Managing Inherited Laboratory Materials: Faculty Transitions

IOWA STATE UNIVERSITY

Environmental Health and Safety

What We'll Cover Today

- Introductions
- Ideal scenarios for laboratory clean-outs
  - Communication
  - Waste scenarios
  - University policy
  - Incentives
- Abandoned laboratories
  - Types of labs
  - Types of hazards
  - Peroxide forming chemicals
- Conclusions & wrap-up with questions

Who are we?

- Corwin Deetz, M.Sc.
  - University of Wisconsin- Eau Claire
  - University of Minnesota - Duluth
- Environmental Health & Safety (EH&S)
  - Environmental programs team
  - 6 full-time team members
    - Waste, water, and air compliance
- Iowa State University (1858)
  - Land grant university
    - Morill Act of 1862 (1864)
  - Statistics
    - 30,000+ students (60% STEM)
    - 1,800+ labs on campus
    - Large quantity generator

What's the Problem?

If I had a nickel for every time we hear…

"This chemical was left over from the previous laboratory."

"These aren't my materials."

"These samples have been here forever."

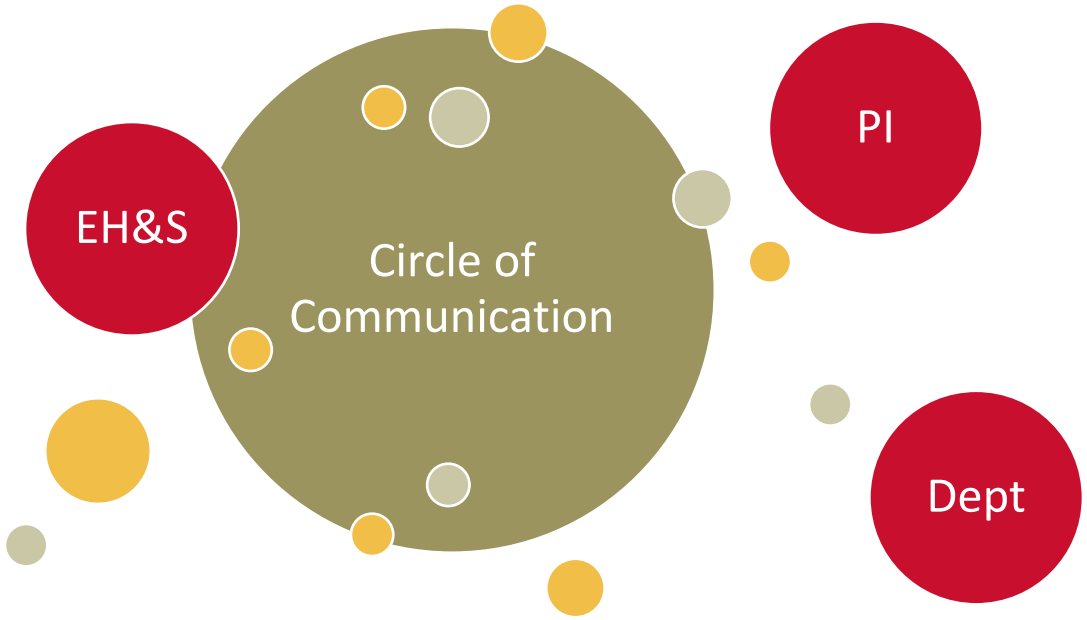
Ideal Scenarios for Laboratory Clean-Outs

Communication, Logistics, University Policy, and Incentives.

Disclaimer:

