (as the figure). However, the Fire Department does not mandate that this design be used. Other legible, durable signs, clearly communicating the "no smoking" requirement, may be used, but are subject to Fire Department enforcement action if found to be inadequate.

(3) Other relevant signs, such as DOT are shown in Appendix II.

B. Fume Hoods and Exhaust Systems

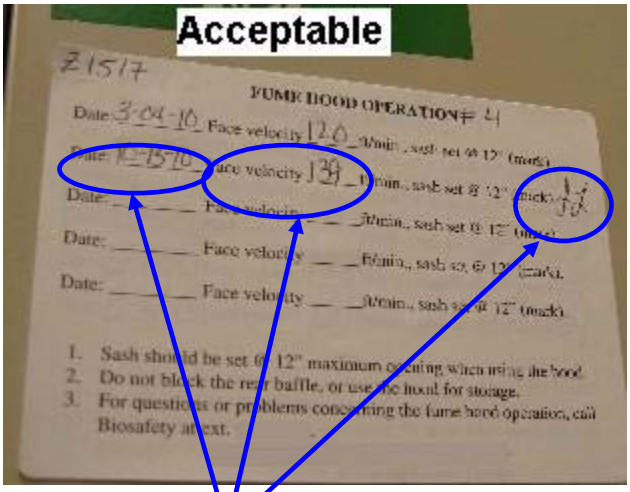
Approved fume hoods and exhaust systems which are installed to limit work place exposure to hazardous or noxious fumes, vapors or dusts. In general, fresh air is drawn in from the open side of the fume hood, and expelled outside the building (ducted type fume hood). Although commonly used outside N.Y.C., hoods made safe through filtration and fed back into the room are not allowed to be used in the city.
The hoods are designed for use when working with chemicals and must NOT be used for the storage of chemicals. Users should be periodically reminded to open hood sashes slowly and to allow hood sashes to be open only when needed. Chemical fume hoods shall be located in areas of minimum air turbulence, so people walking past the hood or place irrelevant activities should be minimized. The Certificate of Fitness holder must make sure that these systems are maintained in good working order and make sure that the face velocity of chemical fume hoods, exhaust systems, and laboratory special exhaust systems are inspected and tested annually by qualified inspectors.

With the exception of educational facilities, fume hood installations in pre-existing laboratories were required to provide a minimum average face velocity of 100 feet per minute (fpm) with a minimum face velocity at any point no less than 75 fpm. While no maximum face velocity or sash test height criteria was adopted, nationally recognized standards did recognize fume hoods with maximum face velocity limits ranging from 120 to 150 fpm and sash heights in the 12 to 18 inch range as acceptable. For new laboratories, NFPA 45 requires fume hoods to be evaluated using ASHRAE Standard 110, Method of Testing Performance of Laboratory Fume Hoods. ASHRAE Standard 15 indicates that face velocities of 80 to 120 fpm will generally provide the required containment. NFPA Standard 45, however, does not mention a required sash height that should be used when tested for face velocity.

In order to allow that pre-existing fume hoods be permitted to meet the lower minimum average fume hood face velocities specified in NFPA Standard 45, and for the sake of uniformity, fume hood installations in all laboratories would be required to meet an average face velocity range of 80 to 150 fpm at a sash height range of 12 to 18 inches. Fume hoods operating outside of this range would be required to be repaired, replaced, or otherwise altered to meet the required range, unless acceptable to the Fire Department based upon an evaluation by a qualified professional of the fume hood's performance. Fume hoods failing to satisfy any of the above criteria should be removed from service until such time as a remedy is established. Fume hoods taken out of service should be marked as such (e.g. "DO NOT USE").

The physical condition of the hood interior, sash, and ductwork need to be visually inspected if they are clean, dry, tight, and friction-free. An annual label (inspection record) for recording inspection interval, last inspection date, average face velocity, and inspector's name shall be affixed to each hood.

Keep the hood sash closed as much as possible when the fume hood is not in use.



An annual inspection record with "Date", "Face velocity" and "Inspector's name".

Special requirements for Chemical fume hood using perchloric acid:
When perchloric acid is heated above ambient temperatures, it will give off vapors that can condense and form explosive perchlorates. In order to decrease the potential hazard, the heating process must be only used in a chemical fume hood specially designed for percholoric acid operations or in a hood that the vapors can be trapped and scrubbed before they are released into the hood. The hood, exhaust ductwork, and fan shall be acid resistant, nonreactive, and impervious to perchloric acid. A water spray system shall be provided for washing down the hood interior behind the baffle and the entire exhaust system after each use, the effective washing down method has been recommended in the *CRC Handbook of Laboratory Safety*.

C. <u>Safety Showers, Neutralizing or Absorbing Agents and Curtains</u>
Where more than 5 gallons of corrosive liquids or flammable liquids are handled, or used, fixed overhead or flexible hand-held safety showers must be available in the laboratory, or outside the laboratory within 25 feet of laboratory/storage-room entrance door. Additionally, neutralizing or absorbing agents shall be provided. Safety showers shall be tested annually and a record of such maintenance must be maintained on the premise.

Curtain and drapes used in laboratories must be documented as "flame proof" (chemically treated) or "inherently flame resistant". Documentation must be provided by a person holding a "flame proofing certificate of fitness".

D. <u>Means of access to an Exit</u>

It shall be unlawful to obstruct or impede access to any required means of egress. All required means of egress, including each exit, exit access and exit discharge, shall be continuously maintained free from obstructions and impediments to immediate use in the event of fire or other emergency. Emergency lighting facilities shall be provided for any laboratory work area requiring a second means of access to an exit.

7. CHEMICAL HANDLING, AND WASTE DISPOSAL

A. General Operations, Housekeeping and Good Work Practices

Poor operations, housekeeping & work practices are one of the leading causes of hazardous material incidents, work place accidents and fires. Before performing any chemical reaction, evaluation shall be made for hazards that can be encountered or generated during the course of the work. The evaluation must include (1) the hazards associated with the properties and the reactivity of the materials used and any intermediate and end products that can be formed; (2) the hazards associated with the operation of the equipment at the operating conditions; (3) and the hazards associated with the proposed reactions, for example, oxidation and polymerization. Poor housekeeping can result in fire accidents, lost tools/supplies, damaged equipment and contribute to higher operating costs. Good housekeeping minimizes fire, accidents, reduces waste & disposal costs, increases efficiency and generally results in cheaper production costs. Areas kept in neat & organized condition provides a positive impression on inspectors. The following is some guidance on good practices.

(1) General Housekeeping and Standards:

- Access doors, aisles and exit doors clear of obstructions.
- Be familiar with the use, limitations and location of emergency equipment such as emergency eyewashes, safety showers, fire alarms, exits and fire extinguishers.
- Material Safety Data Sheet (MSDS) information should be readily available. An example of MSDS could be referred to Appendix III.
- The following areas shall require special consideration:
  - Handling of chemicals, flammable and combustible liquids, and gases
  - Open flame and spark-producing equipment hot work authorization
  - Arrangements and use of portable electric cords

(2)Work Areas:

- Empty, but not clean, containers should be handled as having the same hazards as non-empty containers. In some cases, **the residual vapors are more dangerous than the liquids**. For example, gasoline vapors are more flammable than liquid gasoline.
- Keep work areas clean and free of obstructions.
- Limit the amount of hazardous materials to the minimum needed for an operation and **keep process containers covered when not being used**.
- Clean surfaces (counter tops, bench tops, fume hoods and floors) of drips and residues.
- Clean spilled chemicals immediately. Small spills can be cleaned up by properly trained employees with the appropriate spill response supplies and dispose of all wastes properly.
- Any release of hazardous material into a sewer, water way, ground or atmosphere shall be subjected to comply with all requirement of federal, state, or local regulations.
- Routinely inspect and address potential sources of leaks and spills.
- Good housekeeping shall be maintained so as to avoid accumulations of the combustible dust.

- Do not handle or use of any liquid where the liquid may come in contact with any electrical receptacle, switch or control.
- All furniture, casework, and equipment in laboratory units shall be arranged so that means of access to an exit can be reached easily from any point.

(3) Safety Procedures

School principals, in conjunction with the Custodian Engineer are responsible for ensuring the periodic inspection, testing, and maintenance of the following systems:

- Utilities (Steam, gas, electrical)
- Air supply and exhaust systems
- Fire protection equipment
- Detectors and alarms
- Compressed gas regulators and pressure relief valves
- Waste disposal systems
- Fire doors
- Emergency lighting and exit signs
- Electrically operated equipment

If the Certificate of Fitness holder is aware that any of the above systems are not operational, they shall immediately notify the Custodian Engineer and the Principal.

