Laboratory Safety Considerations for Flammable Liquid Transfers

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Chemical Safety @ LBNL

- Chemical safety assessments by local DOE office
- Resulted in a NFPA finding

NFPA 45, 7.2.6:

The release of chemical vapors into the laboratory shall be controlled by enclosure(s) or captured to prevent any flammable and/or combustible concentrations of vapors from reaching any source of ignition.
Common Laboratory Operations

Safe?
Professional Judgment vs. Technical Basis
Industrial Hygiene Approach

• Addressed fire and exposure risks.
• Obtained stakeholder input.
• Selected acetone:
  − Class IB flammable
  − Flashpoint 0°F
  − Boiling point 134°F
  − TLV = 250 ppm (8-hr TWA)
  − LEL = 2.6% (26,000 ppm)
Acetone Transfer Task

- Transferred 4 liters using 1-liter individual pours.
- Employed bonding and grounding.
- Used Work Planning and Control process.
Laboratory Selection

• 12 different laboratories
  - 5 small labs (< 500 sq. ft.)
  - 3 medium labs (500-1000 sq. ft.)
  - 4 large labs (> 1000 sq. ft.)
• Ages ranged from 2-75 years
• 1-2 fume hoods in most (9 in one)
Measurements for Fire Risk
Equipment Layout
Measurements for Exposure Risk
Maximum Acetone Vapor Concentration Readings from All Locations Sampled
Four Acetone Transfers of 1 Liter Each

Concentration of Acetone Vapor (ppm)

Time From Start of First Transfer (min)

- Maximum (All Locations)
- 25% LEL: 6,500 ppm
Highest Measured Acetone Vapor Concentration at Distance x from Point of Transfer

25% LEL

Distance from Point of Transfer (feet)

Maximum Acetone Vapor Concentration at Distance x (ppm)
Fire Risk Results Summary

• Photoionization Detectors showed maximums
  – 5600 ppm (22% LEL)
  – Near point of generation
  – Within 5 minutes of generation.

• Colorimetric detector tubes showed
  – Non-detect to 200 ppm (breathing zone)
  – No discernible pattern with distance.
15-minute Personal Exposure to Acetone Vapor for Employee Performing the Transfer Operation

- Employee 15-min exposure
- 15-min STEL, 500 ppm

Bars representing exposure levels for different employees:
- Employee A, Dec. 14, 70A-2235: 30 ppm
- Employee A, Dec. 14, 70-279: 38 ppm
- Employee A, Dec. 14, 2224: 56 ppm
- Employee B, Dec. 14, 84-255: 20 ppm
- Employee B, Dec. 15, 30-306: 51 ppm
- Employee B, Dec. 15, 1330: 21 ppm
- Employee B, Dec. 15, 77-244E: 71 ppm
- Employee C, Dec. 16, 83-116A: 52 ppm
- Employee C, Dec. 16, 62-155: 24 ppm
- Employee C, Dec. 16, 26-0032: 27 ppm
Time-Weighted Averages (TWAs)

- **Individual Samples**: 6 - 23 ppm
- **TWAs**: 11 - 21 ppm
- **8-hour TWAs**: 3 - 6 ppm
- **ACGIH TLV**: 250 ppm
Support for Professional Judgement

• Low Potential for fire and exposure risk
  – Vapor concentrations < 22% LEL
  – Full day exposures < 3% of 8-hour TWA
  – Task exposures < 20% of 15-minute STEL

• Laboratory room ventilation is sufficient to control risks.

• Results are representative and border on worst case.
Technical Basis for Compliance

NFPA 45, 7.2.6:

The release of chemical vapors into the laboratory shall be controlled by enclosure(s) or captured to prevent any flammable and/or combustible concentrations of vapors from reaching any source of ignition.

Not applicable, because ....

concentrations below flammable levels.
Elsewhere in NFPA 45 ... 

NFPA 45, 9.3.1:

Dispensing of Class I liquids to or from containers less than or equal to 20 L (5 gal) in capacity shall be performed in ... an area provided with ventilation adequate to prevent accumulations of flammable vapor/air mixtures from exceeding 25 percent of the lower flammable limit.

Applicable, and ... concentrations below exposure limits.
Looking back ...

Safe, but ...
Policy Improvements

• Current policy somewhat generic
• Revising policy to:
  – Require ventilation for Class 1A flammables
  – Limit quantities allowed without local ventilation
  – Improve guidance on controlling ignition sources
  – Clarify bonding and grounding requirements
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Questions?