

# SAFETY EDUCATION VIA LESSONS LEARNED



The image shows the cover of a U.S. Chemical Safety and Hazard Investigation Board (CSB) Case Study report. The top banner features the CSB logo and the text 'Case Study' over a background image of two workers in hard hats. Below this, the title 'Texas Tech University Laboratory Explosion' is displayed, followed by the identifier 'No. 2010-05-I-TX'. A photograph of a laboratory bench with various glassware and equipment is shown. A red box titled 'ISSUES' lists three key findings: 'Laboratory safety management for physical hazards', 'Hazard evaluation of experimental work in research laboratories', and 'Organizational accountability and oversight of safety'. The bottom right corner of the page contains the text 'CSB • Texas Tech University Case Study' and a small page number '1'.

**CSB** Case Study  
U.S. Chemical Safety and Hazard Investigation Board

**Texas Tech University**  
Laboratory Explosion  
No. 2010-05-I-TX

**ISSUES**

- Laboratory safety management for physical hazards
- Hazard evaluation of experimental work in research laboratories
- Organizational accountability and oversight of safety

CSB • Texas Tech University Case Study 1



# **USING CASE STUDIES TO SERVE AS THE FOUNDATION FOR LABORATORY SAFETY EDUCATION**

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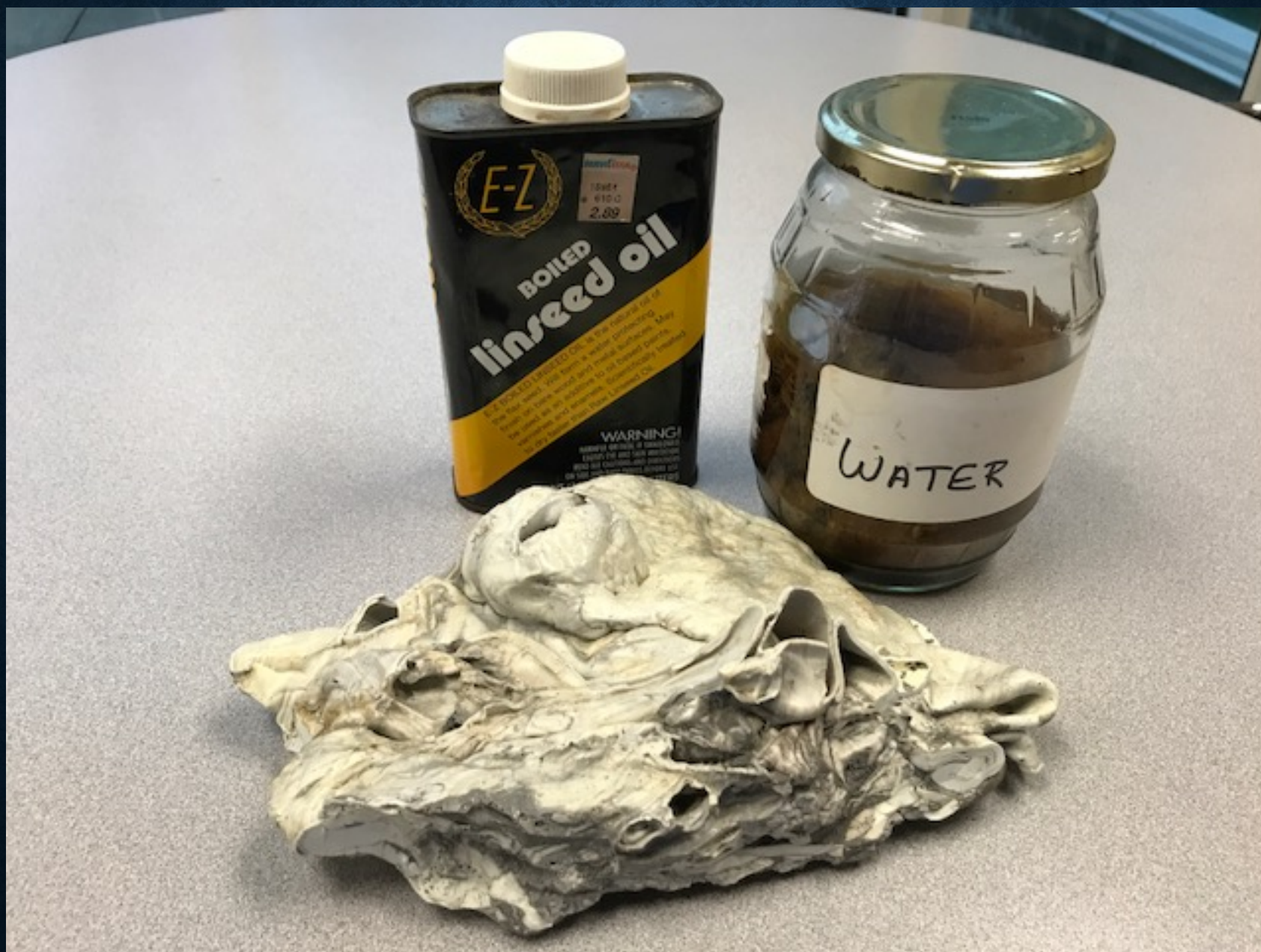
# HOW CLOSE DOES IT NEED TO BE ? (YOUR Lesson Learned ?)