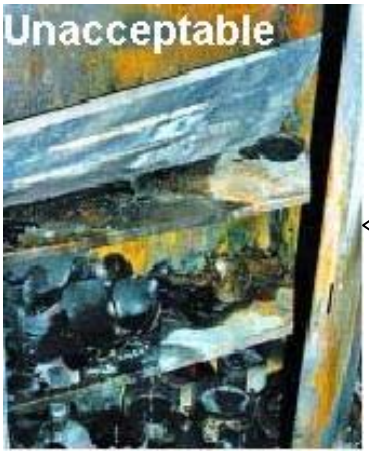
B. Prohibitions

It shall be unlawful in any non-production laboratory to use an open flame for heating or distilling any flammable solid, flammable liquid or flammable gas or to store, handle or use any following hazard materials:

(1) Explosive;
(2) unclassified detonable organic peroxide;
(3) detonable pyrophoric material;
(4) detonable unstable (reactive) material;
(5) detonable water-reactive material;
(6) Class 4 unstable (reactive) material;
(7) Class 4 oxidizing material;
(8) below grade any flammable gas.

C. General Requirements for Safe Handling of Chemicals

- Containers that are not in use should be in good condition, **placed in an upright position** and **closed when not in use**.
- Chemicals should be used or placed per manufacturer's recommendations and in such a way to minimize the potential for tipping, tearing, puncture, or breakage.

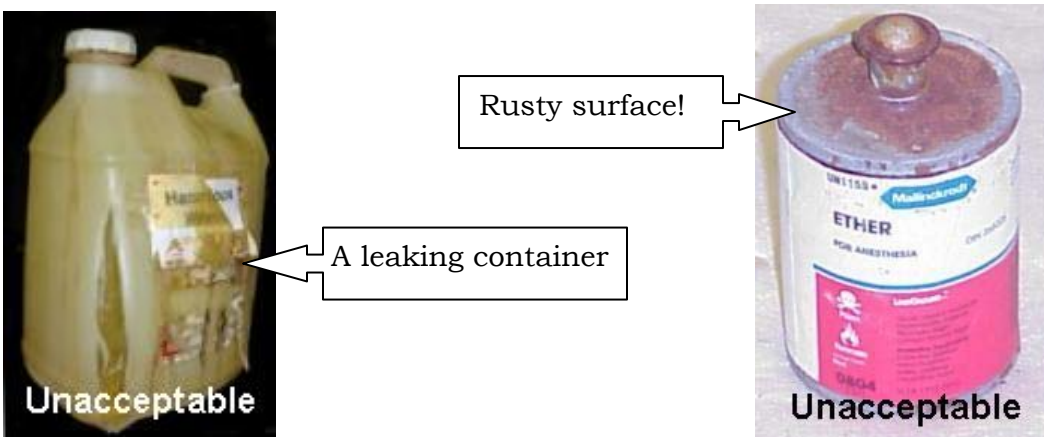


Unstable Shelves and Heavy Chemicals:
The Cause of Explosion and Fire

A collapsed shelf in a solvent storage cabinet is implicated in the fire incident. The fire destroyed a university chemical laboratory completely including **all of the research, laboratory notes, and other work** by the supervisor and his students. The fire also damaged the adjacent laboratory.

- Flammable/combustible material must be used or placed away from open flame or other ignition sources.
- Don't stack equipment against containers.
- Segregate incompatible materials/wastes by hazard category to prevent reactions (e.g. acids and bases). Organize chemicals first by COMPATIBILITY — not alphabetic succession.
- Know the characteristic of the material begin handled and possible interaction with any other material handled.
- Avoid placing any chemicals on the floor, especially chemicals stored in glass containers. If you must place containers of liquids on the floor, it is highly recommended that they should be away from pedestrian traffic and they are in secondary containments to control spills in case any container is accidentally broken.
- Piles of chemicals should be stacked in a secure manner, properly labeled in closed containers.
- Avoid placing chemicals on shelving that is above eye level.

- Defective containers shall be promptly removed from service or disposed of in approved manner.

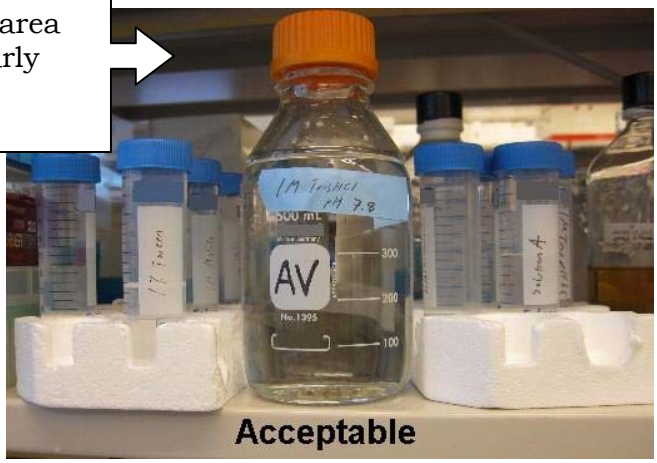


Chemicals shall be handled as per the manufactures' recommendations and material safety data sheets (MSDS). The transportation of hazardous chemicals in laboratory buildings provides the greatest potential for chemical exposure to the building occupants. Spills occurring outside storerooms and laboratories may lead to hazardous concentrations of vapors and gases being distributed throughout the building. As a result, chemical quantities outside of storage shall be maintained at the lowest possible level necessary for the work performed and Class I flammable liquids shall not be transferred from one vessel to another in any exit access corridor. Hazardous chemicals shall be handled in such a manner as to limit a spill scenario to less than 5 gallons.

If the materials need to be transported between different floors, use of elevator for transport of hazardous materials should be accomplished by the minimum number of persons. In addition, it is not encouraged to use stairway to transport any amount of those materials.

All containers used for the storage of chemicals (including water) and gases must be clearly labeled. These labels must indicate the container's contents. **Containers of materials that might become hazardous during prolonged storage shall be dated when first opened**. There are several chemicals that can increase in hazard potential if subjected to long-term storage. For example, exposure to air or light can cause the formation of peroxides (See Appendix VI). Another example is picric acid, which becomes highly shock-sensitive when its normal water content is allowed to evaporate. Reactive monomers that have been inhibited to reduce the chance of unintentional polymerization can become unstable when the inhibitor is consumed. At the end of 6 months, chemicals that can increase in hazard potential over time shall be evaluated (such as picric acid for dryness) or tested (such as isopropyl ether for peroxide formation) for continued safe use and can be re-dated and retained for an additional 6-month period after it is found to be safe. The Certificate of Fitness holder must periodically check the labels to make sure that they are still legible. When the label on a container is not legible and its contents cannot be identified, the Certificate of Fitness holder must treat its contents as hazardous waste. The Certificate of Fitness holder must then make arrangements to have the contents of the container disposed of in a safe manner according to the federal, state, and local regulations.

All containers on the working area must be clearly labeled.



D. Placing Class I and Class II Liquids in Refrigerators

The flammable liquids placed in refrigeration equipment shall be stored in closed containers. Protection against the ignition of flammable vapors in refrigerated equipment is available through two types of laboratory refrigerators:

(1) Explosion-proof model: It is designed to protect against ignition of flammable vapors both inside and outside the refrigerated storage compartment.

(2) Flammable liquids storage refrigerator: The intent is to eliminate ignition of vapors inside the storage compartment by sources also within the compartment. And its design are intended to control or limit the damage should an exothermic reaction occur within the storage compartment and also reduce the potential for ignition of floor-level vapors.

A liter of isopentane

Flammable Liquids and Domestic Refrigerators: An Explosive Combination.

A biomedical laboratory in one research facility were given an unexpected demonstration of what can happen when flammable liquids are stored in a domestic refrigerator.

Ordinary domestic refrigerators are allowed to be installed in chemical laboratories but are not permitted to store flammable liquids. The following signs shall be posted on all ordinary domestic refrigerators that are installed in chemical laboratories:

DO NOT STORE FLAMMABLE SOLVENTS
IN THIS REFRIGERATOR.

OR

STORE NO FLAMMABLE LIQUIDS

Examples of signs for different refrigerators

Domestic Refrigerator (Store No Flammables)	Laboratory-safe Refrigerator (Flammable Materials Storage)
	

Well segregated chemicals in the refrigerator!

Do not leave food with chemicals!

E. Liquid Dispensing

Gases shall not be used to pressurize containers used to transfer Class I, II and IIIA liquids. Dispensing of Class I liquids to or from containers shall be performed either in a separate area outdoors or inside liquid storage areas specifically designed and protected for dispensing Class I flammable liquids. However, if the amount is less than or equal to 5 gal in capacity, it can also be performed in a chemical fume hood or in an area provided with ventilation adequate to prevent accumulations of flammable vapor/air mixtures from exceeding 25 percent of the lower flammable limit. Moreover, avoiding splashing or turbulence is also important for reducing ignition opportunity by using of a stirring rod or pouring liquids down the side of the container or using squeeze bottles. Smaller size containers, low flow rates during pouring/filling and good ventilation system could also reduce the risk.

