BERKELEY LAB

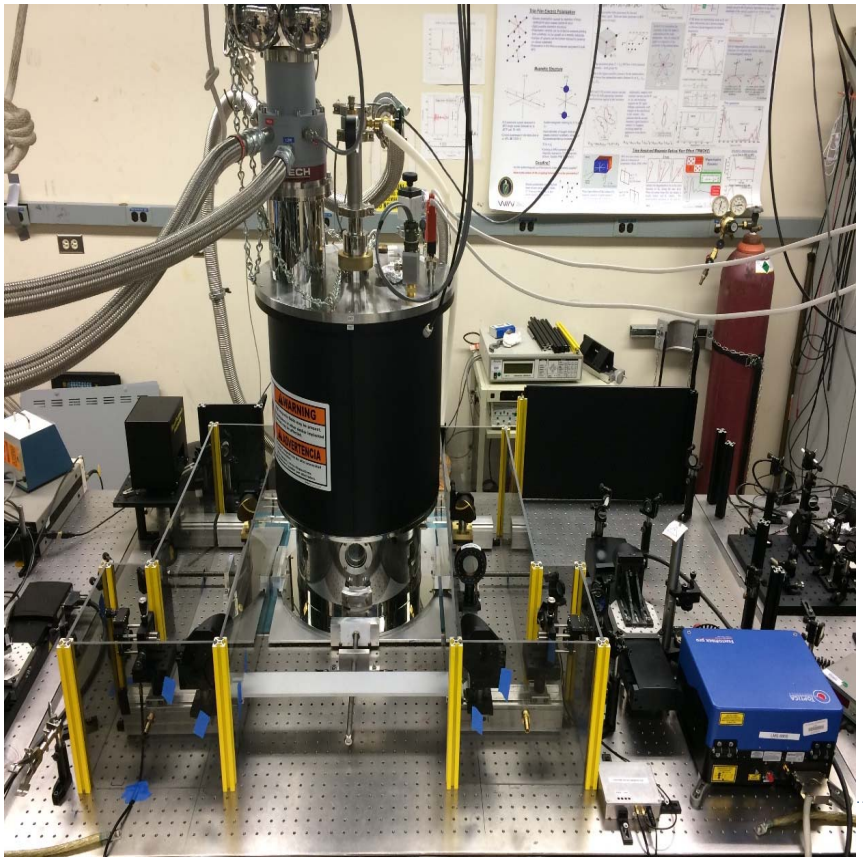
U.S. DEPARTMENT OF ENERGY

UNIVERSITY OF CALIFORNIA

Upcoming Facilities Shutdowns, or Issues

Close Call w/ Superconducting Magnet

Let Paul, Sherry or I know of any off-normal event that happens in your area.

