Department of Chemical and Biological Engineering
University of Colorado – Boulder

Safety Training for:

Transport and Handling of

Compressed Gas Cylinders

and

Liquid Nitrogen Dewars

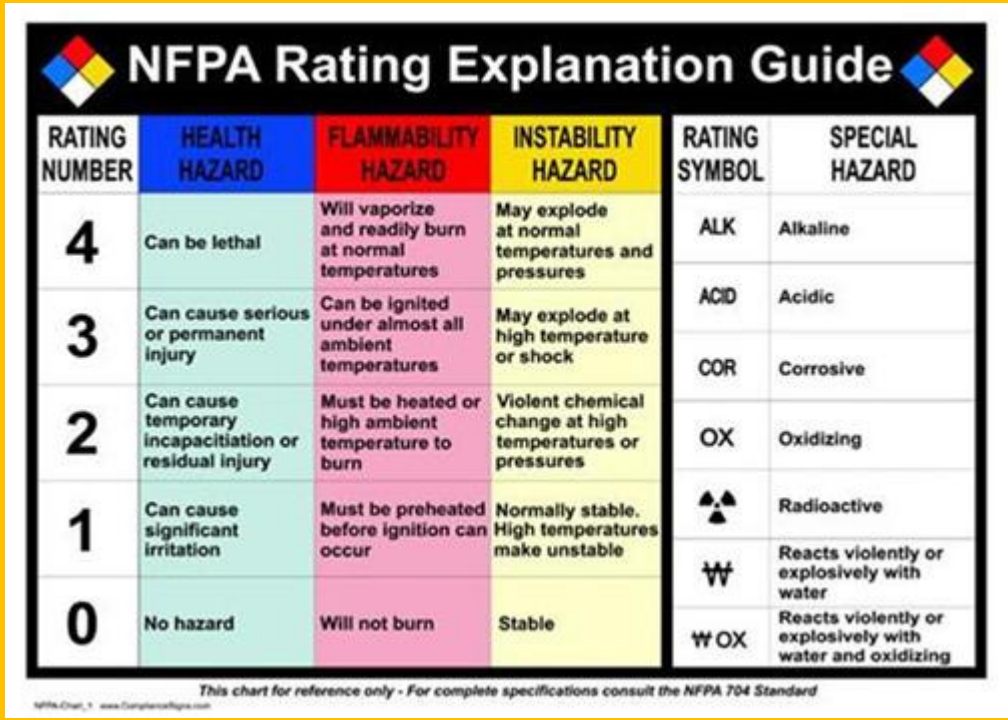
Why do you need compressed gas and dewar safety training?

- Protect yourself
- Protect your colleagues
- Protect your research

Types of gases with respect to colors
(e.g., placards and numerical significance)

- Green (label on cylinder) = Inert. Won't catch fire but can still be harmful so be aware
- Red = flammable (combustible)
- Yellow = oxidizer (feeds fire)…mix oxidizer and flammable – spontaneous combustion
- Numbers on placards – 0 implies no danger present, 4 implies extreme hazard