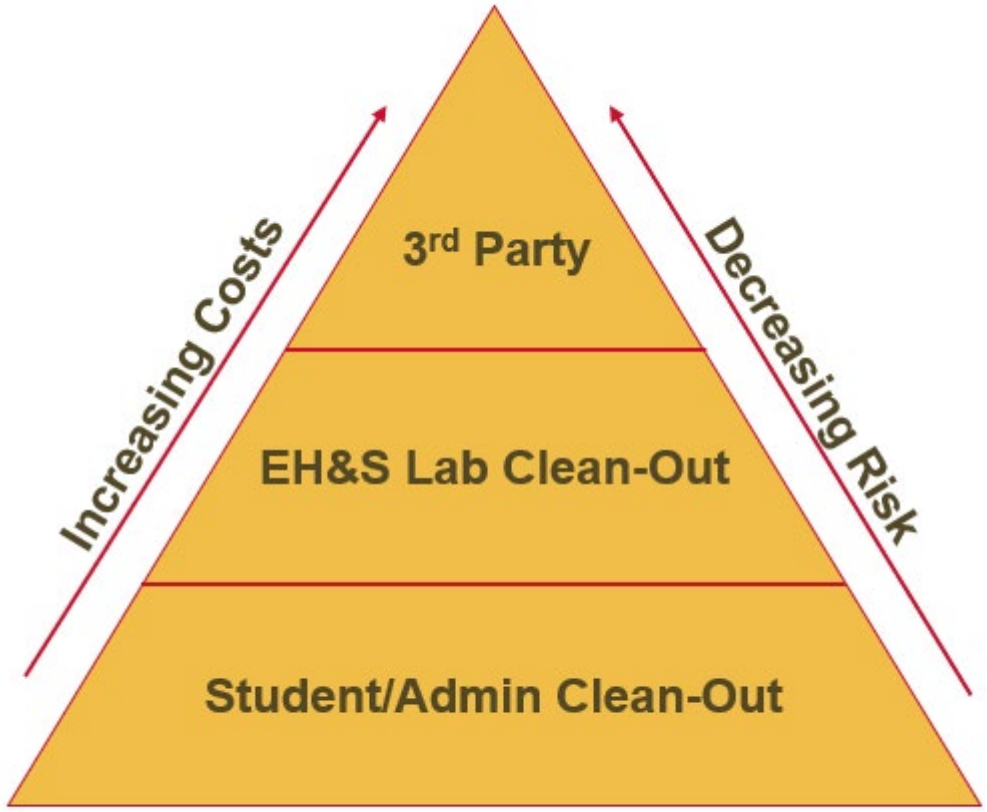
These ideas and topics are highly subjective to each university's requirements. This presentation reflects what I have noticed across multiple universities and ideas about how to safely retire laboratory spaces across multiple disciplines.

Communication



- Retirement/leave intentions
  - Who manages this?
- Communication to EH&S
  - An itemized list
    - Chemicals
    - Samples
    - Equipment
    - Timeline
  - P.I./department
    - Guidance questions
  - Start this process early
    - Who inventories and logs this waste?

Time Factors In Lab Clean-Outs



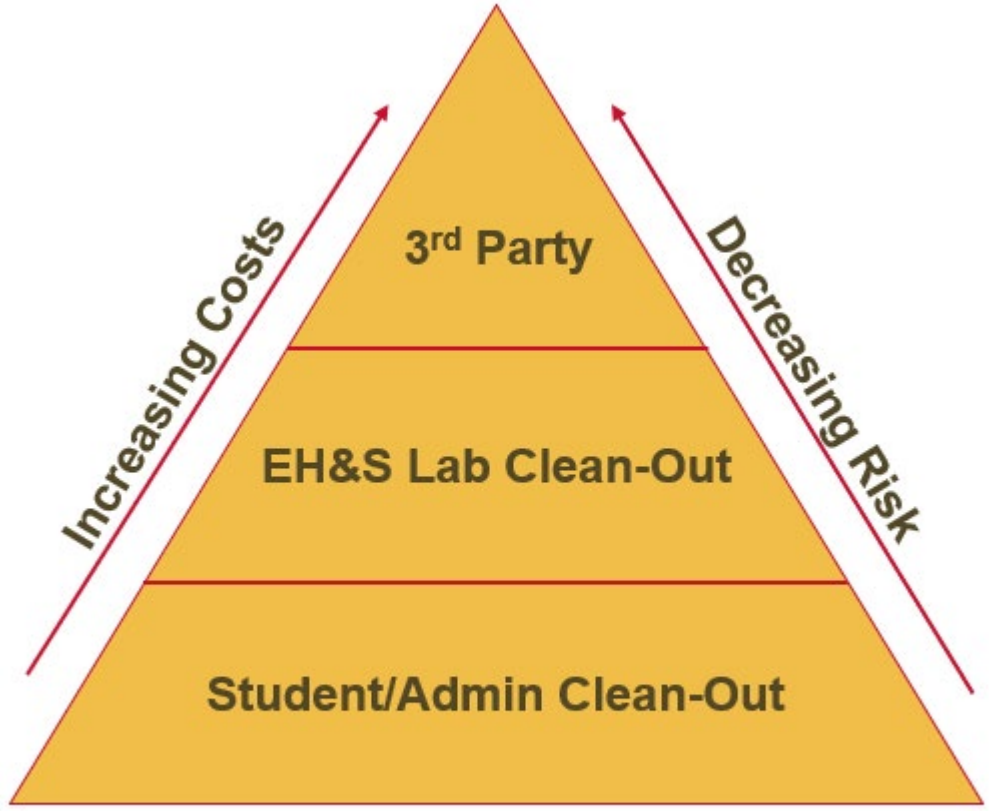
Hierarchy of Lab Clean-Out Responsibilities

