

The Cardinal Rule of Explosive Safety

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American Ordnance

We do what we say.®

The Cardinal Rule of Explosive Safety

“Expose the minimum number of people to the minimum amount of explosive for the minimum amount of time.”

- The primary concern is to prevent accidental detonations.
- When preventive efforts fail, this rule minimizes the negative impact.
- “Be Prepared”

Texas Tech (Jan. 2010)



<http://www.csb.gov/csb-to-investigate-laboratory-explosion-at-texas-tech-university-chemistry-department/>

- Nickel Hydrazine Perchlorate
- Dept. of Homeland Security
- A 100 milligram batch limit was verbally established.
- Scaled up a single batch of approximately 10 grams
- Loss of three fingers, perforation of his eye, and cuts and burns to other parts of his body.
- **Tuesday, Sept. 10th (9:00-4:30)**
Indiana Convention Center, Rm 141
Identifying and Evaluating Hazards in
Research Laboratories
Hazard Assessment

University of Florida (Jan. 2012)



- Sodium Azide
- Injured a graduate student and firefighter
- The graduate student suffered chemical burns on his face and lips, skin torn from his fingertips, and glass embedded in his chest and abdomen. It was prevented from being worse by safety glasses.
- In October, an explosion with injuries happened at the same lab involving the same chemical.
- UF had another laboratory explosion in May 2011 that resulted in a student being injured. The student was mixing water, hydrochloric acid and titanium tetra-chloride.

<http://www.gainesville.com/article/20120112/ARTICLES/120119832?p=1&tc=pg>

<http://www.gatorsports.com/article/20120118/articles/120119491>

http://www.alligator.org/news/local/article_570d47f8-3caf-11e1-923f-0019bb2963f4.html?mode=jqm_gal

Application to “Non-Explosives”

- Following the cardinal principle of explosive safety should be applied to any situation that involve hazardous materials.

Application to “Non-Explosives”



<http://www.ehs.wisc.edu/chem-issue1Volume2-laboratoryexplosion.htm>

- Organic Reactions
 - Lithium Aluminum Hydride
 - University of Wisconsin-Madison, April 2012

Application to “Non-Explosives”

- Anaerobic Cabinet (Hydrogen Atmosphere)
- University of Missouri, June 2010



Lessons from the Experts

- The US Military and its contractors work safely with energetic materials on both an industrial scale and on a laboratory scale.
- We are highly regulated, keenly aware of the hazards and always utilize top-down verified policies and procedures.



The Cardinal Rule of Explosive Safety

- Use administrative and engineering tools to reduce
 - the number of people exposed,
 - the time of exposure, and
 - the quantity of material subject to a single incident.
- Perform a Chemical Hazard Analysis
 - Establish explosive limits
 - Establish personnel limits
- Strictly enforce Standard Laboratory Procedures

The Cardinal Rule of Explosive Safety

“Expose the minimum number of people ...”

“Expose the minimum number of people
...”

- Take into account the numbers of people at risk
 - Operators
 - Bystanders and observers

“Expose the minimum number of people
...”

- Individual Risk – operators should be aware and accept risk
- Group Risk – bystanders, casual observers.
 - May be unaware of hazard
 - May assume safe practices by operators
 - Operators are responsible to protect the group

“Expose the minimum number of people ” ...

- Determination of personnel limits for each work area/
task
 - Personnel limits shall include
 - a maximum number of operators and
 - a maximum number of transients including supervisors, workers,
and visitors.
 - Hazard analysis shall determine the need for
 - Maximum amount of explosives permitted and the need for
shielding.

“Expose the minimum number of people ”

...

Bldg
J-124

Room No.
West Bay

MAXIMUM PERSONNEL

Operators	6
Casuals	5

MAXIMUM QUANTITY OF EXPLOSIVES

5 LBS

“Expose the minimum number of people
”
...

- Maintenance Workers
 - Decontaminate work areas and equipment before maintenance or repair technicians begin work.
 - When complete removal of explosives is not possible, identify areas and parts of the equipment that could not be cleaned.
 - provide maintenance personnel with specific instructions for safe handling.

From the DCHAS-L Discussion List

From: DCHAS-L Discussion List [<mailto:dchas-l@med.cornell.edu>] On Behalf Of Ralph B. Stuart
Sent: Tuesday, August 27, 2013 8:06 AM
To: DCHAS-L@med.cornell.edu
Subject: [DCHAS-L] Lab Plumbing question

A friend writes:

"We received a call from a Healthcare setting whose plumber was removing a cast iron waste line trap from their chemistry lab and it "exploded". No flash, but a boom and the line broke apart. Evidently reagents from tests had been poured down that line and it was dry at the time.