National Fire Protection Association Placard Key



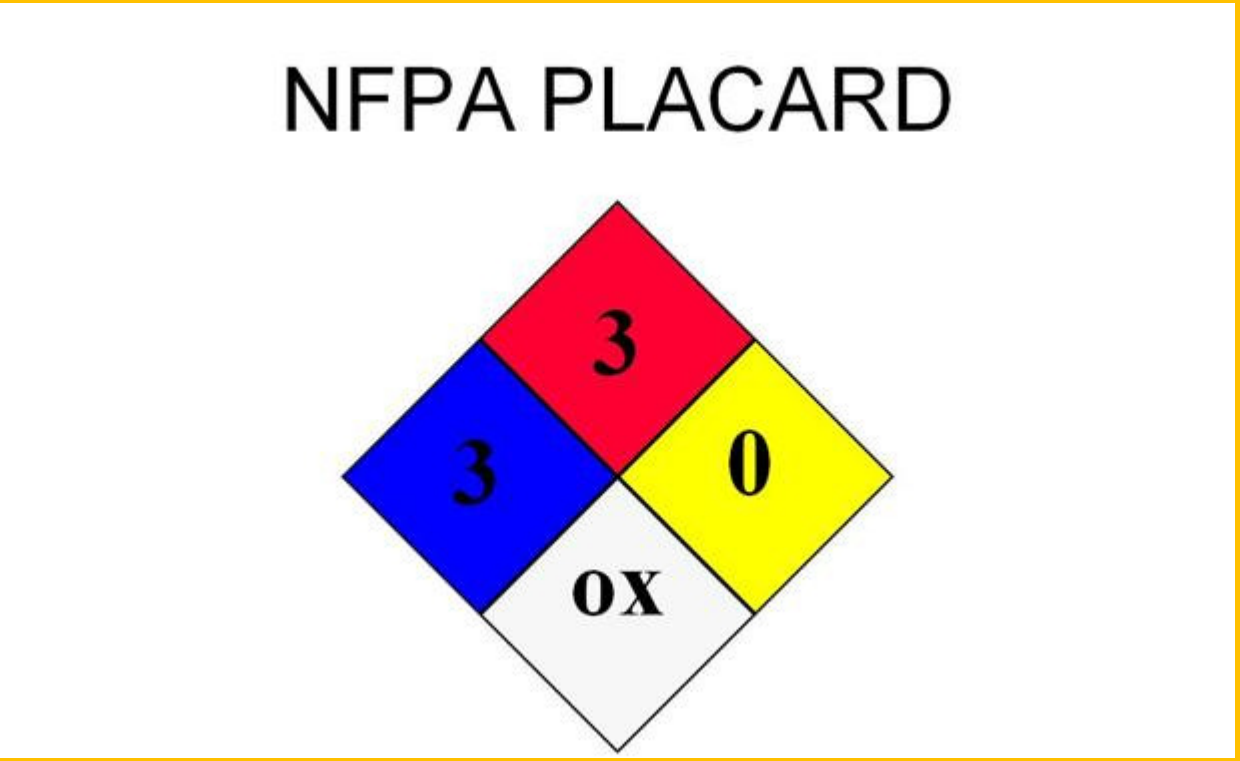
NFPA Rating Explanation Guide

RATING NUMBER	HEALTH HAZARD	FLAMMABILITY HAZARD	INSTABILITY HAZARD
4	Can be lethal	Will vaporize and readily burn at normal temperatures	May explode at normal temperatures and pressures
3	Can cause serious or permanent injury	Can be ignited under almost all ambient temperatures	May explode at high temperature or shock
2	Can cause temporary incapacitiation or residual injury	Must be heated or high ambient temperature to burn	Violent chemical change at high temperatures or pressures
1	Can cause significant irritation	Must be preheated before ignition can occur	Normally stable. High temperatures make unstable
0	No hazard	Will not burn	Stable

RATING SYMBOL	SPECIAL HAZARD
ALK	Alkaline
ACID	Acidic
COR	Corrosive
OX	Oxidizing
	Radioactive
W	Reacts violently or explosively with water
W OX	Reacts violently or explosively with water and oxidizing

This chart for reference only - For complete specifications consult the NFPA 704 Standard

NFPA Example



Inert Gases and Asphyxiation

- THERE IS NO SUCH THING AS A SAFE GGAS LEAK!
- When breathable air is displaced in a room with inert gas:
  - Within TWO minutes a human will lose consciousness.
  - Within FIVE minutes brain death is imminent
- If a cylinder leaks and can not be turned off – evacuate the Lab immediately

Gas Leaks

- Life Safety First
- Evacuate Area Immediately
- Pull Fire Alarm
- Call 911 from a safe location
- Remain available for emergency personnel

General Information

- Compressed gas cylinders are periodically inspected for safety using x-ray analysis of the cylinder integrity
- Cylinders are typically pressurized to 2000-3000 psi
- Brass valves on top of cylinders – the cylinder Achilles heel
  - Brass is a soft metal and the Brass valve can be broken off very easily leading to a disaster
- Cylinder safety caps protect the brass valve
- Brass valve is corrosion and spark resistant
- Do not use screw drivers, wrenches or any other type of pry bars to get the screw cap off
- If screw cap is not easily removed - see the Lab Coordinator

Storage location for compressed gases

- Gas storage rooms in Chemical Engineering Department at UC Boulder are accessed through the ECSL hallway in the basement
- You must have **documented evidence** of compressed gas cylinder safety training to gain access to these rooms
- ECSL hallway is located at the east side of the basement floor of ECCH
- Room 1B27 - Inert and flammable gases
- Room 1B33 – oxidizing gases
- Flammable liquid storage is contained in the flammable cabinet in 1B27
- Flammable compressed gases (Hydrogen, Methane, etc.) in any lab must be in an enclosed ***vented*** cabinet with sprinkler capability

When entering gas cylinder rooms…think…

- Safety first
- Do not move cylinders without safety caps
- Do not remove cylinders that do not have your name on them
- Safety caps securely fastened to the cylinder top are required when ever moving a cylinder (whether 2 inches or 200 feet)
- Wearing safety glasses

Compressed Gas Regulators

- Regulators are specified for the specific compressed gas cylinders
- DO NOT try to use a regulator for oxidizing gases on any other type of gas
- Oxidizing regulators have left handed threads, all other regulators have right handed threads
- Regulators are 2-stage or single-stage
- 2-stage regulators allow a consistent and regulated output of the compressed gas
- 2-stage regulators have a high pressure and low pressure side
- High pressure side is what is attached to the cylinder, low pressure side is what is delivered

Compressed Gas Regulators

- Safety glasses are on at all times
- Inspect the regulator for defects
- Hand tighten the regulator attachment then use a wrench for final tightening
- Make sure low pressure side regulator is off then open high pressure side
- Turn on low pressure side to deliver needed pressure

What happens when compressed gas safety is not a concern?

- These are good examples of what happens when a compressed gas cylinder valve is sheared off and why it is important to handle one with caution.