- Day-to-day process
  - Waste submitted
  - EH&S transports and logs waste in a CAA
- Options that ISU-EH&S offers
  - Student submittal/admins
    - 70 different chemicals a week
  - EH&S clean-out
    - When available
    - ~16 chemicals an hour
  - Third-party clean-out
    - One fell swoop

Waste Scenarios: Pros and Cons

Lab Clean-Outs Scenarios

- Admin
  - Pro: cheap
  - Con: lack of knowledge
- Student submission
  - Pro: cheap, with some knowledge of laboratory practices
  - Con: inaccurate waste determinations, little regulatory knowledge
- EH&S clean-out
  - Pro: knowledge of regulations
  - Con: not familiar with each individual lab
- Third-party clean-out
  - Pro: knowledge of regulations.
  - Con: not familiar with the lab space



Hierarchy of Lab Clean-Out Responsibilities

University Policy

Overcrowded laboratory freezer found during a lab clean-out

- Retirement/leave policy
- P.I. lab check-In
  - “Apartment-style”
  - Get your discrepancies out now.
- P.I. lab check-out
  - Retirement date?
  - Inventory
  - To be signed off by EH&S and the department
- Regularly scheduled clean-outs

Incentivizing Lab Clean-Out

- Regularly scheduled clean-outs
  - University policy
- Paycheck withholding
- Post clean-out costs
- Regulation-based lab clean-out
  - Subpart K
  - ISU is not a Subpart K university

Subpart K Regulations for Lab Clean-Outs

- 40 CFR 262.208(a)
  - Removing container(s) of unwanted material from each laboratory on a regular schedule.
- 40 CFR 262.208(a)(1)
  - Remove all container(s) of unwanted material from each laboratory on a regular interval, not to exceed 12 months; or
- 40 CFR 262.208(a)(2)
  - Remove containers of unwanted material from each laboratory within 12 months of each container(s) accumulation start date
- 40 CFR 262.208(c)
  - Eligible academic entity must specify in Part II of its Laboratory Management Plan how it will comply with (a)(1) or (a)(2) of this section and develop a schedule for regular removals of unwanted material from its laboratories.

Subpart K Rationality

- Subpart K
  - Not practical for Iowa State University
- Let's do the math
  - ~1800 Lab spaces
  - ~ 260 Working days/yr
  - 6.9 Labs/day
- Multiple compliance programs
  - Academic labs
  - Farms
  - Transportation services
  - Veterinary college

Ideal Scenarios: Summary

- University policy
- Proper communication
  - Date of retirement
  - Lab check in/out procedures
  - Inventory
- What's the timeline?
- Identify who does the dirty work
  - Admins/students
  - EH&S
  - Third-party lab-clean out
- Start the work early
  - Give yourself time to do it safely
- Best advice is paradoxical

Abandoned Laboratories and Their Associated Hazards

Types of Laboratories, Equipment, Chemicals, Samples, Time-Sensitive Chemicals, and Peroxide Forming Chemicals

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These ideas and topics are highly subjective to each university's requirements. This presentation reflects what I have noticed across multiple universities and ideas about how to safely retire laboratory spaces across multiple disciplines.