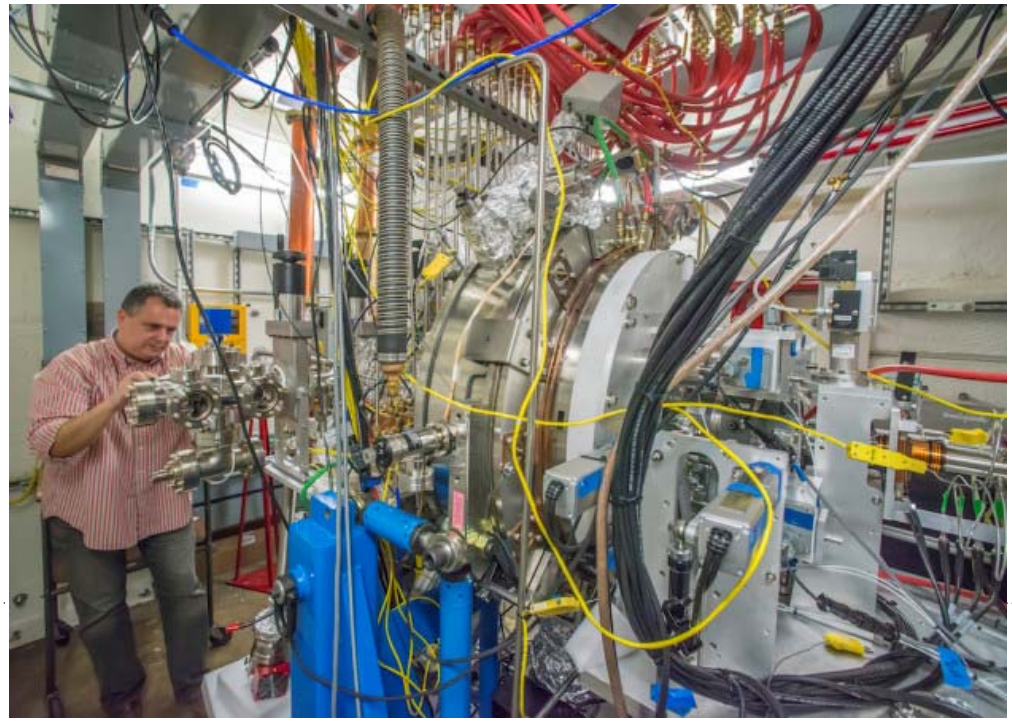


Requires an annual Designated Area Hot Work Permit

Email: hotwork@lbl.gov, or Amy Krigbaum
Area can be hood or lab
Keep flammables away 3 ft
New people can be added to permit

Cable Management

- Avoid kinking or placing where cord will bind
- Don’t overload power strips
- Keep walkways clear, use cable trays or cable bridge
- Replace damaged cords
- Avoid running power cords through doors, walls, etc.
- Insure that grounding system is in good shape.



No Abandoning Chemicals in other’s labs

Not just rude, It is a violation of federal law.

Voluntary use of respirator or N95 filter masks

New hazard in WPC

Will need to contact Julie Zuh in EHS for fit test and training

New gas and Pressure Chapters

Kurt

MSD Safety Meeting Minutes – July 13, 2017

Location: Building 66, Room 203 (CR)

Time: 1:00 to 2:30 PM

Host: Martin Neitzel (MSD/CSD Safety Manager)

Speaker: Kurt Ettinger (LBNL MSD EHS Liaison)

Kurt Ettinger: Topics discussed

- **Lesson Learned** - At the Potter Street lab, the researcher received/used a gas cylinder that was filled with the wrong gas (i.e., they ordered a high purity argon gas cylinder but received a gas cylinder filled with nitrogen that was incorrectly labeled argon). Using the wrong gas in the researcher's glovebox caused over $10,000 damage to the equipment, chemicals and samples. Luckily, no one was injured.
- **Changes were made to Pub 3000, Ch 13: Gases and Pressure** (please see PowerPoint Slides for more info):
    - **Improved Cylinder Disposal Guidance** – If you have "non-routine" empty gas cylinder (i.e., that can't be normally returned to their vendor), please fill out this electronic form. Twice a year, "non-routine" empty gas cylinder tracked on this smartsheet will be picked up for disposal.
    - Chapter 10 (i.e., sections 10.1, 10.2 & 10.3) was revised to comply with NFPA 45 requirements.
    - Please order only 1 backup gas cylinder per process.
        - Example #1: if you have one glovebox, you can hook one nitrogen gas cylinder to it and store one backup nitrogen gas cylinder in the laboratory.
        - Example #2: if you have 4 processes, each can have one gas cylinder hook to it and one backup (i.e., 4 gas cylinders in use and 4 backup gas cylinders) in the laboratory.
        - Any excess gas cylinders must be stored outside of the laboratory (e.g., outdoor gas cylinder storage area).
        - Please do not order excess gas cylinders (i.e., each fire zone has a flammable storage limit).
    - Added new tables: **Hardware Compatibility Tables**
    - Added more detailed language in the **Gas Detection System Guidance.**
    - Usage of compressed gases now authorized in the WPC.
    - **7 notable changes**:
        - #1 - Specifies size restrictions for single cylinders of flammable (and oxidizing) gases: (Fire Code).
        - #2 - Specifies when flashback arrestors are required
        - #3 - Provides guidance regarding liquefied gases and eductor tubes
            - Example: It's important not to mistaken gaseous CO2 vs. liquid CO2 cylinders. Please review the sticker on the side of the gas cylinder regarding educator tubes.
        - #4 - Specifies requirements for flammable-gas detection
        - #5 - Provides guidance regarding flammable gas mixture limits
        - #6 - Addresses flammable + oxidizing gas mixtures
        - #7: Includes information from training and SME "Memos" into new Appendices C & D
- **Changes made to Chapter 7: Pressure System Safety**
    - Section 7.3 and Appendix E were revised.
    - Added 4 new Appendices: (please see PowerPoint Slides for more info):
        - Appendix F. Routine Pressure System Assembly/Disassembly/Adjustment Safety Procedures (All New)
        - Appendix G. Sealed Reactor Vessels for Chemical Synthesis and High-Temperature/Pressure Processing (All New)
        - Appendix H: Chemical Synthesis in Ordinary Glassware (No Pressure Rating) (All New)