F. Waste, Handling and Disposal

Before a chemical material is used, the user shall determine that information and facilities are available for safe disposal of hazardous materials and waste products. Waste chemicals shall not be combined or mixed with other waste chemicals unless they have been evaluated for compatibility by a qualified person. Hazardous waste chemicals containers shall be labeled as "Hazardous Waste" and the ones stored in laboratory work areas should not be allowed to accumulate. Waste quantities shall be subject to the maximum container sizes and type in accordance with the maximum allowable container capacity table mentioned before. **Flammable chemical waste will count towards flammable storage limits**. All hazardous waste shall be stored or handled according to the federal, state, local regulations.

For your quick reference, t*he DOE disposal protocol of hazardous waste:*

a) Identify the chemicals you want removed using colored self-adhesive labels. Do not remove the chemicals yourself; merely attach the colored "dots."
b) List these chemicals on the Chemical Removal Request Form distributed by the Department of Education.
c) Make two copies of the list. Keep the original for your own records; give one copy to the assistant principal and the other to the custodian.
d) The custodian will prepare a work order PO18 using the Trade Code 75 and attach the list of the chemicals.
e) The custodian will then fax the PO18 form listing the chemicals to M. Pedram at (718) 610-0320 via the Passport System and request a pick up.

SUMMARY CHECKLIST OF THE MOST COMMON REQUIREMENTS

Business name: _____
Address: _____
City & State: _____
Phone #: _____

Supervising the handling and use of Chemicals in NYC public K-12 schools

Date: _____
C of F Holder's Name: _____
Signature: _____
C of F # : _____
Exp Date:

SECTION A.		
General Requirement	Responses	Recommended Action
1. Is there a valid fire permit for the laboratory?	□ Yes □ No	If No, no more than 1 gal. of flammable/ combustible liquids or 75 SCF flammable gas allowed!
SECTION B.		
Laboratory Safety	Responses	Recommended Action
1. Have you checked if all portable fire extinguishers are available, operable, unobstructed and clearly marked?	□ Yes □ No	If No: correct and comply
2. Have you checked if all lab exit ways are free and unobstructed?	□ Yes □ No	If No: correct and comply
3. Have you checked if the emergency phone numbers and the evacuation plan are updated and clearly posted in appropriate locations?	□ Yes □ No	If No: correct and comply
4. Do you know where the MSDS sheets are maintained?	□ Yes □ No	If No: correct and comply
5. Have you checked if the electrical cords are in good condition?	□ Yes □ No	If No: correct and comply
6. Have you checked if the inspection record is affixed to each hood, and each fume hood is maintained in good working order?	□ Yes □ No	If No: correct and comply
7. Have you checked if the inspection record is affixed to each safety shower and each shower is unobstructed and can work properly?	□ Yes □ No	If No: correct and comply
8. Have you checked if neutralizing or absorbing agents are provided at all areas used for the handling of corrosives?	□ Yes □ No	If No: correct and comply
9. Have you checked if your work areas neat; Food/drink absent?	□ Yes □ No	If No: correct and comply
SECTION C.		
Signs and Warning Placards	Responses	Recommended Action
1. Have you checked if the appropriate warning signs are properly posted?	□ Yes □ No	If No: correct and comply

SECTION D.		
Chemical Handling	Responses	Recommended Action
1. Is there any prohibited hazardous material used in the laboratory?	□ Yes □ No	If Yes: correct and comply
3. Have you checked if all chemical containers are properly labeled?	□ Yes □ No	If No: correct and comply
4. Have you checked if all containers are in good conditions?	□ Yes □ No	If No: correct and comply
5. Have you checked if all chemicals are properly and safely segregated?	□ Yes □ No	If No: correct and comply
6. Have you checked if all gas containers are properly secured and clearly labeled?	□ Yes □ No	If No: correct and comply
7. Have you checked if peroxide forming chemicals are not expired or have been tested after last expiration date?	□ Yes □ No	If No: correct and comply
8. Have you checked if water-reactive chemicals are placed in suitable receptacles, properly identified and away from water?	□ Yes □ No	If No: correct and comply

Additional Comments:

Section/Item #	Description of Deficiencies

APPENDIX I. CLASSIFICATIONS

A. Class of Flammable and Combustible Liquids

There are 3 classes of flammable liquids and 3 classes of combustible liquids defined as the following table.

Table. Class of Flammable and Combustible Liquids

		Flash point	Boiling point	Examples
Flammable liquids (Class I liquids)	**Class IA**	< 73°F	< 100°F	Acetaldehyde, Ethyl ether, Gasoline, Methyl formate, Pentane
	Class IB	< 73°F	≥ 100°F	Acetone, Benzene, Carbon disulfide, Cyclohexane, Ethanol, Methyl alcohol, Toluene
	Class IC	≥ 73°F but < 100°F	Not Applicable	Amylacetate, Butyl alcohol, Hydrazine, Styrene, Xylene
Combustible liquids (Class II & III liquids)	**Class II**	≥ 100°F but < 140°F	Not Applicable	Acetic acid, Formaldehyde, Glacial acetic acid, Hydrazine, Naphtha, Stoddard solvent
	Class IIIA	≥ 140°F but < 200°F	Not Applicable	Cyclohexanol, Formic acid, Naphthalene, Nitrobenzene, Octyl alcohol
	Class IIIB	≥ 200°F	Not Applicable	Formalin, Glycerine, Picric acid, Propylene glycol

B. General Rule of Hazard Classes

Some hazard classes are assigned numerical designations based upon their hazard potential. For example, oxidizers and unstable (reactive) materials are classified as Class 1, 2, 3 or 4 materials; water –reactive solids and liquids are classified as Class 1, 2 or 3 materials; and organic peroxides are classified as Class I, II, III IV or V materials. The following chart explains the severity of each class:

Arabic Numeral		Roman Numeral
4	**HIGHEST HAZARD**	I
3		II
2		III
1		IV
0	**LOWEST HAZARD**	V

C. <u>Class of Organic Peroxide</u>

- **Class V**. Organic peroxides that burn with less intensity than ordinary combustibles or do not sustain combustion and that pose no reactivity hazard.
- **Class IV**. Organic peroxides that burn in the same manner as ordinary combustibles and that pose a minimal reactivity hazard.
- **Class III**. Organic peroxides that burn rapidly and that pose a moderate reactivity hazard.
- **Class II**. Organic peroxides that burn very rapidly and that pose a severe reactivity hazard
- **Class I**. Organic peroxides that are capable of deflagration but not detonation.
- **Unclassified detonable**: Organic peroxides that are capable of detonation and pose an extremely high-explosion hazard through rapid explosive decomposition.

APPENDIX II. DOT Placards

Class	Label	Examples
Class 1 : Explosives		Ammonium nitrate; Hydrated picric acid which becomes explosive upon drying
Class 2 :Gases		
Division 2.1 Flammable gases		Hydrogen; Methane
Division 2.2 Non-flammable, non-toxic compressed gases		Carbon Dioxide; Oxygen
Division 2.3 Gases toxic by inhalation		Diborane; Fluorine; Nitrogen dioxide
Class 3 : Flammable liquids		Methanol; Ethanol; Esters; Ethers; Ketones
Class 4: Flammable solids		
Division 4.1 Flammable solids		Naphthalene; Finely divided metal (e.g., aluminum, cadmium, chromium, titanium, zinc)

Class	Label	Examples
Division 4.2 Spontaneously combustible materials		Acetic acid; Cumene; Phenol; Propionic acid
Division 4.3 Dangerous when wet materials		Acetyl chloride; Aluminum; Calcium carbide; Chloride (anhydrous); Chlorosulfonic acid; Magnesium; Phosphorus pentatchloride; Sodium; Stannic chloride; Thionyl chloride
Class 5 : Oxidizers and Organic peroxides		
Division 5.1 Oxidizers		Ammonium nitrate; Bromine; Calcium nitrate; Chromic acid; Fluorine; Nitric acid; Oxygen; Peroxide; Perchloric acid; Potassium chlorate; Potassium nitrate; Sodium dichromate; Sodium nitrate; Sulfuric acid
Division 5.2 Organic peroxides		Benzoyl peroxide; Hydrogen peroxide; Ethyl methyl ketone peroxide
Class 6: Toxic materials and Infectious substances		Acrolein; Arsenic salts; Calcium cyanide; Nicotine; Hydrocyanic acid; Organic mercury compounds

Class	Label	Examples
Class 7: Radioactive materials		Any material having a specific activity greater than 0.002 microcuries per gram (μCi/g)
Class 8: Corrosive materials		Acids (Acetic acid; Citric acid; Formic acid; Oxalic acid) Bases (Ammonium hydroxide; Calcium hydroxide; Potassium hydroxide; Sodium hydroxide)

APPENDIX III. SAMPLE MATERIAL SAFETY DATA SHEET (MSDS)

Sample Material Safety Data Sheet (MSDS)

SECTION 1: PRODUCT IDENTIFICATION

PRODUCT NAME: **Squeaky Clean Solution**

MANUFACTURER: **Batty's Batch of Chemicals**
ADDRESS: **111 Elm Ave**
Astoria, NY 11105

EMERGENCY PHONE: **1-800-555-5555**
CHEMTREC PHONE:
OTHER CALLS:
FAX PHONE:

PRODUCT USE: **Cleaning Solution**

SECTION 2: COMPOSITION/INFORMATION ON INGREDIENTS

INGREDIENT:
Methanol 90%

CAS NO.
67-56-1

INGREDIENT:
Acetic Acid 10%

CAS NO.
64-19-7

SECTION 3: HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW: Corrosive! Flammable liquid and vapor. May be fatal or cause blindness if swallowed. Causes respiratory tract irritation. Causes eye and skin irritation. May be absorbed through intact skin. May cause central nervous system depression. May cause liver, kidney, and heart damage.