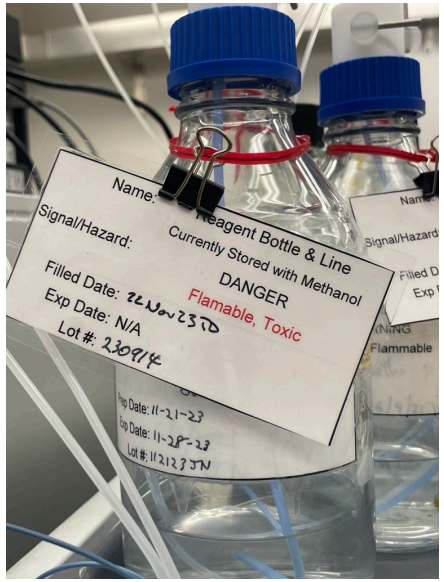
Types of Laboratories

- How do we find out about?
  - The entire point of a retirement and lab check-out policy
- Hazards to think about
  - Equipment
  - Biological
  - Radioactive materials
  - Samples
  - Chemicals
- Know the limit of your expertise
  - Benefits of a university

Equipment

A)

B)



C)

D)

- Rotary evaporator
  - Bumping flask
  - Time sensitive chemicals
- Machines that use liquid eluent
  - Labeling
  - Time sensitive chemicals
- Gloveboxes
  - Inventory prior to decommission
  - Inert atmosphere
- More equipment
  - Know when to ask for help

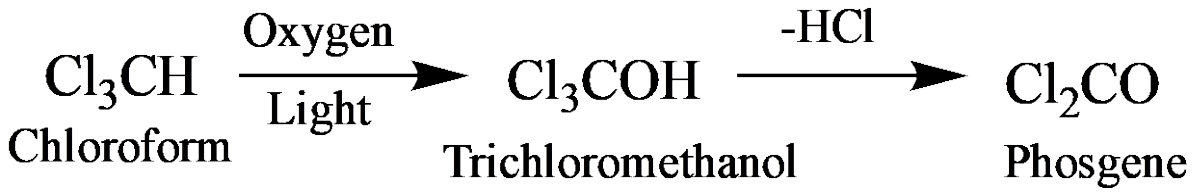
Simply put. What are we dealing with?

A)

B)

- Samples
  - Unknown samples
  - Quantity
  - Graduate student side projects
- Time-sensitive chemicals
  - Chloroform
  - Picric acid/picrates
  - Peroxide forming chemicals

C)



Peroxide Forming Chemicals: Our Story

What Happened:

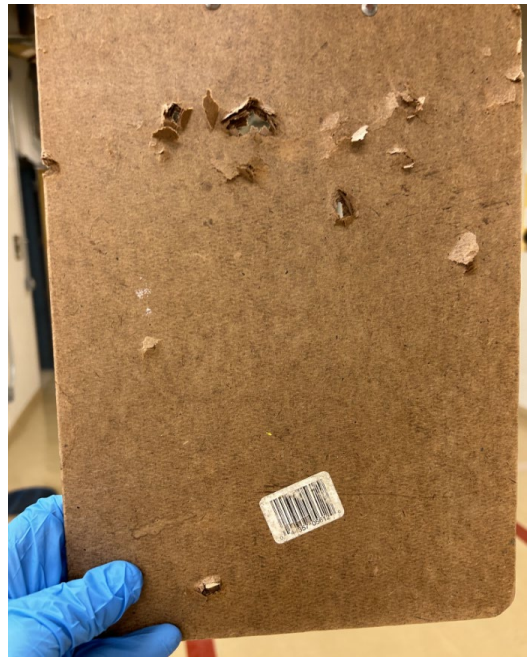
- Detonation of peroxides formed in isopropanol following lab cleanout
- EH&S worker hospitalized with serious injuries

Response:

- Knowledge share with the University of Minnesota
- Redeveloped our Peroxide Forming Chemicals Guidelines

