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# Fire Safety and Fire Extinguishers

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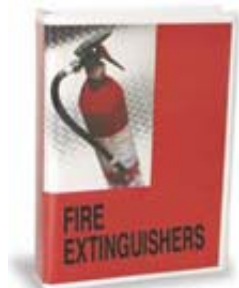


## Introduction

This document was originally designed to focus on fire situations in chemistry laboratories. While it continues to mention laboratories, the information contained herein is broadly applicable to almost all workplaces.

Fire is the most common serious hazard that one faces in a typical chemistry laboratory. While proper procedure and training can minimize the chances of an accidental fire, you must still be prepared to deal with a fire emergency should it occur ([Look here for a graphic example](#)). This document teaches you the basics about fire extinguishers - proper types, how to use them, when and when not to use them as well as the proper procedures to follow should a fire occur. It is **not** a comprehensive guide; be sure to read the [disclaimer](#) given below.

**If your clothing is on fire** (and the floor is not), STOP, DROP and ROLL on the ground to extinguish the flames. If you are **within a few feet** of a safety shower or fire blanket, you can use these instead, but do not try to make it "just down the hall" if you are on fire. If one of your coworkers



Fire and extinguisher training videos and pamphlets at [SafetyEmporium.com](http://SafetyEmporium.com).

catches fire and runs down the hallway in panic, tackle them and extinguish their clothing.



## Basic types of fire extinguishers

The two most common types of extinguishers in laboratories are pressurized dry chemical (Type BC or ABC, left) and [carbon dioxide](#) (CO<sub>2</sub>, right) extinguishers:



You can buy these in our on-line store, [SafetyEmporium.com](http://SafetyEmporium.com).

You may have other "clean agent" extinguishers besides CO<sub>2</sub> (see next section), particularly if your workplace has sensitive electronic devices such as computers. Those who work with [flammable](#) metals may also have a specialized Class D dry powder extinguisher for use on fires (in a pinch, a bucket of **dry** sand will do, but you really should have a Class D unit if you work with such materials). Water-filled extinguishers are **not** acceptable for chemistry laboratory use. If you have a water-filled extinguisher in your laboratory, have it replaced immediately by contacting your campus or corporate Fire Marshal's office.

If you are not familiar with fire extinguishers and have not been trained in their use, DO NOT attempt to use them! If you work in a laboratory you should have received this training (it is usually a state or federal [OSHA](#) requirement); if not contact your supervisor immediately (TODAY....no kidding).



## Which kind of extinguisher should I use?

The [National Fire Protection Association \(NFPA\)](#) classifies fires into five general categories (U.S.):

- **Class A** fires are ordinary materials like burning paper, lumber, cardboard, plastics etc.

- **Class B** fires involve [flammable](#) or [combustible](#) liquids such as gasoline, kerosene, and common [organic solvents](#) used in the laboratory.
- **Class C** fires involve energized electrical equipment, such as appliances, switches, panel boxes, power tools, [hot plates](#) and stirrers. Water can be a dangerous extinguishing medium for class C fires because of the risk of electrical shock unless a specialized water mist extinguisher is used.
- **Class D** fires involve combustible metals, such as magnesium, titanium, [potassium and sodium](#) as well as [pyrophoric organometallic](#) reagents such as alkyllithiums, Grignards and diethylzinc. These materials burn at high temperatures and will [react violently with water](#), air, and/or other chemicals. Handle with care!!
- **Class K** fires are kitchen fires. This class was added to the NFPA portable extinguishers Standard 10 in 1998. [Kitchen extinguishers](#) installed before June 30, 1998 are "grandfathered" into the standard.

**Now available:** Our on-line store, [SafetyEmporium.com](http://SafetyEmporium.com), carries all kinds of fire extinguishers including foam, Halotron and those hard-to-find Class D models. Everything from small hand-held units to large wheeled units and fixed distribution systems. If you need 1 extinguisher or 1,000 we can meet your needs!