- Appendix I: Unrated Commercial Pressurized Systems (All New)

Martin Neitzel: Topics discussed

- **Close Call w/ Superconducting Magnet –** Please contact Martin, Paul or Sherry if you experience or heard about any unusual occurrence(s).
  - Example: A tool that was left near a superconducting magnet was accidentally pulled towards it when it was turned on and damaged the instrument.
- **Usage of Bunsen burners and butane torches requires a hot permit.**
  - LBNL Fire protection inspectors will work with you to issue hot permits on a yearly basis.
- **Cable Management** – Please keep your cables organized. Prevent tripping hazards.
- **No Abandoning Chemicals in other's labs –** There's NO cost to requisition your waste and unused chemicals for pickup/disposal. The reason you enter your Project ID/Activity Code into the Hazardous Waste Disposal database (aka Shoebox) is ONLY for tracking purposes. LBNL EHS pays for the cost of pickup/disposal.
- **Voluntary use of respirator or N95 filter masks –** Please contact Julie Zhu for more info. She can be reached at 510-486-6871 or LiZhu@lbl.gov

Pressure Safety Program
PUB3000 (EH&S Manual) Chapter 7

REVISED CHAPTER HIGHLIGHTS

March 2017

BACKGROUND AND OBJECTIVES

Prior State

- Evidence of “revision creep”
- Excessive or insufficient information across the chapter
- Didn’t reflect current understanding of risks and hazard management

Current State

- More tailored to Lab operations and needs
- Simplifies and/or clarifies several existing sections
- Differentiates research and “conventional” guidance
- Adds sections that address emerging issues

COLLABORATION WITH SCIENCE*

- Jonathon Ajo-Franklin – Energy Geosciences
- Elke Arenholz – Advanced Light Source
- Mike Carr – DOE/Berkeley Site Office
- John Christensen – Energy Geosciences (our SAC Representative)
- Mike Dong – Facilities
- Kurt Ettinger – EHS
- Tim Kneafsey – Earth & Environmental Sciences
- Martin Neitzel – Chemical Sciences
- Joe Saba – Engineering

*special thanks to Tracy Mattox (MSD) and Doug Taube (ALS)

HIGHLIGHTS

- Focuses on pressure safety (cryogen safety and gas safety now in separate chapters)
- Improves definition of technical terms
- Clarifies high-pressure/high-hazard triggers
- Updates of vacuum system guidance
- Partitions research pressure systems vs conventional pressure systems
- Provides a functional stored energy calculator
- Adds five new sections:
    - Assembly/disassembly/adjustment (LOTO)
    - Sealed reactor vessels
    - Chemical synthesis and high temp/pressure processing
    - Chemical synthesis in glassware
    - Unrated commercial pressure systems

NEXT STEPS

- Revise EHS0171 – Pressure Safety training
- Place more emphasis on recognizing stored energy in pressure systems (via WP&C)

CHAPTER 7 PRESSURE SYSTEM SAFETY

7.1 Policy
7.2 Scope and Applicability
7.3 Exceptions
7.4 Roles and Responsibilities
7.5 Definitions
7.6 Work Processes
Work Process A. Pressure Safety Process Flow Chart (New Chart)
Work Process B. General Requirements
Work Process C. Low-Hazard Pressure Systems
Work Process D. High-Hazard Pressure Systems
Work Process E. Vacuum Systems (updated)
Work Process F. Cryogenic Systems
Work Process G. Training Requirements
7.7 Source Requirements
7.8 Reference Documents
7.9 Appendices
Appendix A. Facility ("Conventional") Pressure Systems
Appendix B. Design Criteria for Responsible Designers
Appendix C. Safety Notes
Appendix D. Pressure System Testing and Inspection
Appendix E. Calculation of Stored Energy Within a Pressurized Gas Vessel
Appendix F. Routine Pressure System Assembly/Disassembly/Adjustment Safety Procedures (All New)
Appendix G. Sealed Reactor Vessels for Chemical Synthesis and High-Temperature/Pressure Processing (All New)
Appendix H: Chemical Synthesis in Ordinary Glassware (No Pressure Rating) (All New)
Appendix I: Unrated Commercial Pressurized Systems (All New)

EXCEPTIONS

SYSTEMS AND/OR ACTIVITIES EXEMPTED FROM A FORMAL PRESSURE SAFETY REVIEW INCLUDE:

- PRESSURE SYSTEMS THAT (1) OPERATE BELOW 150 PSIG, (2) DO NOT CONTAIN IRRITANT, TOXIC, INFECTIOUS, RADIOACTIVE, OR FLAMMABLE FLUIDS, AND (3) DO NOT CONTAIN STORED ENERGY EXCEEDING 75,000 FOOT POUNDS (FT-LB). VACUUM SYSTEMS ARE NOT INCLUDED IN THIS EXEMPTION.