ROUTES OF ENTRY: Inhalation, Ingestion, Absorption.

POTENTIAL HEALTH EFFECTS
EYES: May cause conjunctivitis and corneal damage. Mild eye irritation. May cause disruption of vision, possibly leading to blindness.

SKIN: May cause irritation

INGESTION: May be fatal if swallowed or cause blindness. May cause central nervous system depression, characterized by excitement, followed by headache, dizziness, drowsiness, and nausea.

INHALATION: Heavy, dense vapors may quickly collect and may be easily inhaled. Symptoms of poisoning by inhalation include visual effects and increased sensitivity to light, blurred, double, impaired vision, and/or blindness. ACUTE HEALTH HAZARDS: May cause death, blindness, or severe health reactions within 24 hours of ingestion or inhalation of particles.

CHRONIC HEALTH HAZARDS: May cause effects similar to acute inhalation or ingestion. Methanol may accumulate in the body as a poison.

CARCINOGENICITY
ACGIH: Not listed NTP: Not listed IARC: Group 1 carcinogen
OTHER: Carcinogen in California

SECTION 4: FIRST AID MEASURES

EYES: Flush with water for at least 30 minutes. Immediate medical aid.

SKIN: Remove any clothing and flush skin with water. Immediate medical aid.

INGESTION: Do NOT induce vomiting. Call poison control and get medical aid.

INHALATION: Remove from exposure and get medical aid immediately. If breathing is impeded, give oxygen. Do NOT administer mouth-to-mouth resuscitation when substance inhaled or ingested.

NOTES TO PHYSICIANS OR FIRST AID PROVIDERS: Effects may be delayed. Ethanol may inhibit methanol metabolism.

SECTION 5: FIRE-FIGHTING MEASURES

FLASH POINT: 52˚F

AUTOIGNITION TEMPERATURE: 867˚F

NFPA HAZARD CLASSIFICATION
HEALTH: 2 FLAMMABILITY: 3 REACTIVITY: 0
Note: ratings are estimated

EXTINGUISHING MEDIA: Use water spray, dry chemical, carbon dioxide, or chemical foam. Use water to cool containers. For extinguishing flames; use fog, or alcohol-resistant foam. Do NOT use straight streams of water.

SPECIAL FIRE FIGHTING PROCEDURES: None

General: Use self-containe breathing apparatus, or approved respiratory gear in the case of a fire.

SECTION 6: ACCIDENTAL RELEASE MEASURES

ACCIDENTAL RELEASE MEASURES: Promote proper ventilation. Absorb the spill with non-combustible absorbents such as soil, sand, or vermiculite (do NOT use sawdust). Collect material with nonsparking tools and place in containers for disposal. Use water spray to disperse vapors.

SECTION 7: HANDLING AND STORAGE

STORAGE: Keep away from heat, sparks, and flame. Store away from incompatible substances. Store in a cool, dry place in closed container. Do not get in eyes, skin, or clothing. Do not store in metal containers due to risk of corrosion.
HANDLING: Use only in well-ventilated areas. Ground and bond containers when transferring materials. Observe proper PPE to avoid exposure. Keep containers tightly closed when in use. Keep away flames and ignition sources.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

ENGINEERING CONTROLS: Eyewash facility and safety shower. Use only in chemical fume hood.

RESPIRATORY PROTECTION: Follow the OSHA respirator regulations found in 29 CFR 1910.134 or European Standard EN 149. Use a NIOSH/MSHA or European Standard EN 149 approved respirator if exposure limits are exceeded or if irritation or other symptoms are experienced.

EYE PROTECTION: Wear appropriate safety eye protection per OSHA 29 CFR 1910.133

SKIN PROTECTION: Wear appropriate safety gloves

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE: Clear, Colorless

ODOR: alcohol and vinegar smells

PHYSICAL STATE: liquid

pH: 2.1

BOILING POINT:Not available
MELTING POINT: not available
FREEZING POINT: not available
SPECIFIC GRAVITY (H2O = 1): 0.89
Molecular Formula: Solution

SECTION 10: STABILITY AND REACTIVITY

STABLE **UNSTABLE**

STABILITY: Hygroscopic

CONDITIONS TO AVOID (STABILITY): High temperatures and ignition sources

INCOMPATIBILITY (MATERIAL TO AVOID): Strong oxidizing agents, strong bases

HAZARDOUS DECOMPOSITION OR BY-PRODUCTS: Carbon monoxide, carbon dioxide, formaldehyde

HAZARDOUS POLYMERIZATION: Will not occur

SECTION 11: TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION:
Oral, mouse: LD50=7300 mg/kg
Oral, rat: LD50=5600 mg/kg

SECTION 12: ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION: Degrades in water and land through biodegradation.

SECTION 13: DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHOD: Consult federal and state regulations for proper disposal guidance.

SECTION 14: TRANSPORT INFORMATION

U.S. DEPARTMENT OF TRANSPORTATION
PROPER SHIPPING NAME: Flammable Liquids, Corrosive, n.o.s.
HAZARD CLASS: 3(8)
ID NUMBER: 2924
PACKING GROUP: II

APPENDIX IV. EXAMPLES OF INCOMPATIBLE CHEMICALS

SOURCE: Prudent Practices for Handling Hazardous Chemicals in Laboratories, National Research Council, Washington, D.C.,1995.

Chemical	Incompatibles
Acetic acid	Chromic acid, ethylene glycol, hydroxyl-containing compounds, nitric acid, perchloric acid, permanganates, peroxides
Acetone	Concentrated nitric and sulfuric acid mixtures
Acetylene	Bromine, chlorine, copper, fluorine, mercury, silver
Alkali and alkaline earth metals (lithium, sodium, potassium)	Carbon dioxide, carbon tetrachloride or other chlorinated hydrocarbons, halogens, powdered metals (e.g. aluminum or magnesium),water
Ammonia(anhydrous)	Bromine, calcium hypochlorite, chlorine, iodine, hydrofluoric acid (anhydrous),mercury (e.g. in manometers),
Ammonium nitrate	Acids, chlorates, finely divided organic or combustible materials powdered metals, flammable liquids, nitrates, sulfur
Aniline	Hydrogen peroxide, nitric acid
Azides	Acids
Bromine	See Chlorine
Calcium oxide	Water
Carbon (activated)	All oxidizing agents, Calcium hypochlorite
Carbon tetrachloride	Acids, ammonium salts, chlorates, finely divided organic or combustible materials, powdered metals, sodium, sulfur,
Chlorine	Ammonia, acetylene, benzene, butadiene, butane, hydrogen, finely divided metals, methane, propane (or other petroleum gases), sodium carbide, turpentine
Chromic acid and chromium	Acetic acid, alcohol, camphor, flammable liquids in general, glycerol naphthalene
Cyanides	Acids
Flammable liquids	Ammonium nitrate, chromatic acid, halogens, hydrogen peroxide, nitric acid, sodium peroxide

Examples of incompatible chemicals (continued)

Chemical	**Incompatibles**
Hydrofluoric acid (anhydrous)	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Acetone, alcohols, aniline, chromium, combustible materials, copper, iron, most metals or their salts, nitromethane, organic materials,
Hypochlorites	Acids, activated carbon
Mercury	Acetylene, ammonia, fulminic acid
Nitrates	Sulfuric acid
Nitric acid (concentrated)	Acetic acid, aniline, any heavy metals, brass, chromic acid, copper, flammable gases, flammable liquids, hydrocyanic acid, hydrogen sulfide
Nitrites	Potassium or sodium cyanide.
Oxygen	Flammable liquids, solids, or gases; grease, hydrogen, oils
Perchloric acid	Acetic anhydride, alcohol, bismuth and its alloys, grease, oils, paper, wood
Peroxides, Organic	Acids (organic or mineral), avoid friction, store cold
Phosphorus (white)	Air, alkalis, oxygen, reducing agents
Phosphorus pentoxide	Water
Potassium	Carbon dioxide, carbon tetrachloride, water
Potassium permanganate	Benzaldehyde, ethylene glycol, glycerol, sulfuric acid
Sodium	See Potassium
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Acetic anhydride, benzaldehyde, carbon disulfide, Ethyl or methyl alcohol, ethyl acetate, ethylene glycol, furfural, glacial acetic acid, glycerin, methyl acetate
Sulfides	Acids
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate (similar compounds

Examples of incompatible chemicals (continued)

Chemical	**Incompatibles**
	of light metals, such as sodium, lithium)
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, sulfur trioxide

APPENDIX V. GENERAL QUANTITY LIMITATIONS

A. Flammable & Combustible Liquids Quantity Limitation

Chemical inventories in each laboratory unit shall be maintained within the maximum allowable quantities specified in the following tables. It is the Certificate of Fitness holder's responsibility to figure out what is the approximate maximum quantity that he/she can handle and/or use in the laboratory according the laboratory size.