Some fires may be a combination of these! Your fire extinguishers should have ABC ratings on them. These ratings are determined under [ANSI/UL Standard 711](#) and look something like "3-A:40-B:C". Higher numbers mean more firefighting power. In this example, the extinguisher has a good firefighting capacity for Class A, B and C fires. NFPA has [a brief description of UL 711](#) if you want to know more.

Here are some typical extinguishers and their uses:

- [Water extinguishers](#) (not pictured and not found in laboratories) are suitable for class A (paper, wood etc.) fires, but not for class B, C and D fires such as burning liquids, electrical fires or reactive metal fires. In these cases, the flames will be spread or the hazard made greater! Water mist extinguishers are suitable for class A and C; see below.
- **Dry chemical extinguishers** are useful for either class ABC or class BC fires (check the label) and are your best all around choice for common fire situations. They have an advantage over CO<sub>2</sub> and "clean agent" extinguishers in that they leave a blanket of non-flammable material on the extinguished material which reduces the likelihood of reignition. They also make a terrible mess - but if the choice is a fire or a mess, take the mess! Note that there are two kinds of dry chemical extinguishers:
  - **Type BC** fire extinguishers contain sodium or potassium bicarbonate.

- **Type ABC** fire extinguishers contain ammonium phosphate.

### When to use (or not use) Dry Chemical Extinguishers?

Dry chemical extinguishers can be quite [corrosive](#) to metals such as aluminum and are also potentially abrasive. ABC extinguishers are much more corrosive than BC extinguishers because the ammonium phosphate agent can undergo [hydrolysis](#) to form [phosphoric acid](#) and because the molten agent flows into minute cracks.

For this reason, **dry chemical ABC extinguishers are not recommended for use on aircraft or electronics** such as computers, MRI scanners, and scientific instruments. Boeing has stated in a service letter "Dry chemical extinguishers can cause extensive corrosion damage to airplane structure, electrical systems, and electronic equipment...Dry chemical fire extinguishers should only be used for airplane firefighting if there are no other extinguishers available and there is imminent danger to property or personnel."

Proper planning can avoid situations where you might have to make a choice between extinguisher types. Ensure that the extinguishers closest to your computers or aircraft are of an appropriate type (if local fire codes permit) and that workers in those areas are trained on when and how to use them. And remember, if your computer or airplane is fully engulfed in flames or a person is in danger, then possible added damage from an ABC extinguisher is moot.

- **CO<sub>2</sub> (carbon dioxide) extinguishers** are for class B and C fires. They don't work very well on class A fires because the material usually reignites. CO<sub>2</sub> extinguishers have an advantage over dry chemical in that they leave behind no harmful residue. That makes carbon dioxide (or Halotron I or FE-36; see below) a good choice for an electrical fire involving a computer or other delicate instrument. Note that CO<sub>2</sub> is a bad choice for a flammable metal fires such as Grignard reagents, alkyllithiums and [sodium metal](#) because CO<sub>2</sub> reacts with these materials. CO<sub>2</sub> extinguishers are **not** approved for class D fires!



To get an idea for what could happen, take a look at this [General Chemistry demonstration page](#) that includes a QuickTime movie of a magnesium metal fire contained inside a block of solid CO<sub>2</sub>!

Carbon dioxide extinguishers do not have pressure gauges because [carbon dioxide](#) is a condensable gas. Thus, pressure does not tell you how much agent remains in the cylinder. Instead, the extinguisher should have a tare (empty) weight stamped on it. To determine the amount of carbon dioxide remaining in the extinguisher, subtract the tare weight from the current weight

weight.