"He is sending me the MSDS' but he has identified Sodium Azide as potential culprit.

“Expose the minimum number of people ”

...

- Housekeepers

- Keep structures clean and orderly.
- Do not perform general cleaning concurrently with hazardous operations.
- Use cleaning methods that do not create ignition hazards, flammable compounds shall not be used.
- Do not use incompatible cleaning agents. Alkalis can form sensitive explosive compounds with nitrated organic explosives.
- Use fiber rather than synthetic brooms to reduce generation of static charge.

“Expose the minimum number of people
”

...



<http://www.fashionisspinach.com/images/salvor2.jpg>



<http://www.capcityequipment.com/gshovels1216.html>

“Expose the minimum number of people”

...

- Sanitation Workers
 - Proper disposal or destruction is mandatory.
 - Explosives safety should not be compromised while meeting environmental considerations.



<http://wnws.point5digital.com:8080/p5d/images/articles/3/article0000026491/wastemgmttruckexplosion.jpg>

“Expose the minimum number of people”

...

- The Public
 - Site Selection Considerations
 - Locate labs processing energetic materials thoughtfully
 - They should be located a safe distance from
 - administrative areas
 - break areas
 - common use areas
 - combustible structures
 - Utilities providing vital services

“Expose the minimum number of people ...”

- The Public
 - Site Selection Considerations
 - Traffic Routes
 - Regardless if use is regular or occasional
 - Construction Factors
 - The use of conventional glass in areas with a potential blast overpressure hazard creates a serious secondary fragmentation hazard.

“Expose the minimum number of people
”
...

- FIRE PLAN

- OSHA and NFPA guidelines for normal fire protection apply.
- Local fire fighters should be notified that explosive hazard firefighting guidelines should be followed
- Installed fire extinguishing systems protect energetics from unrelated fires!
- Inform the firefighters of the additional hazards present with these compounds when they respond.



“Expose the minimum number of people ”

...

- HAZARD CLASSIFICATION
 - HD 1.1 - Mass-explosion
 - HD 1.2 - Non-mass explosion, fragment producing
 - HD 1.3 - Mass fire, minor blast overpressure or fragment.
 - HD 1.4 - Moderate fire, no significant blast or fragment.
 - HD 1.5 - Very insensitive explosive substance (with mass explosion hazard).
 - HD 1.6 - Explosive article, extremely insensitive.
 - If the hazard is unknown, treat it as HD 1.1.

The Cardinal Rule of Explosive Safety

“...to the minimum amount of explosive ...”

“...to the minimum amount of explosive ...”

- Retain the minimum amount of energetic material necessary for an operation
- If additional energetic material is in the lab, keep it separated from process areas by “safe distances” in explosion proof magazines.
- Long term storage of these materials should be separated by as great a distance as is practical.
 - Separate Rooms (no flammable liquids)
 - Separate, secure, isolated buildings

“...to the minimum amount of explosive ...”