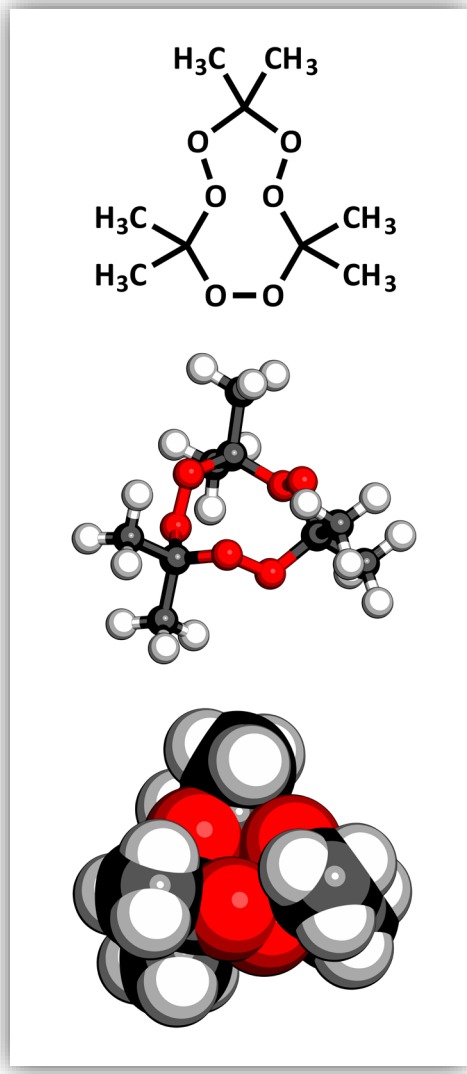
What We Learned:

- Improved chemical storage guidelines and time limits for PFCs
- Best management practices for certain pieces of equipment
  - Disconnect solvents
  - Rotating stock
- Inspect all PFCs before use with established testing methods and guidelines
- Overhauled chemical waste management and inventory systems



What Is A Peroxide-Forming Chemical (PFCs)?

- Chemicals that auto-oxidize (react with atmosphere oxygen) to form organic peroxides
- Due to a weak O-O bond prone to violent decomposition from:
  - Exposure to heat
  - Mechanical shock
  - Friction
- PFCs are strongly recommended to be purchased with inhibitors
  - Slow or prevent the formation of peroxides
- What's a safe concentration?



Classification of PFCs

Class A	Class B	Class C	Class D

• Spontaneous decomposition
• Explosive when exposed to air without concentration
• Can occur when unopened
	• Form explosive peroxides when:
	  ○ Distilled
	  ○ Evaporated
	  ○ Concentrated
		• Highly reactive
		• Autopolymerize into extremely shock and heat sensitive peroxides
			• Can form peroxides
			• Not clearly classified as A, B, or C

Common PFCs at ISU

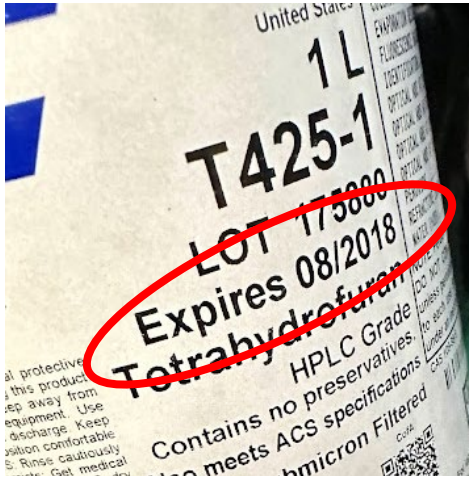
Most common peroxide formers on ISU campus	
Class A	
Spontaneously decomposes; explosive in air	
Isopropyl Ether	Potassium
Class B	
Form explosive peroxides when distilled, evaporated or otherwise concentrated	
1,2-Dimethoxyethane	Cyclohexanol
1,4 Dioxane	Cyclohexene
2-Butanol	Diglyme
2-Butanone (MEK)	Diethyl Ether (Ether)
2-Methyltetrahydrofuran	Isoamyl Alcohol
Acetaldehyde	Isopropanol
Benzyl Alcohol	Tetrahydrofuran
Class C	
If polymerized: reactive, shock & heat sensitive	
Acrylic Acid	Methyl Methacrylate
Acrylonitrile	Styrene
Class D	
Acetophenone	Diethylene Glycol
Anisole	Ethylbenzene