- **Metal/Sand Extinguishers** are for flammable metals (class D fires) and work by simply smothering the fire. The most common extinguishing agent in this class is sodium chloride, but there are a variety of other options. You should have an approved class D unit if you are working with flammable metals. The following types of class D extinguishing units are available through our on-line store, [Safety Emporium](#).
  - [Sodium chloride \(NaCl\)](#) works well for metal fires involving magnesium, sodium (spills and in depth), potassium, sodium/potassium alloys, uranium and powdered aluminum. Heat from the fire causes the agent to cake and form a crust that excludes air and dissipates heat.
  - [Powdered copper metal \(Cu metal\)](#) is preferred for fires involving lithium and lithium alloys. Developed in conjunction with the U.S. Navy, it is the only known lithium fire fighting agent which will cling to a vertical surface thus making it the preferred agent on three dimensional and flowing fires.
  - Graphite-based powders are also designed for use on lithium fires. This agent can also be effective on fires involving high-melting metals such as zirconium and titanium.
  - Specially-designed sodium bicarbonate-based dry agents can suppress fires with most [metal alkyls](#), [pyrophoric](#) liquids which ignite on contact with air, such as triethylaluminum, but do not rely on a standard BC extinguisher for this purpose.
  - Sodium carbonate-based dry powders can be used with most Class D fires involving sodium, potassium or sodium/potassium alloys. This agent is recommended where stress corrosion of stainless steel must be kept to an absolute minimum.

A few other extinguishers worth noting (and also available at [Safety Emporium](#)) are:

- [Halotron I extinguishers](#), like carbon dioxide units, are "clean agents" that leave no residue after discharge. Halotron I is less damaging to the Earth's ozone layer than Halon 1211 (which was banned by international agreements starting in 1994). This "clean agent" discharges as a liquid, has high visibility during discharge, does not cause thermal or static shock, leaves no residue and is non-conducting. These properties make it ideal for computer rooms, clean rooms, telecommunications equipment, and electronics. These superior properties of Halotron I come at a higher cost relative to carbon dioxide.
- **FE-36<sup>TM</sup>** (Hydrofluorocarbon-236fa or HFC-236fa) is another "clean agent" replacement for Halon 1211. This DuPont-manufactured substance is available commercially in [Cleanguard® extinguishers](#). The FE-36 agent is less toxic than both Halon 1211 and Halotron I. In addition, FE-36 has zero ozone-depleting potential; FE-36 is not scheduled for phase-out whereas Halotron I production is slated to cease in 2015. A 100% non-magnetic CleanGuard model is now available (see the warning box below).

now available (see the warning box below).

- **Water mist extinguishers** are ideal for Class A fires where a potential Class C hazard exists. Unlike an ordinary water extinguisher, the misting nozzle provides safety from electric shock and reduces scattering of burning materials. This is one of the best choices for protection of hospital environments, books, documents and clean room facilities. In non-magnetic versions, water mist extinguishers are the preferred choice for MRI or NMR facilities (see warning box below) or for deployment on mine sweepers.

### MAGNETIC FIELD WARNING



If you work around extremely high field magnets such as magnetic resonance imaging (MRI) machines or nuclear magnetic resonance spectrometers (NMR's), you should only have **non-magnetic fire extinguishers** on hand. The magnetic field of an MRI or NMR machine is strong enough to make a steel cylinder fly across the room with [lethal force](#).



Our on-line store, [Safety Emporium](#), carries 100% non-magnetic Cleanguard and water mist extinguishers (picture, right) for use in MRI/NMR facilities.

Check out the potential fire hazards in your area. Is there an extinguisher available? Do you know how to operate it? Are your extinguishers suitable for the fires you may encounter? If not, you'll want to contact your campus or corporate Fire Marshal's office.

Typical small lab fires (in a hood or on a bench) can easily be controlled by a dry chemical (ABC) or CO<sub>2</sub> extinguisher provided that you are properly trained.



## Using fire extinguishers

You are not required to fight a fire. Ever. If you have the slightest doubt about your control of the situation DO NOT FIGHT THE FIRE. Please see the [Disclaimer](#) below.