OSHA 1910.109 Explosive Distance Requirements

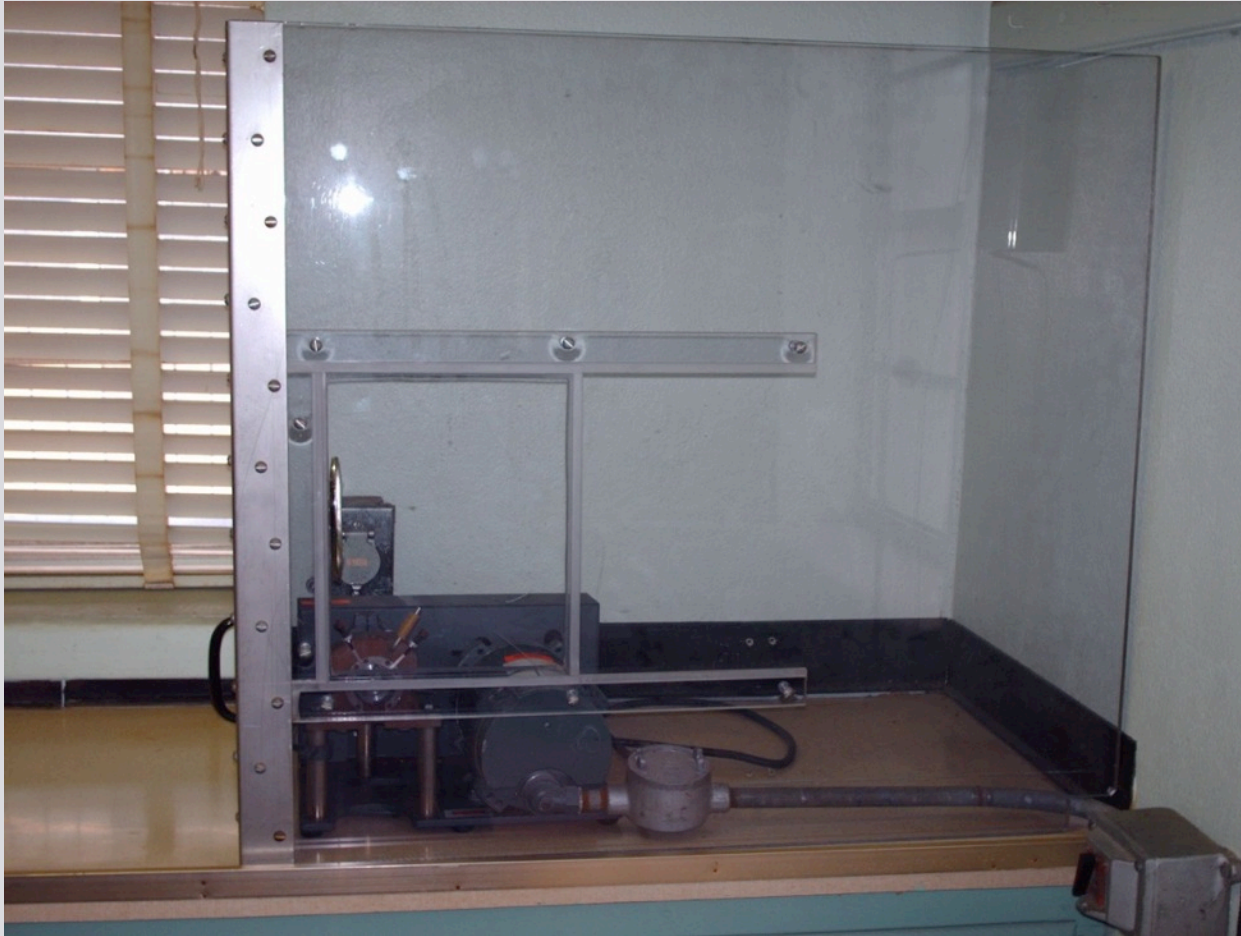


“...to the minimum amount of explosive ...”

OPERATIONAL SHIELDS

- This is not a splash hazard, the shields may need to be ‘bullet proof’ or stronger.
- Shields should offer protection from thermal effects.
- Hazards of combustion products on exposed personnel should also be considered.

“...to the minimum amount of explosive ...”



The Cardinal Rule of Explosive Safety

“...for the minimum amount of time.”

“...for the minimum amount of time.”

- When there is an unacceptable probability of explosion or deflagration, conduct operations remotely.
- If the hazards can be controlled by using operational shields, design, install, and use shields that effectively protect personnel from the hazards.
- Shields complying with MIL-STD-398 are acceptable protection.

“...for the minimum amount of time.”

- When the doors of explosive processing equipment function as operational shields, interlocking devices shall prevent the operator from opening the door while the equipment is in operation or operating the equipment when the door is open.

Chemical Hazard Analysis

- All explosives operations require a hazard assessment prior to work performance to determine the type of hazard involved, the level of risk associated with the material, and the corresponding level of protection required.
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Chemical Hazard Analysis

- Ensure the risks have been reduced to a level as low as reasonably practicable (ALARP).
- Determine if this is within the Tolerability of Risk (TOR)
- If not, the project should not move forward.

Standard Laboratory Procedures

- Clearly written procedures are essential to avoid operator errors and ensure process control.
- Before starting operations qualified personnel shall develop, review, and approve written procedures.

Standard Laboratory Procedures

- Should be user friendly, readable, specific where needed, but allowing flexibility when safety is not compromised.
- Err on the side of caution
- Comply with Federal, State, and local laws and regulations.
- Review and update SOPs as often as necessary.