- PRESSURE SYSTEMS CONTAINING IRRITANT, TOXIC, INFECTIOUS, RADIOACTIVE, OR FLAMMABLE MATERIALS THAT OPERATE BELOW 15 PSIG. SUCH SYSTEMS DO NOT REQUIRE A PRESSURE SAFETY REVIEW BUT REMAIN SUBJECT TO RELATED HAZARD REVIEW PROCESSES (I.E., GAS SAFETY, CHEMICAL HYGIENE AND SAFETY, FIRE SAFETY, ETC.)

- COMMERCIALLY AVAILABLE INSTRUMENTS AND EQUIPMENT THAT IS INSTALLED, OPERATED AND MAINTAINED ENTIRELY WITHIN THE MANUFACTURER'S EXPRESSLY STATED SPECIFICATIONS, AND WHICH ARE NOT COMBINED WITH COMPONENTS PROVIDED BY VENDORS NOT OTHERWISE RECOMMENDED BY THE MANUFACTURER OF THE PRIMARY PRESSURE SYSTEM COMPONENT(S)

- VACUUM SYSTEMS THAT ONLY VENT TO ATMOSPHERE

- CRYOGENIC SYSTEMS OR VESSELS OPEN TO THE ATMOSPHERE AT ALL TIMES

- FIRE PROTECTION SYSTEMS

- PNEUMATIC AND HYDRAULIC SYSTEMS THAT ARE AN INTEGRAL PART OF A VEHICLE.

APPENDIX E. CALCULATION OF STORED ENERGY WITHIN A PRESSURIZED GAS VESSEL

The following information is useful in calculating the stored energy of a pressure system.

When a gas is compressed, it stores energy. If the stored energy (U) is released in an uncontrolled manner, it may cause serious injury and/or damage. Stored energies in excess of 75,000 foot-pounds (~101 kilojoules (kJ)) are considered high hazard.

Variables:

Vh = the volume of the vessel.

Ph = the absolute pressure of the vessel.

Pl = the absolute pressure to which the vessel would drop if it burst. Generally this would be one atmosphere (14.696 psi or 101,325 N/m2).

γ = the adiabatic exponent or ratio of specific heats, Cp/Cv. The value is 1.666 for monatomic gases such as argon and helium; 1.4 for diatomic gases such as nitrogen, oxygen, hydrogen, and air; and variable for polyatomic gases such as methane, water, and carbon dioxide, but generally very nearly 1.3.

$$U = \frac{P_h V_h}{\gamma - 1}\left[1 - \left(\frac{P_l}{P_h}\right)^{\frac{\gamma-1}{\gamma}}\right]$$

N icketed value is dimensionless but that Ph Vh is not. Therefore, the length units used in Ph and Vh must match.

Example:

The gas is air (γ = 1.4)

Vh = 1.0 cubic meter

Ph = 1,100,000 N/m2

Pl = 101,352 N/m2

$$U = \frac{(11*10^5\ N/m^2)(1.0\ m^3)}{1.4-1}\left[1 - \left(\frac{1*10^5\ N/m^2}{11*10^5\ N/m^2}\right)^{\frac{1.4-1}{1.4}}\right] = 1.4*10^6\ N-m$$

One N-m is equivalent to one joule, so the stored energy is 1.4 megajoules (MJ). This is the equivalent of a little over one million foot-pounds. In this case, the pressure system would be classified as a High-Hazard Pressure System and require a formal work authorization.

Click on the Stored Energy Calculator to calculate stored energy in a system.

EXAMPLE:

- The gas is air (g = 1.4)
- Vh = 1.0 cubic meter
- Ph = 1,100,000 N/m2
- Pl = 101,352 N/m2

$$U = \frac{(11*10^5\ N/m^2)(1.0\ m^3)}{1.4-1}\left[1-\left(\frac{1*10^5\ N/m^2}{11*10^5\ N/m^2}\right)^{\frac{1.4-1}{1.4}}\right] = 1.4*10^6\ N-m$$

One N-m equals one joule, so the stored energy is 1.4 MJ.