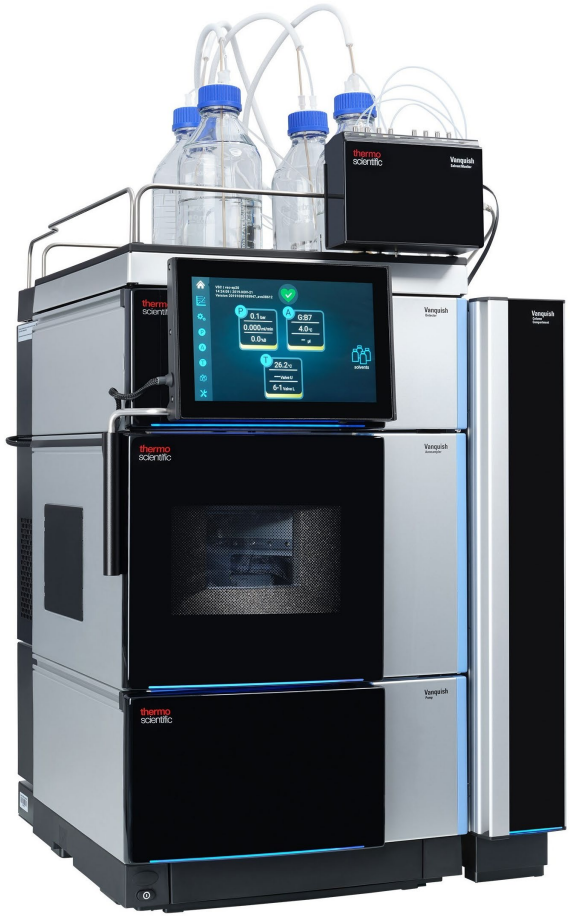
Classes of PFCs

Class B		
Forms explosive peroxides when distilled, evaporated or otherwise concentrated. Test before concentration or distillation. Dispose within 12 months of opening. If unopened, dispose by manufacturer's expiration date.		
1-Phenylethanol	Acetal	Diethyl ether (Ether) *
1,4 Dioxane*	Acetaldehyde*	Diethylene glycol dimethyl ether (Diglyme)*
2-Butanol*	Benzyl alcohol*	Ethylene glycol dimethyl ether
2-Butanone (MEK)*	Chlorofluoroethylene	Furan
2-Methyltetrahydrofuran*	Cumene	Methyl acetylene (Propyne)
2-Pentanol	Cyclohexanol*	Methyl cyclopentane
2-Phenylethanol	Cyclohexene*	Methyl isobutyl ketone
Isoamyl alcohol (3-Methyl-1-butanol)	Cyclopentene	Other Secondary Alcohols (such as 2-propanol) *
4-Heptanol	Decahydronaphthalene (Decalin)	Tetrahydrofuran*
4-Methyl-2-pentanol	Diacetylene	Tetrahydronaphthalene (Tetralin)
4-Penten-1-ol	Dicyclopentadiene	Vinyl ethers

Class B peroxide formers list. Mostly consists of solvents that, when concentrated, create a risk of detonation

Proper Storage

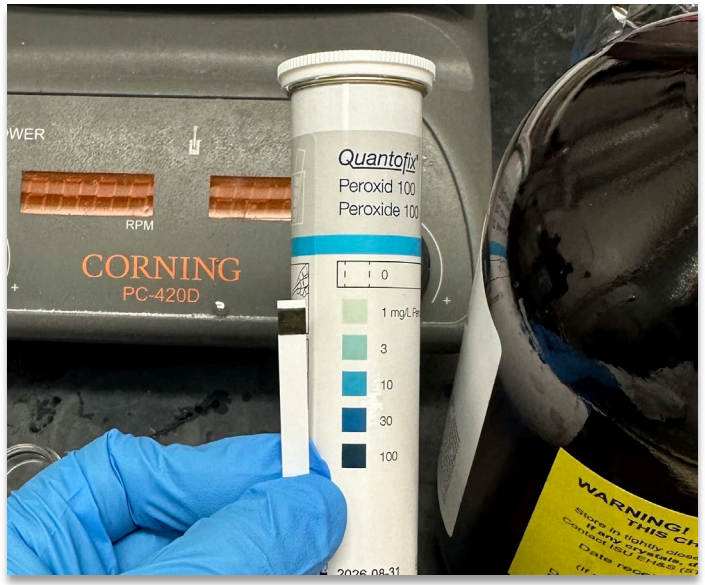




Oxygen	Store tightly sealed
Time	Dispose of PFCs as recommended
Heat/concentration Light	Store in a cool, dry, and dark cabinet