(1) Pre-existing laboratory

The laboratories approved by the Fire Department prior to July 1, 2008 are considered to be "pre-existing laboratories". There are four types of laboratories and classified according to **their fire rating** and **whether or not an automatic sprinkler system is installed**. The four different classifications are shown in the table below. The majority of the science laboratories in NYC public schools are classified as Type II or Type IV laboratories unless the areas have a fire-resistance rating of at least 2 hours. The following table provides the quantity limitation for the laboratory units used for the instruction of students through the 12th grade.

Table. Quantity Limitation for Pre-existing Laboratory

Lab Type	Fire Rating (hr)	Fire Protection	Flammable and Combustible liquids
I	2	Sprinklered	30 Gallons
II	1	Sprinklered	25 Gallons
III	2	Nonsprinklered	20 Gallons
IV	1	Nonsprinklered	15 Gallons

(2) New laboratory

All educational and instructional non-production laboratories established on or after July 1, 2008 are required to be in compliance with the 2008/2014 Fire Code and shall comply with the Class "D" laboratory requirements. The following table provides the quantity limitation for the laboratory units used for the instruction of students through the 12th grade.

Table. Quantity Limitation Flammable and Combustible Liquids

Laboratory unit hazard classification	Excluding Quantities in Storage Cabinets or Safety Cans		Including Quantities in Storage Cabinets or Safety Cans	
	Maximum Quantity Class I Liquids Alone per Lab Unit (gal)	Maximum Quantity Class I, II, IIIA Liquids per Lab Unit (gal)	Maximum Quantity Class I Liquids Alone per Lab Unit (gal)	Maximum Quantity Class I, II, IIIA Liquids per Lab Unit (gal)
Class D	0.5 gals/100 ft^2 37.5 (max)	0.5 gals/100 ft^2 37.5 (max)	1 gals/100 ft^2 75 (max)	1 gals/100 ft^2 75 (max)

B. <u>Other Laboratory Hazardous Material Quantity Limitations</u>

The following quantity limitations are independent of any hazardous materials that are handled and used in an approved laboratory:

<u>Table. Laboratory Hazardous Material Quantity Limitations</u>

	Maximum quantity in 1-hr fire rated lab	**Maximum quantity in 2-hr fire rated lab**
Water-Reactive Material	2.5 Lbs.	5 Lbs.
Pyrophoric Material	0.5 Lbs.	1 Lbs.
Highly Toxic Material	5 Lbs.	5 Lbs.
Toxic Material	250 Lbs.	250 Lbs.
Corrosive Material	250 Gallons	250 Gallons
Flammable Solids	10 Lbs.	15 Lbs.
Oxidizers/Org Peroxides	40 Lbs.[a]	50 Lbs.[a]
Unstable reactive material	6 Lbs. [b]	12 Lbs.[b]

a. maximum 2 lbs of Class 3 oxidizers & 1 lb of Class I organic peroxides
b. maximum 1 lb of Class 3 unstable reactive material

In addition, there are special quantity limitations for compressed gases. For the educational or instructional laboratories, **the total number of lecture bottle-sized containers of any type shall be limited to 10.** For the containers other than the lecture bottles, the material quantity limitations are listed as the following table:

Table. Hazardous Gases Quantity Limitations
(Educational and Instructional Labs)

Gas Type	**Maximum Capacity**
Flammable gases	6 Cu. Ft[a]
Oxidizing gases	6 Cu. Ft[a]
Liquefied flammable gases	1.2 Cu. Ft[a]
Health hazard 3 or 4 gases	20 SCF[b]

a. The quantity limitation is limited by NFPA which uses water container capacity units
b. The quantity limitation is limited by Fire Code which uses SCF units (20 SCF is approximately equal to 0.10 cu ft).

Typical internal volume of common gas containers are listed in Appendix VI. It is the Certificate of fitness holder's responsibility to figure out what is the approximate maximum quantity that he/she can store or use in the laboratory according the laboratory class and size.

APPENDIX VI. COMMON HAZARDOUS MATERIALS

In this appendix, the supplementary information of common hazardous materials in non-production chemical laboratory is covered.

A. CORROSIVE MATERIALS

A. Storage and Use Requirements

Special care needs to be taken when storing acids. Minor spills and acid fumes can quickly corrode standard metal storage cabinets or soapstone countertops, for example. The best choice for storing acid containers is a chemically-resistant cabinet designed for that purpose, with polyethylene construction being the best choice. Polyethylene spill trays are also a very good idea, whether acids are stored on a bench top or in a cabinet. Containers of sodium bicarbonate or other suitable neutralizing or absorbing agents must be provided where more than 5 gallons are stored or used per laboratory or storage room and accessible in these storage areas at all times. Corrosives, if exposed to incompatible materials, can lead to dangerous reactions such as explosions, release of toxic gas, or extreme fire conditions. Compressed gas containers and systems should not be exposed to corrosive chemicals or fumes that could damage containers, valves or valve-protective caps. Acids and bases should not be stored or used near each other as their accidental combination could generate a huge amount of heat and energy, possibly resulting in an explosion.

When corrosive liquids are stored in excess of 5 gallons, special emergency showers must be installed in the laboratory/storage-room, or outside the laboratory within 25 feet of laboratory/storage-room entrance door. Store containers at a convenient height for handling, below eye level if possible. High shelving increases the risk of dropping containers and the severity of damage if a fall occurs. The showers are designed to quickly drench the individual in case of emergency. The Certificate of Fitness holder must make sure the showers remain accessible and unobstructed at all times.

Handling and use of corrosive materials shall be located in accordance with the distances and exposures noted for storage.

B. COMPRESSED AND LIQUEFIED GASES

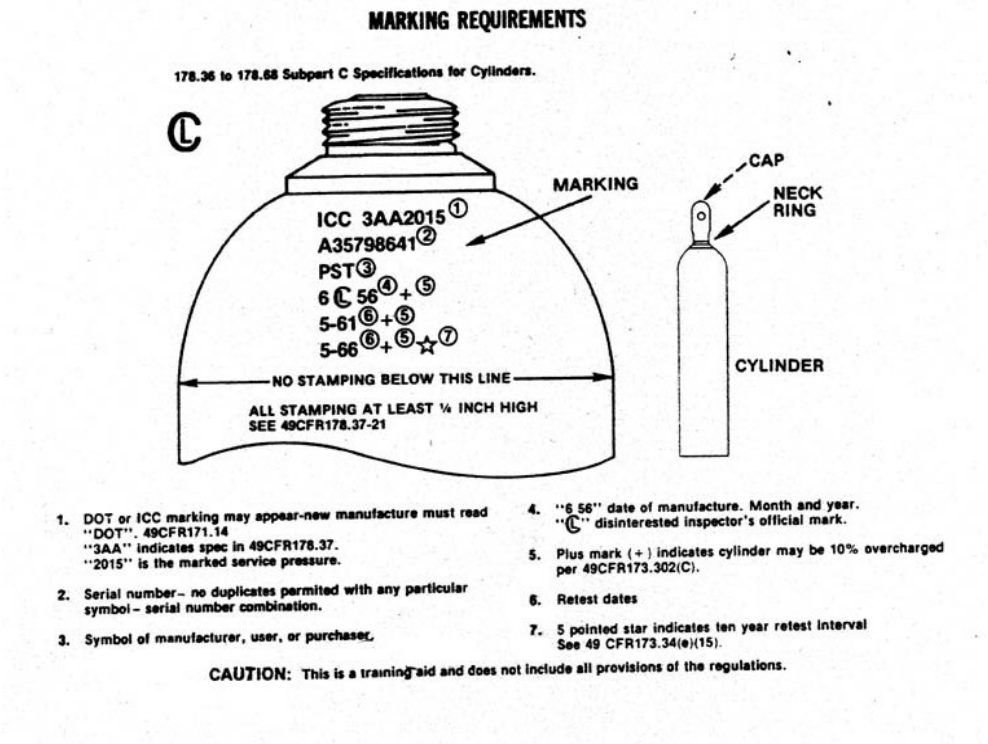
ADDITIONAL PERMITS AND CERTIFICATES OF FITNESS

Quantities requiring a permit AND Supervision by a G-97 certificate of fitness holder: When there are more than 60 gallons cryogenic containers in a storage area outside of the laboratory, permits and a G-97 Certificate of Fitness (Supervision of Commercial Cryogenic Systems and for Storage and Handling of Cryogenic Liquids) holder must be present.