1. Use a mental checklist to make a Fight-or-Flight Decision. Attempt to use an extinguisher only if **ALL** of the following apply:

- The building is being evacuated (fire alarm is pulled)

- The fire department is being called (**dial 911**).
- The fire is small, contained and not spreading beyond its starting point.
- The exit is clear, there is no imminent peril and you can fight the fire with your back to the exit.
- You can stay low and avoid smoke.
- The proper extinguisher is immediately at hand.
- You have read the instructions and know how to use the extinguisher.



Mark the location of all your extinguishers with our vinyl or aluminum signs (as low as \$5 each; English or Spanish). Get them now at [SafetyEmporium.com](http://SafetyEmporium.com).

**IF ANY OF THESE CONDITIONS HAVE NOT BEEN MET, DON'T FIGHT THE FIRE YOURSELF. CALL FOR HELP, PULL THE FIRE ALARM AND LEAVE THE AREA.**

2. Whenever possible, use the "Buddy System" to have someone back you up when using a fire extinguisher. If you have any doubt about your personal safety, or if you can not extinguish a fire, leave immediately and close off the area (close the doors, but DO NOT lock them). Leave the building but contact a firefighter to relay whatever information you have about the fire.
3. Pull the pin on the fire extinguisher.
4. Stand several feet from the fire, depress the handle and sweep back and forth towards the fire.  
Note:
  - Do not walk on an area that you have "extinguished" in case the fire reignites or the extinguisher runs out! Remember: you usually can't expect more than 10 full seconds of extinguishing power on a typical unit and this could be significantly less if the extinguisher was not properly maintained or partially discharged.
  - The metal parts of CO<sub>2</sub> extinguishers tend to get dangerously cold -- practice using one beforehand or have someone show you the proper way to hold one.
  - Again, proper training is usually required by state or federal [OSHA](http://www.osha-slc.gov)!
5. Direct the extinguisher at the base of the flames until the fire is completely out.
6. Recharge any discharged extinguisher **immediately** after use. If you discharge an extinguisher (even just a tiny bit) or pull the pin for any reason, call your campus or corporate Fire Marshal's office to arrange a replacement.



## Care and Maintenance of Your Extinguisher

At least once a month (more often in severe environments) you should inspect your extinguisher. Ensure that:

- a. The extinguisher is not blocked by equipment, coats or other objects that could interfere with access in an emergency.
- b. The pressure is at the recommended level. On extinguishers equipped with a gauge (such as that shown on the right) that means the needle should be in the green zone - not too high and not too low.
- c. The nozzle or other parts are not obstructed.
- d. The pin and tamper seal (if it has one) are intact.
- e. There are no dents, leaks, rust, chemical deposits and other signs of abuse/wear. Wipe off any corrosive chemicals, oil, gunk etc. that may have landed on the extinguisher.
- f. Some manufacturers recommend shaking your dry chemical extinguishers once a month to prevent the powder from settling/packing. We are dubious this has any value (see this [Ansul technical bulletin](#) for a detailed discussion), but you are going to pick it up to inspect it anyway, so why not give it a good shake?
- g. Fire extinguishers should be pressure tested (a process called hydrostatic testing) after a number of years to ensure that the cylinder is safe to use. Consult your owner's manual, extinguisher label or the manufacturer to see when yours may need such testing.



If the extinguisher is damaged or needs recharging, get it replaced **immediately!**

One more time: Recharge all extinguishers **immediately** after use regardless of how much they were used.



## Additional Resources

- The Fairfax County (Virginia) Fire & Rescue Department has developed a PowerPoint presentation titled "Fire Safety Awareness and Fire Extinguisher Training". This classroom component of a fire safety/extinguisher training program is provided **free of charge** for public use. The following items are available for download:
  - [fire\\_safety.pdf](#) - the full awareness and extinguisher training (768 K, PDF).
  - [fire\\_extinguisher.ppt](#) - the fire extinguisher training component only (1.23 Mb, PowerPoint).
  - [extinguisher\\_truck.ppt](#) - Extinguisher training for waste trucks (1.26 Mb, PowerPoint).
  - [checklist.doc](#) - Handy sheet for posting next to extinguishers (49 kB, MS Word).
  - [safety\\_exam.doc](#) - Short handout quiz to follow training (49 kB, MS Word).
  - [sign\\_in.doc](#) - A training sign-in sheet for your record keeping convenience (22 kB, MS Word).