Testing and Disposal of PFCs

	Testing	Disposal	
		Opened	Unopened
Class A	**Always** test Class B PFCs prior to concentration or distillation.	Dispose within 3 months of opening or by expiration date	Dispose by the expiration date or within 1 year of receipt.
Class B	**Inhibited (Class A-C):** Test upon expiration, and then every 90 days.	Dispose within 12 months of opening or by expiration date	Dispose by the manufacturer's expiration date or within 5 years of receipt.
Class C*	**Uninhibited (Class A-C):** Test upon expiration, and then at least every 90 days. More frequent testing is recommended.		
Class D	**Test at least every 12 months.**	Dispose by the expiration date.	Dispose by the expiration date or within 5 years of receipt.



WARNING: MAY FORM EXPLOSIVE PEROXIDES

Store in tightly closed original container. Avoid exposure to light, air, or heat.
If any crystals, discoloration, or cloudiness are visible, DO NOT open.
Contact ISU EH&S at (515) 294-5359 for assistance.

Date received: _____ ☐ Inhibited
Date opened: _____
Dispose of by: _____ ☐ Uninhibited
Class (circle one): A B C D

PEROXIDE TEST RESULTS
Testing is mandatory every **90 days** after initial test.

Results (ppm)	_____	Date	_____	Initials	_____
Results (ppm)	_____	Date	_____	Initials	_____
Results (ppm)	_____	Date	_____	Initials	_____
Results (ppm)	_____	Date	_____	Initials	_____

Do not use chemicals if greater than 100 ppm of peroxides are detected.

Visual Inspection

Before testing, always check for signs of peroxide formation including:

Cloudiness

Precipitated crystal formation appearing as chips, ice-like structures, or solid masses

Wisp-like structures floating in liquid

Other visible contamination or unexpected layering- check around caps/lids

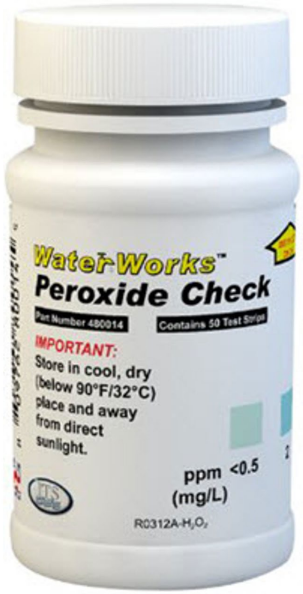
If you see any of these signs, do not touch, open, or otherwise disturb the container. Inform all lab occupants and contact EH&S immediately for assistance.

Concentration Guidelines

Peroxide Concentration	Actions
0 – 25 ppm	Do not concentrate to near-dryness if peroxides are present.
> 25 ppm	Do not concentrate or distill. Use at your own discretion. Disposal is recommended.
≥ 100 ppm	DO NOT USE. Contact EH&S for assistance. Additional testing may be required prior to disposal.
≤ 100 ppm*	DO NOT USE. EH&S will pick up for disposal.
100 – 500 ppm*	Waste vendor will neutralize, stabilize, and dispose.
≥ 500 ppm*	Waste vendor may use remote stabilization. Bomb squad may need to be utilized.

*Dependent on current waste vendor policies. Subject to change.

Use the Right Strips



Used **only** for testing **water**.

Used for testing **organic** liquids.