A. General Requirement

Compressed gas containers are often used in the laboratory. All compressed gases are potential hazards because of the pressure within the container, their flammability, and/or their toxicity. The chemical is in gaseous form and pressurized, it can quickly contaminate a large area in the event of a leak.

(1) Labeling all compressed gas container clearly



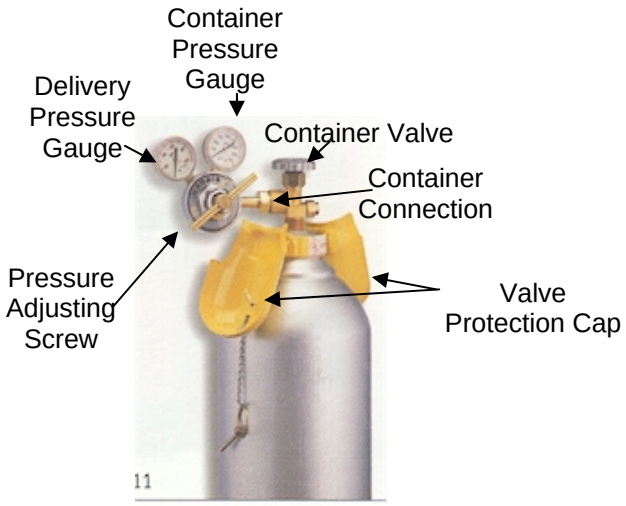
The contents of any compressed gas container must be clearly identified. Gas identification should be stenciled or stamped on the container or a label which shall be marked to show the authorizing code and its working pressure at 70°F. Do not rely

solely on the color of the container to identify the contents. Reject any container that is unmarked or has conflicting marking or labels.

(2) Refilling container
The practice of transferring compressed gases from one commercial container to another is not permitted.

B. Use of Containers
(1) Train Users
Before attempting to connect a container to a system, be certain that the personnel handling the containers are trained and knowledgeable regarding the product, container, fittings, equipment, and proper connection procedures.

(2) Regulator use
Containers, when in use, must be connected to gas delivery systems and a regulator instrument. The regulator system shall be equipped with two gauges installed so as to show both the pressure in the container and the pressure in the system.



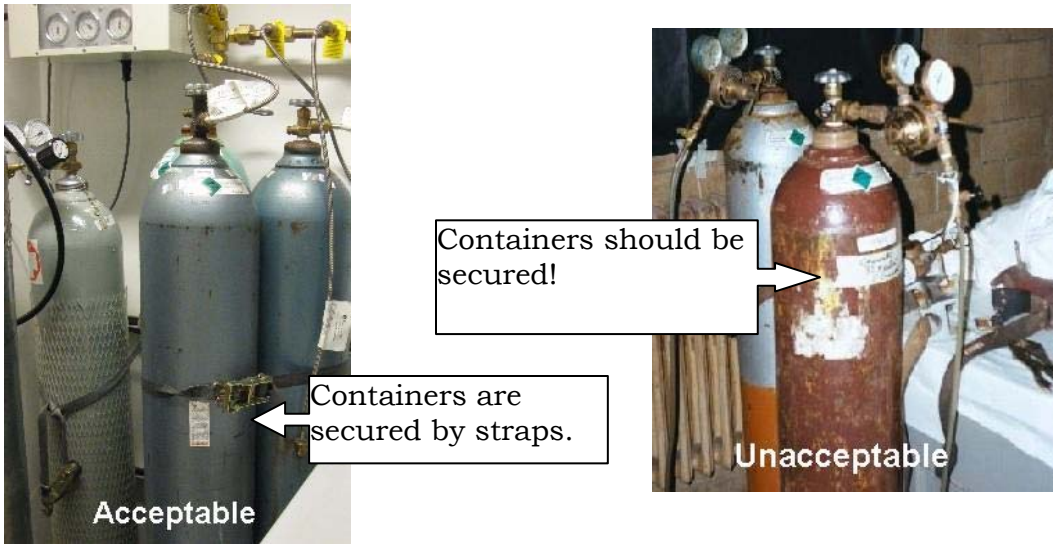
(3) Valves
Valves utilized on compressed gas systems shall be suitable for the use intended and shall be accessible. Valve handles or operators for required shutoff valves shall not be removed or otherwise altered to prevent access or hinder operation. Always open the valves slowly and only with the proper regulator in place. Valve protection caps should remain in place until ready to withdraw gas, or connect to a manifold. Before removing the regulator from the container, close the container valve first and release all pressure from the regulator.

(4) Eye protection
Always wear eye protection when working on or near compressed gas systems. Never let anyone without eye protection into any area where compressed gas are used or stored.

(5) Containers not in use
In order to decrease the potential hazards for the laboratory personnel, all not "in use" containers, except nominal 1lb propane containers made for consumer use, shall be removed from the laboratory unit to a storage facility (" in use" can include connected to a regulator; connected to a manifold; or an unconnected reserve stored alongside a connected container). Always shut off and have a container cap on any container that is not in use or is being stored.

C. Storing Containers

(1) Upright position
All containers must be secured from tipping over and shall be stored in an upright position and be equipped with a pressure regulator designed for the specific gas and marked for its maximum container pressure. You can use appropriate material, such as chain, plastic coated wire cable, commercial straps, etc., to secure containers. The only exception for storing the compressed gas containers in a horizontal position is those containers with an internal volume is less than 0.174 Cu. Ft. (e.g. lecture bottles).



(2) Well-ventilated areas
Containers of all gases that have health hazard ratings of 3 or 4; or have a health hazard rating of 2 without physiological warning properties; or are pyrophoric gases shall be kept in a continuously mechanically ventilated hood or enclosure. The containers that are greater than lecture bottle size shall be kept in continuously mechanically ventilated gas cabinets.

(3) Separation from hazardous conditions
All compressed gas containers and systems in storage or use shall be away from materials and conditions that present potential hazards to them or to which they present potential hazards. Those containers shall be segregated in hazard classes while in storage, especially be separated from incompatible materials. It is recommended to group containers according to the type of gas (e.g. flammable, oxidizer, toxic or corrosive) or whether containers are full or empty, if they are stored

at the same location. Combustible waste shall be kept a minimum of 10 feet from compressed gas containers and systems. Generally, corridors are not designed for storage of compressed gases. However, there are circumstances when the Fire Department may allow this. Any corridor storage of compressed gases should be approved by the Fire Department prior to commencing such storage. Oxidizing gases shall not be stored/used or come in contact with oil, grease, or other petroleum base.

Generally, the compressed gas containers shall be kept away from

- Sources of ignition
- Temperature extremes (Above 125 degrees F or less than mean low atmospheric temperatures)
- Corrosive chemicals or fumes
- Falling objects
- Ledges, unprotected platforms, and elevators or other areas where the container could drop a distance exceeding one-half the height of the container

D. Typical Internal Volume of Cylinders

The following table provides information on the typical internal volume of cylinders:

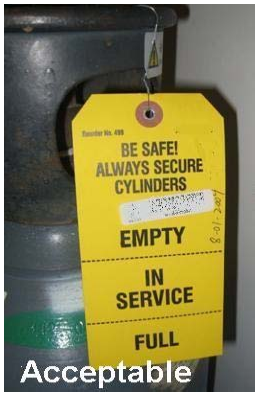
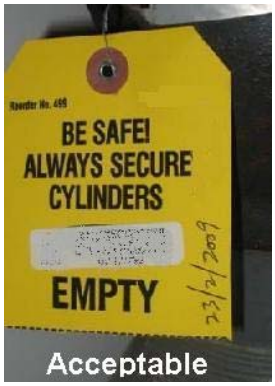
Model	Nominal Dimension (Diameter x Length*, inch)	Internal Volume (Water volume, Cu. Ft.)
TYPE	**STANDARD CYLINDER SIZES AND CAPACITIES** (NFPA 45)	
Lecture Bottle	2 x 15	0.016
D	4.5 x 18	0.08
E	4.5 x 31	0.164
M	7 x 43	0.77
G	9 x 55	1.54
H	9 x 60	1.75
LPG WEIGHT	**COMMON LPG CONTAINER SIZES AND CAPACITIES**	
16.4 oz.	4¼ x 6¼	0.051
5 lbs.	9 ⅜ x 12½	0.192
20 lbs.	12 ⅛ x 20⅛	0.769
TYPE	**COMMON ACETYLENE CONTAINER SIZES AND CAPACITIES**	
B (40 SCF)	6 x 25	0.278
WC (110 SCF)	8½ x 33½	0.885
WK (330 SCF)	13 x 42	2.414

* Includes valve and cap

E. Compressed Gas Container Disposal or Return

It is dangerous to empty a compressed gas container completely, a container is considered empty when the container pressure is at atmospheric pressure or 15 psia (pounds per square inch absolute) remaining. The empty containers shall be labeled with the word “empty” or the abbreviation “MT and the date”. Always handle empty containers as carefully as full ones; residual pressure can be dangerous.