- Mythbusters...http://www.youtube.com/watch?v=ejEJGNLTo84&feature=related
- Live TV: http://www.youtube.com/watch?v=k0ZiI_VGGBE
- More cylinder danger: http://www.colorado.edu/che/downloads/lunchbreakrocket.wmv

In-house safety concerns…

- Someone came into the instrument shop since they were unable to open a gas cylinder valve manually.
- Prior to asking for help, the person had removed the hand-wheel on top of the tank and **tried to force the valve with a pipe-wrench**.
- This was a full Hydrogen tank with 2000 PSI pressure.
- **NEVER, EVER, FORCE A VALVE.**
- Anyone handling gas cylinders shouldn't even have to be told this, they should know this before they are even allowed to touch a cylinder.
- If a valve does not open with the hand-wheel on top of the tank, it is DEFECTIVE and needs to go back to the distributor.
- This might cost you a couple of days delay to your research but it's better than what could have happened.

General Overview for compressed gas transport

- Picking up a compressed gas cylinder: remove chain from storage location, place cylinder on transport cart, secure with chain, replace chain on storage location for the other cylinders.

- Last corral – empty cylinder location (both flammable/inert and oxidizer rooms have empty cylinder locations clearly labeled)

- Cylinder transport and movement…

- Caps MUST be on cylinder during any transport
- Use carts for transport to and from labs
- Once in lab, secure cylinder to wall (or lab bench) with mounting bracket and strap or chain

Cylinders are secured with safety chains

- Remove safety chain to get your cylinder.
- Make sure the cylinder has your name on it.

What is wrong with this picture?

NO SAFETY CAP ON CYLINDER !

Roll cylinder away from storage location

Tilt slightly forward as you slide cart under base

Secure cylinder to cart with chain

Cylinder is ready to be moved to lab

It is heavy (200+ lbs) so if you can’t move it yourself, ask a colleague for help

Cylinders secured in lab the WRONG WAY

Each Cylinder should be secured separately and individually with it's own safety chain

Why?

Removing the safety chain to scoot out a cylinder in this image could easily knock over the cylinder next to it

All 3 cylinders in this picture are vulnerable because they have safety caps removed and regulators attached

If one is knocked over the Brass valve will be sheared OFF

Cylinders secured in lab…

General Overview of Liquid Nitrogen Dewar Transport

- Dewars weigh between 500 lbs – 800 lbs
- No one can handle that weight.
- You must use the special dewar transport cart for moving
- There are 4 different positions to index the dewar hook-latch on the top of the cart and only one of these is correct for any given dewar
- Dewars are different depending on what kind of liquid/gas they are holding, age of dewar and manufacturer of the dewar

General Overview of Liquid Nitrogen Dewar Transport

- The dewar transport cart has a slotted base that fits onto the dewar base
- The cart must be secured onto the dewar before movement
- If you use whatever position on the hook-latch just happens to be facing forward, there is a very good chance you will use the wrong one and likely loose control of a 5 foot tall 500 pound tank
- The hook-latch has to fully engage the top of the tank AND the bottom of the cart has to be completely against the tank before any attempt is made to tilt the cart back
- If both of these aren't occurring then something is WRONG and you need to get someone to help you

How does a 500 pound Nitrogen dewar tip over and crash to the ground ?

- A new person was sent out to get the dewar without proper training – including, supervised, hands-on examples with experienced lab personnel/colleagues
- We were lucky that no one got hurt
- If it falls on you, or ruptures and dumps liquid nitrogen on you, you will be seriously injured or killed
- Do not send out “the new guy” to fumble with something they don't understand
- Please take the time to show all the new people proper and safe handling of not only LN2 dewars but also the high-pressure cylinders

Liquid Nitrogen dewars are not all alike…
Make sure you name is on the tagged dewar.

Select appropriate latch height by initially placing dewar cart flush with dewar. Appropriate latch should be 1-2 inches higher than latch hole.

DON’T FORCE LATCH!

Create a gap at base of dewar and dewar cart

Like this…

Now slide dewar cart base forward so dewar cart is flush with dewar and latch fastens securely into latch hole of dewar

Cart base is now flush with dewar, latch is secure in latch hole
…ready to transport

Use foot lever at base next to small wheels to move dewar onto large wheel base…

Pull towards yourself…

Continue to pull down until dewar is supported on a four wheels

Dewar is ready to transport

Unloading is opposite of loading

Ordering LN2 and Compressed Gases

- Send lab coordinator or person ordering an email with material request, speedtype and faculty group
- Do not expect a response unless there has been an egregious time lapse after your order
- Compressed gases are delivered on Tuesdays and Thursdays, most gases arrive within one – four days after order request
- Specialty gases can take several weeks
- LN2 dewars are typically delivered within 1-2 days after request for order
- Plan ahead…an emergency need is not the fault of the ordering system or people delivering material requests

Final comments…

- No matter the size of the lab, large or small, keep an eye out for everyone
- Safety glasses on?
- Are tanks secure?
- Are regulators off if tanks are not in use?
- Are caps on for transport?
- Show new people how to transport
- Safety FIRST

Gas cylinder and liquid nitrogen dewar safety exam

- Link to exam
- Link to answers
- Print out a copy of you exam…sign, date and submit to Lab Coordinator
- Keep a copy for your records
- Request ECSL access