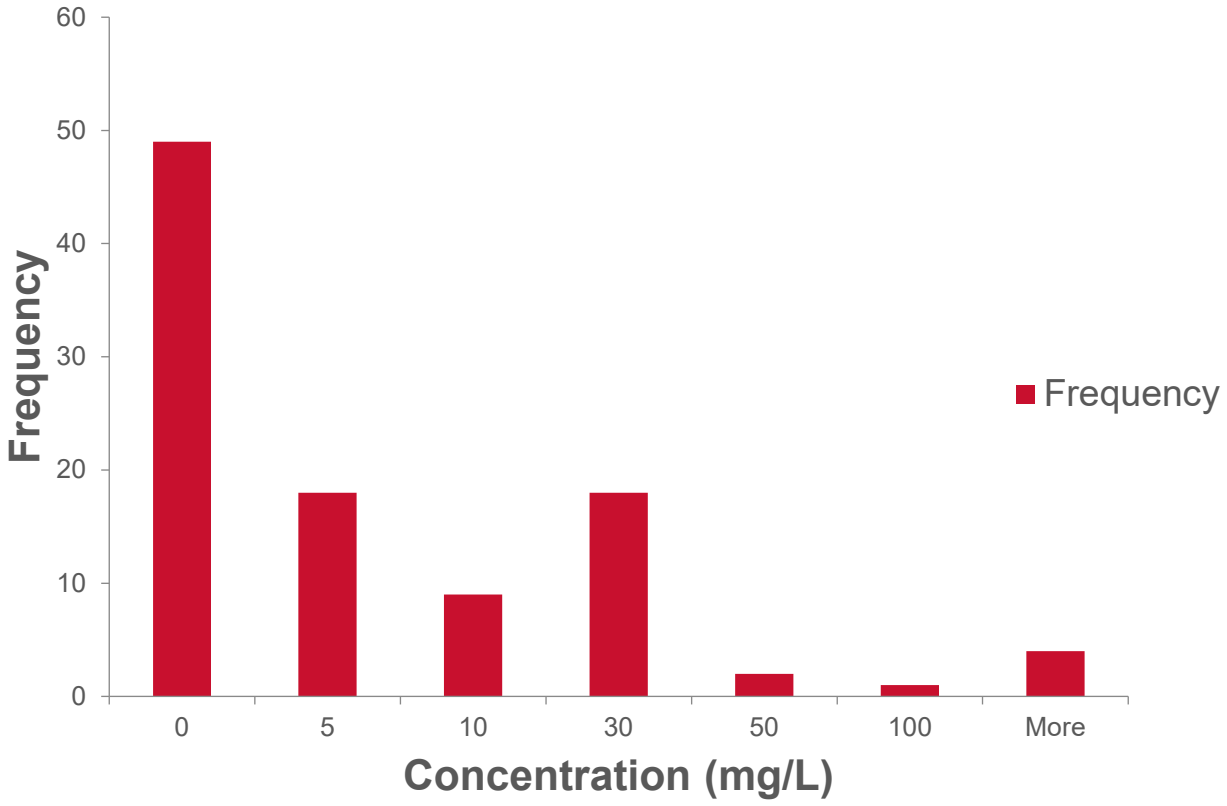
Treatment of Peroxide Formers

A)

B)

- 40 CFR 268.42
  - CHRED: Chemical reduction utilizing the following reducing reagents (or waste reagents) or combinations of reagents (1) Sulfur Dioxide; (2) Sodium, potassium, or alkali salts or, sulfites, bisulfites, meta bisulfites, and polyethylene glycols (e.g., NaPEG and KPEG) (3) sodium hydrosulfide; (4) Ferrous Salts; and/or preformed (5) other reducing reagents of equivalent efficiency, performed in units operated such that surrogate compound or indicator parameter has been substantially reduced in concentration in the residuals.

Most Common Types of PFCs for Disposal



Histogram of Peroxide Concentration in PFCs

- Histogram only includes PFCs with no visual indicators.
- Top Three:
  - 1) Isopropanol
  - 2) Isoamyl alcohol (2 treated)
  - 3) Tetrahydrofuran (3 treated)
  - n=101
- Conservative approach
  - Since Q4 of 2024, we have identified 27 bottles.
  - Two more bottles in August

Conclusions

Ideal Situations for Laboratory Clean-Outs

- University Policy is KEY.
  - Subpart K
  - ISU has no regulation to rely upon
- Communication
- Start the clean-out process early
  - Ensures proper time and avoids rushing
- Paradoxical situation

Abandoned Laboratories and Potential Hazards

- Avoid this by having a strict university policy
- Identify potential hazards
  - Type of laboratory
  - Inventory
  - Equipment
- Peroxide forming chemicals
  - What's the chemical
  - What are the storage conditions
  - Age
  - Prior test results

Contact Information & Questions

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Questions?