Examples of the gas container tag

Container before use	Container in service	Empty container
		

F. Cryogenic Liquid

(1) Safety Practices

Always handle cryogenic/refrigerated liquids carefully. At their extremely low temperatures, they can produce frostbite on the skin and exposed eye tissue. When spilled, they tend to cover a surface completely, cooling a large area. Delicate tissues, such as those of the eyes, can be damaged by exposure to these cold vapors, even when the contact has been so brief to affect the skin of the hands or face. Boiling and splashing always occurs when charging a warm container, or when inserting warm objects into a liquid. Always perform the operations slowly to minimize boiling and splashing. Never allow any unprotected part of the body to touch uninsulated pipes or vessels which contain cryogenic/refrigerated fluids. Even nonmetallic materials are dangerous to touch at low temperatures. Use tongs to withdraw objects dipped in a cryogenic/refrigerated liquid. Objects that are soft and pliable at room temperature, such as rubber or plastics, are easily broken because they become hard and brittle at extremely low temperatures. Carbon steels also become brittle at low temperatures and will easily break.

If severe spraying or splashing may occur, a face shield or chemical goggles should be worn for additional protection. Insulated gloves should always be worn when handling anything that comes in contact with cold liquids and vapors. Gloves should be loose fitting so that they can be removed quickly if liquids are spilled into them. Trousers should be left outside of boots or work shoes.

In the event of unlikely contact with a cryogenic/refrigerated liquid, a cold-contact burn may occur, which means that the skin tissue freezes. If this should occur, remove any clothing that may restrict the blood circulating to the frozen area. Do not rub frozen parts because the tissue may become damaged. Immerse the affected parts in warm water (105°F to 115°F). Never use dry heat. If possible, put the victim in a warm room. Obtain medical assistance as soon as possible.

Persons who work with cryogenic/refrigerated liquids, including handling, storage, and transfer operations should be trained in the:

1. nature and properties of cryogenics in both liquid and gaseous phases;
2. specific instructions on the equipment to be used;
3. approved materials that are compatible with the cryogens;
4. use and care of protective equipment and clothing;
5. safety, first aid, and self aid when first aid and/or medical treatment is not available;
6. handling emergency situations such as fire, leaks, and spills;
7. good housekeeping practices are essential for the safety of personnel.

(2) Ventilation
All gases should be used and stored in well-ventilated areas. All of the gases except oxygen can cause a person to suffocate by replacing breathable air in an enclosed workplace. However, workers will not be aware of the presence of such gases without a tool to help them detect the gases. Therefore, an oxygen sensor equipped with an audible alarm must be installed to monitor the level of oxygen in the area when the total cryogenic gas capacity exceeds 60 gallons. In addition, all entrances to such areas should have prominent durable signs indicating danger due to extreme cold and possibility of rapid suffocation.

C. HIGHLY TOXIC AND TOXIC MATERIALS

A. General Description

Toxic chemicals are chemicals that can produce injury or death when inhaled, ingested, or absorbed through the skin. While damage may be acute or chronic the Fire Code is only concerned with acute lethality. The extent of lethality depends on the dose and duration of exposure. Exposure may enter the body through three routes: inhalation, ingestion, or contact with the skin and eyes.

For the purposes of the Fire Code, Toxic & Highly Toxic Material are defined in terms of LD50 values as follows.

Summary Definitions Toxic & Highly Toxic

	Toxic	**Highly Toxic**
Oral LD50 (albino rats)	50-500 mg/kg	<50 mg/kg
Skin Contact LD50 (albino rabbits)	200-1000 mg/kg	<200 mg/kg
Inhalation LC50 (albino rats) gas	200-2000 ppmv/air	<200 ppmv/air
Inhalation LC50 (albino rats) mists/dust	2-20 mg/L	<2 mg/L

For the purposes of Fire Code compliance, it is important to have supporting documentation regarding the toxicity of the specific materials being stored, handled or used. Generally this would be MSDS's. Care should be exercised when changing material vendors as the MSDS information may be different. It is the facility storing, handling or using these chemicals to know their toxicity and be able to demonstrate to

an inspector that the appropriate classification and handling procedures are being used.

The level of toxicity of Highly Toxic and Toxic Materials may be reduced by diluting such materials with other materials, such as water, to a degree that the resulting mixture may no longer be Highly Toxic or Toxic. For the purposes of Fire Code compliance, a mixture containing any amount of Highly Toxic and/or Toxic material is presumed to be a highly toxic or toxic material, as applicable, unless it is otherwise certified and labeled by the manufacturer.

Highly Toxic and Toxic Materials that are compressed gases can be referred to the section of this study guide, Part III-1 [COMPRESSED AND LIQUEFIED GASES], which follows requirements of the NFPA 45 and the New Fire Code Chapter 30 [Compressed Gases]. Additionally Highly Toxic and Toxic Materials that meet the definition of other hazard classes shall comply with those requirements also including New Fire Code Chapters 35 (Flammable Gases), 37 (Highly Toxic and Toxic Materials), 40 (Oxidizers) and 41 (Pyrophoric), as applicable.

B. <u>Storage and Use Requirements (liquids/solids)</u>

The indoor and outdoor storage, handling or use of Highly Toxic and Toxic solids or liquids in amounts that do not exceed the maximum allowable quantity per control area shall be in accordance with the general provisions for hazardous materials and with the general previsions for Highly Toxic & Toxic Materials.

D. FLAMMABLE SOLID

A. <u>General Description</u>

Many flammable solids may react violently or explosively on contact with water including water applied for extinguishment purposes (i.e., water fire extinguishers). They may also be ignited by friction, heat, sparks or flame. Some of these materials will burn with intense heat. Dusts or fumes may form explosive mixtures in air. Containers may explode when heated. Materials may re-ignite after fire is extinguished.

Fires may produce irritating, corrosive and/or toxic gases. Some of these materials may also be pyrophoric – spontaneously reacting with oxygen in air to ignite. Many flammable solids are metals. Oxides from metallic fires are a severe health hazard, inhalation or contact with substance or decomposition products may cause severe injury or death. Cutting some flammable solids can initiate a fire. For example, using a torch to cut titanium tubing will generate sufficient heat to ignite the material. Dry sand can usually be used to smother a fire involving flammable solids. Keep a container of sand near the work area.

E. OXIDIZERS AND ORGANIC PEROXIDES

A. General Description

(1) Oxidizers

Oxidizers are chemicals that release large amounts of oxygen. Because this class of compounds can act as an oxygen source, they can be unpredictable and dangerous during fire situation. Inorganic oxidizers can increase the danger of fire around flammable or combustible materials, while organic oxidizers are flammable in themselves. Oxidizers and organic peroxides are both considered "oxidizing materials" in that they provide oxygen to chemical and physical reactions. Some organic oxidizers can even explode when they are exposed to heat, shock or friction. Most oxidizer are corrosive and can irritate skin or lungs. In general, oxidizers shall be kept away with organic or combustible materials.

(2) Organic peroxides

Organic peroxide is a compound having a double oxygen or peroxy (-O-O-) in its chemical structure. The oxygen-oxygen linkage (-O-O-), a thermally sensitive and energetic bond, makes organic peroxides become relative unstable compounds which can decompose spontaneously and sometimes explosively. For example, if one liter of liquid with 100 ppm peroxides is distilled down to dryness and the residue explodes, the energy is roughly equivalent to good firecracker or a .22 caliber bullet charge (i.e., one kilo-Joule). This is the same energy as a 280 pound weight falling from a 30-inch height onto the floor or a change of two degrees Fahrenheit in a cup of water. Moreover, the decomposition of organic peroxide generally produces heat and by-products (e.g. free radicals, gases, mists) which can becomes uncontrolled and violent. Improper storage or handling could lead to an uncontrolled decomposition. All materials in the vicinity of organic peroxides should be investigated for compatibility, and segregated if necessary.

Solid oxidizers and organic peroxides are less likely to pose problems than liquids and gases due to their physical characteristics. However, special attention must be paid to the class of oxidizer and organic peroxides that may be found on the label accompanying the material, it's MSDS (Material Safety Data Sheet), or through a phone call 1-800-CHEMTREC or to the manufacturer. For instance, greater care must be used in the storage of Class 4 oxidizers than with Class 1 oxidizers. Similarly, greater care must be used in the storage of Class I organic peroxides than with Class IV organic peroxides.

B. Storage and Use Requirements

Solid oxidizers are less likely to pose problems than liquids and gases due to their physical characteristics. However, great care must be used in the handling and use of all oxidizing materials. In some respects, the hazard during handling may be significantly increased due to the potential absence of a suitable container. The use of these materials near potential fuels must be avoided. Fuels include paper, wood, and flammable liquids. Also of concern is the use of oxidizing materials near some acids, as a dangerous reaction may occur when these materials are mixed. All materials in

the vicinity of oxidizers and organic peroxides should be investigated for compatibility, and segregated if necessary.