Federal, state or local government or other emergency management organizations who would like a PowerPoint version of the full training program so they can include their agency or local-specific material for noncommercial, educational or public safety use should contact Ed Harris through the [Virginia RACES Training Page](#)

If you can't find the file on your computer after downloading, use the Find feature of your computer operating system to search for the file name(s) listed above.

- The following books at Amazon.com may also be useful:
  - [NFPA 10 Standard for Portable Fire Extinguishers : 2002 Edition](#)  
National Fire Protection Association/ Paperback / Published 2002 / Approximate Price: \$29.75
  - [NFPA 12: Standard on Carbon Dioxide Extinguishing Systems : 2000 Edition](#)  
National Fire Protection Association/ Paperback / Published 2000 / Approximate Price: \$27.75
  - [Design of Special Hazard & Fire Alarm Systems](#)  
Robert M. Gagnon / Hardcover / Published 1997 / Approximate Price: \$80.95
  - [Fire Suppression and Detection Systems: Facsimile \(MacMillan's Fire Science Series\)](#)  
John L. Bryan / Hardcover / Published 1993 / Approximate Price: \$81.00
  - [Design of Water-Based Fire Protection Systems](#)  
Robert M. Gagnon / Hardcover / Published 1996 / Approximate Price: \$84.95
- The [National Fire Protection Association \(NFPA\)](#) issues a number of life and fire-safety standards. You can view (but not copy, paste, print, or save) copies of these from [the NFPA web site](#).
- [10 Questions about NFPA 10](#), What you might want to know about maintaining and using portable fire extinguishers at NFPA's site.
- [OSHA](#) has many standards covering fire safety. These include the following:

- [29 CFR 1910.106](#) - Flammable and combustible liquids.
  - [29 CFR 1910.156](#) - Fire brigades.
  - [29 CFR 1910.157](#) - Portable Fire Extinguishers.
  - [29 CFR 1910.158](#) - Stand pipe and hose systems.
  - [29 CFR 1910.159](#) - Automatic sprinkler systems.
  - [29 CFR 1910.160](#) - Fixed extinguishing systems, general.
  - [29 CFR 1910.161](#) - Fixed extinguishing systems, dry chemical.
  - [29 CFR 1910.162](#) - Fixed extinguishing systems, gaseous agent.
  - [29 CFR 1910.163](#) - Fixed extinguishing systems, water spray and foam.
  - [29 CFR 1910.164](#) - Fire detection systems.
  - [29 CFR 1910.165](#) - Employee alarm systems.
- Want to see just how serious a laboratory fire can get? Look here:
    - [University of Georgia, 2003](#) - Damage of \$1-2 million started with a simple chemical spill. (Try [BugMeNot](#) for a password)
    - [University of California at Irvine, 2001](#) - Fire injures 3 and destroys a laboratory.
    - [Texas Tech University, 2001](#) - Includes a similarly impressive picture.
    - [University of Kentucky, 1997](#) - Includes impressive photographs and lots of additional safety tips.
    - [University of Texas at Austin, 1996](#) Bad lab practices lead to a six-alarm lab fire, over \$300,000 in direct damages, and \$24 million+ in renovations.
  - Our retail store, [Safety Emporium](#) carries a wide range of [extinguishers](#), [signs](#), [labels](#), [cabinets](#), [covers](#) and more.



## Questions?

**Disclaimer:** This page contains **guidelines** for the use of fire extinguishers and is not meant to be a comprehensive reference. There are many circumstances that these guidelines can not foresee and you should recognize the inherent danger in relying solely on this information!

If you would like to take a course on the proper use of fire extinguishers (including some hands-on training) your campus or corporate Fire Marshal's office may be able to assist you. If not, try your local fire department's non-emergency phone number for more information.

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