- Yourself ?
- Your Lab Mate ?
- Lab Next Door ?
- Your Building ?
- Your University ?
- University Down the Road ?
- University Across the Country ?











**WHAT IS THE LESSON ?**







**WHAT IS THE LESSON ?**



# WHAT IS THE LESSON ?

- “I am a physician and a medical toxicologist and one of my particular interests is HF.
- Hardware store..... you can buy 6-13% HF as a cleaning agent for "chrome wheels" or as a rust remover.
- I had a patient who bought one of these "rust/stain removers" and used it for 8 hours to clean windows in her house... didn't wear any gloves, and went to bed. Woke up in the middle of the night with really, really bad pain in her dominant hand. Dilute HF may not cause pain for several hours after exposure, but it is all out of proportion to the obvious clinical appearance.
- Didn't want to wake up her primary care physician, so toughed it out until office hours. Told him she had used a usual window cleaner. He treated her as an allergic reaction.
- By the time we figured out it was HF, she lost her thumb and the first 2 fingers of her dominant hand. ....”
- Alan H. Hall, M.D.
- Medical Toxicologist



**WHAT IS THE LESSON ?**



# MISSING THE POINT ?

- National Safety Council Publication – Early 90s
- Glove Box Incident Involving Hydrogen
- Initially - Used a Non Flammable Hydrogen Mixture
- Later - Changed to 100% H<sub>2</sub>
- Soon - Glove Box Explosion
- Conclusion – Glove Box Explosion Due to Leak, plus Flammable Gas, plus Ignition Source
- End of Article
- Lesson(s) Learned ?



# ONE ATTEMPT - AIHA WEBSITE

- <https://www.aiha.org/get-involved/VolunteerGroups/LabHSCommittee/Pages/Lessons-Learned.aspx>



# **HUMAN ERROR**

## **TREVOR KLETZ - “WHAT WENT WRONG”**

“They know what they should do, want to do it, and are physically and mentally capable of doing it. But they forget to do it. Exhortation, punishment, or further training will have no effect. We must either accept an occasional mistake or change the work situation so as to remove the opportunities for error or make errors less likely.”