All potential sources of ignition must be removed from the vicinity of oxidizers in use. "No smoking" signs must be posted prominently and no open flames – such as those associated with boilers or water heaters – are permissible where oxidizers and organic peroxides are used or stored.

(1)Oxidizers

It is important to understand that the conditions of acceptable storage for oxidizing materials are based upon their ability to cause combustible and flammable materials to ignite and burn, or explode. The fundamental and general rule is to keep fuels (including wood, paper, cardboard, flammable liquids and gases, metals, etc…) and sources of ignition away from the stored oxidizing materials.

Many oxidizing materials possess other hazards such as flammability, corrosivity and toxicity. Chlorine, for instance, is an oxidizer that is also both corrosive and toxic. Strong oxidizing materials, such as perchloric acid, shall not be heated by gas flames or oil baths. Adequate safety glasses must be worn at all times when handling oxidizing chemicals (ordinary glasses do not provide adequate protection). All hazards should be investigated prior to use and handling and steps taken to reduce the potential for problems, in accordance with the Fire Code.

In the event of an uncontrolled spill or release of a liquid, solid or gaseous oxidizing material, the area should be evacuated and notification to 911 made as soon as possible.

(2)Organic Peroxides

In general, great care of temperature and contamination must be used in handling or storing organic peroxides. The most important one is the control of the temperature. Whether handling or storing organic peroxides, if the temperature is maintained below its Self-Accelerating Decomposition Temperature, most uncontrollable reaction are avoided. In addition, where the required storage temperature range, as specified by the manufacturer, extends beyond normal ambient temperatures, high or low temperature limit switches, as applicable, shall be provided in addition to normal temperature controls. These limit switches shall actuate an alarm in a supervised area to ensure reporting to the Fire Department. In addition, contamination can lead to rapid decomposition too. Organic peroxides shall be stored in their original DOT shipping containers. Organic peroxides shall be stored in a manner to prevent contamination.

For any containers holding a peroxide-forming compound, label it with the words "Date received", "Date opened" and "Expiration date". Laboratory chemicals known to form peroxides have been categorized into three groups (Group A, Group B, Group C) based on their susceptibility to peroxide formation. The chemicals in Group A can form explosive peroxide levels even in an unopened container, and severe peroxide hazard after prolonged storage, especially after exposure to air. All have been responsible for fatalities. The chemicals in Group B have peroxide hazards on concentration. The chemicals in Group C, which are hazardous due to, peroxide initiation of autopolymerization. The peroxide-forming potential increases for liquids of Group C, especially for butadiene, chloroprene and tetrafluoroethylene, such that

these materials should be considered as a peroxide hazard. The sample chemicals in each group are listed in the following table.

Table. Peroxide-Forming Chemicals

SOURCE: Clark, D.E., Peroxides and Peroxide - Forming Compounds, *Chemical Health and Safety*, 2001, 8 (5), 12-21

Group A		
Butadiene[a]	Isopropyl ether	Sodium amide
Chloroprene [a]	Potassium amide	Tetrafluoroethylene [a]
Divinyl acetylene	Potassium metal	Vinylidene chloride
Group B		
Acetal	Diacetylene (butadiyne)	Methyl-isobutyl ketone
Acetaldehyde	Dicyclopentadiene	4-Methyl-2-pentanol
Benzyl alcohol	Diethylene glycol dimethyl ether (diglyme)	4-Penten-1-ol
2-Butanol Dioxanes	Diethyl ether	1-Phenylethanol
Chlorofluoroethylene	Ethylene glycol ether acetates (cellosolves)	2-Phenylethanol
Cumene (isopropylbenzene)	Furan	Tetrahydrofuran
Cyclohexene	4-Heptanol	Tetrahydronaphthalene
2-Cyclohexen-1-ol	2-Hexanol	Vinyl ethers
Cyclopentene	Methyl acetylene	Other secondary alcohols
Decahydronaphthalene (decalin)	3-Methyl-1-butanol	
Group C		
Butadiene [b]	Styrene	Vinyl chloride
Chlorobutadiene	Tetrafluoroethylene [b]	Vinyl pyridine
Chloroprene [b]	Vinyl acetate	Vinyladiene chloride
Chlorotrifluoroethylene	Vinyl acetylene	

a. When stored as a liquid monomer.

b. Can form explosive levels of peroxides when stored as liquid. When stored as gas, peroxide accumulation may cause autopolymerization.

F. UNSTABLE REACTIVES (INSTABILITY HAZARD)

A. General Description

In storing unstable reactive materials, care must be taken to ensure that the materials do not encounter any incompatible materials or conditions that could cause a reaction. Storage of temperature-sensitive materials requires the use of temperature controls. Whenever the chemical manufacturer or MSDS specifies a maximum/minimum storage temperature, the storage area must also have an emergency alarm that notifies personnel whenever the temperature falls below or exceeds the set point. These personnel must ensure notification to the Fire Department.

There are different storage considerations for "deflagrating" unstable reactives, as opposed to those for "non-deflagrating" unstable reactives. To determine whether or not a material is considered deflagrating, one must consult an MSDS or the chemical manufacturer.

Additionally, one must determine the class of unstable reactive by consulting an MSDS or by contacting the chemical manufacturer. The classes of unstable reactives are ordered in incrementally increasing hazard. A Class 4 unstable reactive, therefore, must be handled more carefully than a Class 1 unstable reactive.

B. <u>Storage and Use Requirements</u>

The storage and use of these materials near incompatibles such as heat sources must be avoided. Material must be kept away from any possible fuel sources. Proper personal protective equipment must be worn at all times while handling these materials.

Many unstable materials possess other hazards such as flammability, corrosivity, and toxicity. Be sure to reference MSDS's or manufacturer's information for all materials prior to working with material. All hazards should be investigated prior to use and handling and steps taken to reduce the potential for problems, in accordance with the Fire Code. In the event of an uncontrolled spill or release of material, the area should be evacuated and notification made to 911 as soon as possible.

G. WATER-REACTIVE SOLID & LIQUIDS

A. <u>General Description</u>

Water-Reactive chemicals react with the hydrogen and oxygen in water to create new combinations of chemicals and produce energy, resulting in an exothermic reaction. Water reactive materials often produce byproducts that may be ignited by the heat generated, thereby producing a flame or explosion. Water-reactive materials are often elemental metals in either whole or powder form. Examples include Potassium, calcium, and sodium.

The chemical equation below shows the reaction of elemental potassium with water. The heat generated by the reaction ignites the hydrogen gas, creating a bright flame.

$$2\ K\ +\ 2\ H_2O \rightarrow 2\ KOH + H_2$$

A reaction of potassium metal with water.

Water-reactive materials are divided in to Classes 1 through 3, with increasing levels of hazard from Class 1 to Class 3. To determine the class of the water-reactive material, one should consult the MSDS or call the chemical manufacturer.

B. Storage and Use Requirements

In storing water reactive materials, care must be taken to ensure that the materials do not come in to contact with any water or other incompatible materials.

The hazards presented by these materials in storage also exist during the use of these materials. The use of these materials near incompatibles such as heat sources and water must be avoided. Material must be kept away from any possible fuel sources. All water reactives should be managed under solvent or in an inert atmosphere.

Many water reactive materials possess other hazards such as flammability, corrosivity and toxicity. Be sure to reference MSDS' or manufacturer's information for all materials prior to working with material. All hazards should be investigated prior to use and handling and steps taken to reduce the potential for problems, in accordance with the Fire Code.

H. PYROPHORICS MATERIALS

A. Storage and Use Requirements

The handling and use of pyrophoric materials near incompatibles such as heat sources and water must be avoided. Material must be kept away from any possible fuel sources. All pyrophorics should be managed under inert gases, solvent or in an inert atmosphere. Compressed pyrophoric gas systems shall have approved emergency shutoff valves that can be activated at each point of use and each source. Proper personal protective equipment must be worn at all times while handling these materials.

Many pyrophorics possess other hazards such as flammability, corrosivity and toxicity. Be sure to reference MSDS' or manufacturer's information for all materials prior to working with material. All hazards should be investigated prior to use and handling and steps taken to reduce the potential for problems, in accordance with the Fire Code.

Appropriate fire extinguishing equipment must be present in each in areas where these materials are handled. Extinguishing agents include a Class D fire extinguisher and Metal X for metal fires.

In the event of an uncontrolled spill or release of material, the area should be evacuated and notification made to 911 as soon as possible.

Manufacturing, storing, handling and/or using of detonable pyrophoric materials is prohibited in most cases. Always consult the Fire Code prior to conducting any activities with any of these materials.

Pyrophoric materials will often have very specific storage or handling requirements due to the volatile nature of the chemicals. It is important to consult the MSDS or to contact the chemical manufacture for specific guidelines. Some examples of pyrophoric materials include diethylaluminum chloride, lithium metal or silane gases.