Lessons from the Experts

“Kilgore is the world's foremost supplier of airborne expendable IR decoy flares, and serves as the sole-source IR decoy flare supplier for some of the worlds most sophisticated and advanced airborne platforms. Kilgore's automated facilities produce pressed, extruded, and cast IR flares at a rate that far out performs any other manufacturer. This automated capability, combined with Kilgore's strict compliance to ISO9001:2008 requirements, lean / six sigma techniques, and the highest levels of personnel/equipment safety, assures the customer of unprecedented quality and on-time delivery.”

<http://www.kilgoreflares.com/>
8/20/2013

Kilgore Flares

Seven people have died in fires at the Kilgore plant in the last 25 years, according to the Tennessee Occupational Safety and Health Administration (TOSHA)

- **New Details About Plant Fire: What Went Wrong?**, localmemphis.com, Nexstar Broadcasting, Inc.
3/31/2011 10:38 pm, <http://www.localmemphis.com/news/local/story/New-Details-About-Plant-Fire-What-Went-Wrong/kbb8soLKHUip-hYPtNjsbA.csp>

Kilgore Flares September 14, 2011

"I felt safe."

"Honestly, my supervisor, he was on top of safety,"

"Catrina spent five weeks in the hospital,
2 others spent months"

"the people that work there are a special breed of people,"

"People who work near the plant say they believe the owners mean well"

"So, overall, I think it's a good place to work."

• "Kilgore Flares Summary Released", Daniel Wilkerson, wbbjtv.com, Mar 30, 2011 at 9:11 PM CDT, <http://www.wbbjtv.com/news/local/Kilgore-Flares-Summary-Released-118959324.html>

Kilgore Flares September 14, 2011

"All I remember is an explosion..."

"it knocked me down..."

"all I could see is fire..."

"everything went black and fire was all around me"

"you know I lost my leg..."

"It's changed my life dramatically..."

"They showed me the do's and don'ts, but as far as training.... I didn't get no training,"

"...everyone needs a job... but they need to work in a safe environment,"

• "Kilgore Flares Summary Released", Daniel Wilkerson, wbbjtv.com, Mar 30, 2011 at 9:11 PM CDT, <http://www.wbbjtv.com/news/local/Kilgore-Flares-Summary-Released-118959324.html>

Kilgore Flares

- A TOSHA investigation revealed serious flaws in safety protocol at the plant. There were 26 findings.
 - The report cites a warning days before the September 14th fire. It says on September 10th, TOSHA received a formal complaint about **workstations overloaded with hazardous materials.**
 - Kilgore had not determined through testing if the personal protective equipment worn by employees would protect them from the potential fire/explosion.
 - Failed to implement written procedures for certain processes or for handling certain chemicals.
 - Did not keep records of which or when employees received training nor was it documented whether each worker understood what he or she was taught.
 - **Exit signs** in the building where the explosion and fire happened were neither properly illuminated nor positioned correctly.
- According to the state report, the fire was started by an electrostatic discharge, but investigators couldn't pinpoint the exact source.

• New Details About Plant Fire: What Went Wrong?, localmemphis.com, Nexstar Broadcasting, Inc.
3/31/2011 10:38 pm <http://www.localmemphis.com/news/local/story/New-Details-About-Plant-Fire-What-Went-Wrong/kbb8solKHUip-hYPtNjsbA.csp>

Lessons from the Experts

- Work shall not be conducted in the vicinity of actual or potential electromagnetic or electrostatic fields.
- Sources of static electricity and electromagnetic energy include radio transmission i.e. Cell Phones

References

- DoD 4145.26-M, “DOD Contractor’s Safety Manual For Ammunition and Explosives”, March 13, 2008, <http://www.dtic.mil/whs/directives/corres/pdf/414526mp.pdf>
- Contract Safety Requirements Guidebook, Defense Contract Management Agency, November 2009, <http://guidebook.dcmamc.mil/49/index.cfm>
- Parts 1904 and 1910 of title 29, Code of Federal Regulations (CFR)
- MIL-STD-882D, “Standard Practice for System Safety,” February 10, 2000
- Department of Defense Explosives Safety Board (DDESB) Technical Paper (TP) No. 15, “Approved Protective Construction (Version 2.0),” June 2004
- Military Standard MIL-STD-398, “Shields, Operational for Ammunition Operations, Criteria for Design of and Tests for Acceptance,” November 5, 1976
- NFPA 77, “Recommended Practice on Static Electricity,” current version

The Cardinal Rule of Explosive Safety

- Minimize amount of hazardous material
- Minimize the number of employees exposed
- Minimize employee exposure time
- Respect the power of these materials.
- If the work makes you nervous, find a new job.
- Do it for yourself as well as for your co-workers.