# FOUR LEVELS OF LEARNING

- Unconscious Incompetence
- Conscious Incompetence
- Conscious Competence
- Unconscious Competence



# HOW DO WE GET THE MOST BANG FOR OUR LESSONS LEARNED BUCK ?

- <https://www.aiha.org/get-involved/VolunteerGroups/LabHSCommittee/Pages/Lessons-Learned.aspx>
- <https://www.aiha.org/get-involved/VolunteerGroups/LabHSCommittee/Pages/Compressed-Gas-Incidents.aspx>



# PRIORITIZING OUR MESSAGE

- Global Concepts to Start – Broad Application for Hazard Identification and Injury Prevention – Short List
- Unwrap as Appropriate
- Smaller Scope Lessons as Supplements



# FOUNDATIONAL CONCEPTS

- Onboarding is Essential – General Training and Specific Training – Awareness vs Competence - Mentoring
- Establish a Safe Environment for Communications
- No One Knows Everything – ASK Questions
- Do Your Homework – SDS .. Literature Review
- Read Your Labels
- Conduct Your Hazard Reviews
- Establish and Update Your SOPs
- Obtain and Wear the Necessary PPE
- Manage Change Effectively



# **Obtain and Wear the Necessary PPE**

## **- Drilling Further**

- Even If I am not performing hazardous operations ?
- Even When I am performing something I have done many times ?
- Even When No One Else Is In the Lab ?
  - Benchtop Operation
  - Drierite Column
  - Visiting Minors
  - Closed and Stored Waste Container







# **DRIERITE COLUMN EXPLOSION INCIDENT CAUSE (S) ?**

- Inadequate Understanding – Chemical, Physical Properties of Products / Byproducts
- Inadequate Engineering Controls
- Reliance on Work Practices in Lieu of Engineering Controls
- Inadequate Selection / Use of PPE
- Failure to Practice Lockout/ Tagout
- Human Factors Problems Not Recognized
- Inadequate Attention to Management of Change
- Other ?



# MATCHING STORIES WITH KEY CONCEPTS

- Disilane Fire (lockout / tagout)
- Clean Hood Hotplate ( human factors)
- MOCVD Purge Sequence (engineering controls in lieu of work practices)
- Silane Scrubber (don't make assumptions)
- Clean Room Immersion Heater (redundant controls and devastating business interruption)
- Hydrogen Fire in Glove Box (Mgt of Change)



# DRILLING FURTHER - SOME COMMON INCIDENT CAUSES

- Inadequate Understanding – Chemical, Physical Properties of Products / Byproducts
- Inadequate Engineering Controls
- Reliance on Work Practices in Lieu of Engineering Controls
- Inadequate Selection / Use of PPE
- Failure to Practice Lockout/ Tagout
- Human Factors Problems Not Recognized
- Inadequate Attention to Management of Change