<u>Enter experimental apparatus values to calculate the stored energy in a vessel:</u>

Enter γ	Enter Ph		Enter Vh		Enter Pl	
1.3	8,000,000	(N/m2)	5.00E-03	(m3)	101,325	(N/m2)

= Entered Value

= Returned Value

U =	**84,683**	N-m (joule)
U =	**0.1**	MJ
U =	**62,459**	Ft-lbs

<u>Review other hazards to determine the need for WPC activity review</u>

Gas Safety Program
Summary of Proposed Changes

Kurt Ettinger
10/7/2016

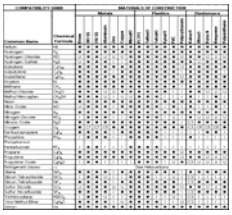
Improved Cylinder Disposal Guidance

Complies with NFPA 45[1] Requirements

Chapter 10 Compressed and Liquefied Gases 45–21
10.1 Compressed and Liquefied Gases in Cylinders 45–21
10.2 Storage and Piping Systems 45–22
10.3 Outdoor Installation of Compressed Gas Cylinders for Servicing Laboratory Work Areas (Located Outside of Laboratory Work Areas) 45–22
10.4 Cryogenic Fluids 45–22

[1] Standard on Fire Protection for Laboratories Using Chemicals – 2015 Edition

Inclusion of Hardware Compatibility Tables (via manufacturer links)



Improved Gas Detection System Guidance

- Defines options for alarm signal transmission
- Clarifies roles regarding inspections and audits of gas systems

Now Aligned with Work Planning and Control

"The use of compressed gases must be authorized using the LBNL Work Planning Control (WPC) Activity Manager database. (See Work Planning and Controls website for more information on documenting of research activities.) Ensure the work is properly authorized and that personnel working with compressed gases are also authorized on appropriate work activities before work begins."

Other Notable Changes #1

Specifies size restrictions for single cylinders of flammable (and oxidizing) gases: (Fire Code)

- Inside laboratory/building of 250 cf maximum (T cylinder is around 260 cf)

Other Notable Changes #2

Specifies when flashback arrestors are required

- Flashback arrestors are required when fuel and oxidizing gases are connected to a torch or other equipment where gases mix or have the potential for mixing. Check valves will not stop a flashback

Other Notable Changes #3

Provides guidance regarding liquefied gases and eductor tubes

Other Notable Changes #4

Specifies requirements for flammable-gas detection

- A hydrogen gas room per California Fire Code
- Vaults where compressed gases are generated, compressed, stored, or dispensed per California Fire Code
- Non-bulk hydrogen compressed gas systems above Maximum Allowable Quantity (MAQ) per NFPA 55 Chapter 10, Gas Hydrogen Systems
- Locations where ethylene oxide is dispensed per NFPA 55 Chapter 14
- Indoor locations where acetylene cylinders are charged per NFPA 55 Chapter 15
- Hydrogen equipment enclosures other than exhausted enclosures with gas volumes exceeding 1,000 scf per NFPA 2, Chapter 7
- High-Hazard Group H-2 Occupancies
- High-Hazard Group H-5 Occupancies (Semiconductor fabrication)

Other Notable Changes #5

Provides guidance regarding flammable gas mixture limits

- Maximum Concentration (%) of a Flammable Component in a Non-flammable Binary Mixture

Flammable Component	Nonflammable			
	N2	CO2	He	Ar/Kr/Ne/Xe
Hydrogen	5.7	8.3	3.9	2.9

Other Notable Changes #6

Addresses flammable + oxidizing gas mixtures

Operations that require a flammable and oxidizing gas mixture require review under the WPC process. If a fuel and oxidizer are to be mixed together, it is recommended to follow the precautions in CGA P-58, "Safe Preparation of Compressed Oxidant - Fuel Gas Mixtures in Cylinders."

Other Notable Changes #7

Includes information from training and SME "Memos" into new Appendices

- Appendix C. Gas System Component Information (From Training)

- Appendix D. Additional Information: Mixed Gases, Toxic Gases

Enclosures for toxic gases, calculation procedures for release analysis, fire code hazard classification of gas mixtures

Review Committee Members

Laurel Davis
Michelle Flynn
Todd LaBerge
Larry McLouth
Nick Palaio (Research Associate Reviewer)
Andrew Peterson
Scott Robinson
Doug Taube
Michael Torkelson
Arron Ward

Thank You!