# **HORROR STORIES (LESSONS LEARNED FOR EXPERIMENTAL PLANNING)**

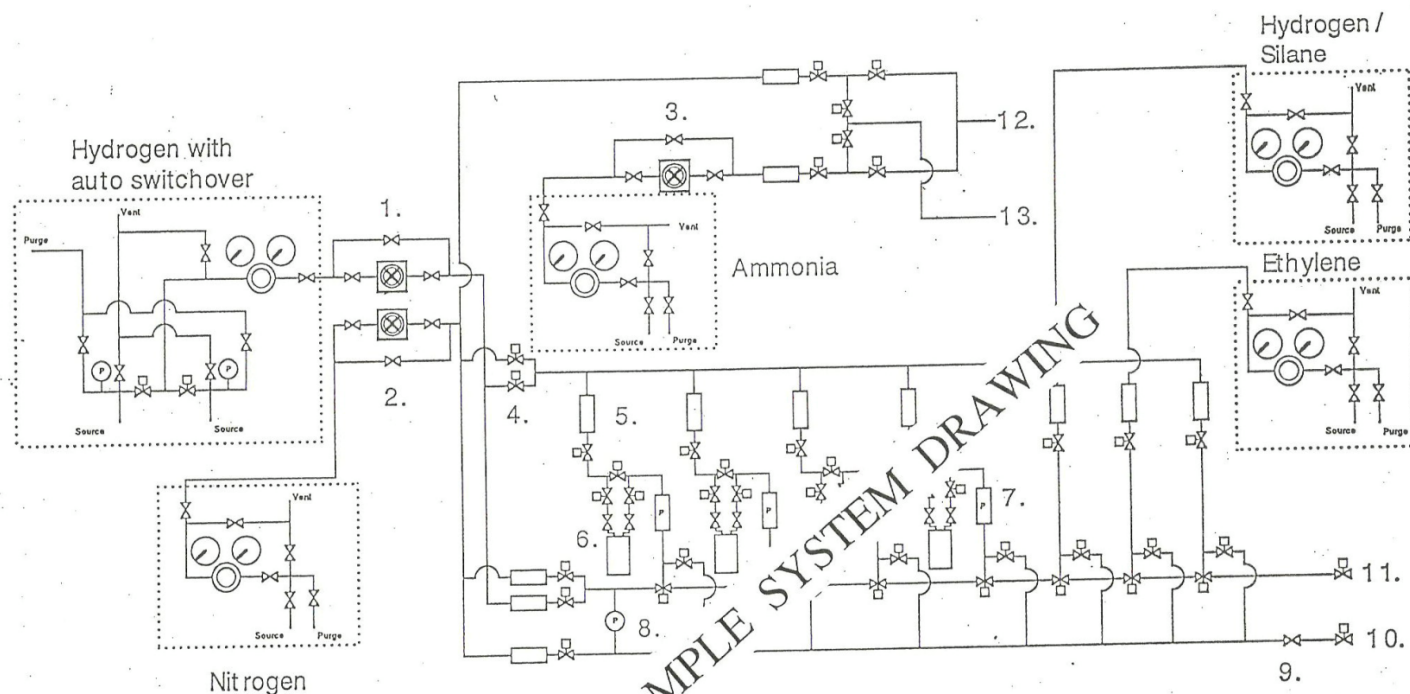
- Lockout / Tagout - Disilane Fire in Cluster Tool
- Human Factors - Clean Hood Hotplate
- SOPS Instead of Engineering Controls - MOCVD Purge Sequence
- Failure to Examine / Test Systems - Silane Scrubber Alarms
- Lack of Redundant Controls -Clean Room Immersion Heater
- Failure to Read the Label - Cylinder Stencil vs Label - Arsine
- Management of Change - Hydrogen Fire in Glove Box



**HAZARD REVIEWS ARE USEFUL  
BEYOND IDENTIFYING HAZARDS  
AND CONTROLS**



# SAMPLE SYSTEM DIAGRAM



1. Hydrogen purifier
2. Nitrogen purifier
3. Ammonia purifier
4. Carrier gas selection valves
5. Metalorganic carrier gas MFC
6. Metalorganic bubbler
7. Metalorganic bubbler pressure regulator

8. Run/vent differential pressure gauge
9. Vent pressure regulation valve
10. Vent line, diluent and metalorganics
11. Run line, diluent and metalorganics
12. Vent line, ammonia
13. Run line, ammonia



# LESSONS FOR THE TEAM MEMBERS (LESSONS LEARNED)

- Process Safety Review with Maintenance Input – “I won’t do that”  
Involve Maintenance Early – Pre-review is useful
- Safety Review with Post Doc and Graduate Student – “I’m leaving, she will manage this equipment” – Knowledge transition – Management of Change
- Process Safety Review including Cylinder Change Procedure – “you never closed the gas supply valve” – Benefit of Drawings and written SOPs
- Blue Collar Input on Silane Review – “There’s that V-2 again”
- Lockout / Tagout on Silane Review – “Not sure we addressed this adequately on our installation” – Benefits to the reviewers as well as those reviewed
- Hydrogen Fire in Glove Box Article (How Not to Write a Lessons Learned)



# **ADDITIONAL BENEFITS FROM REVIEW**

- Participants Learn and Remember Expectations – Useful for Future Projects
- Procedural Controls are Rolled Into SOPs (also could test SOPs during review)
- Participants Learn the Process
- PHR itself is documented for future reference
- Can apply to non research applications – Lab Exhaust / HVAC, etc