Chemical Safety Levels: A tool whose time has come?

R. Stuart

Laboratory Risk Assessment
- or -
Who Needs a Hood?

Ralph Stuart, Univ of Vermont

The Laboratory Safety Challenge

- Ever-evolving chemical selection and process
- Lab walls are getting thinner, both figuratively and literally
- Turnover – 20% per year in academia
- The educational culture currently doesn't include risk assessment: but it can

Stakeholders in Laboratory Risk Assessment

- **Laboratory workers** (personal safety and efficient work)
- **Laboratory upper management** (financial and carbon issues)
- **Laboratory designers** (design choices)
- **Laboratory building operators** (personal safety and operations costs)
- **Emergency responders** (emergency planning and response)

Emerging Issues in Lab Risks

- **Ventilation design and energy costs**
  - Optimum ACH
  - Hood design goals
- **Building operation**
  - Protection of maintenance staff
  - Building operations costs
  - Education of lab staff about their buildings
  - Re- and retro- commissioning
- **Emergency planning and response**
  - Pre-plans
  - Scene assessment
  - Response rate: 1 emergency response/250 lab-years
- **Do these challenges point the way from risk assessment to control banding?**
  - Addressing these issues requires development of broader understanding and language for lab chemical risks

Lab Planning and Design: Moving beyond Tradition

- The traditional engineering approach uses a lot of energy without much thought
- Control Banding:
  Define Chemical Safety Levels from 1 to 4
- For many purposes, the control band deals with a collection of chemicals rather than a specific biological agent
- The result is a general guideline to appropriate protections (which is likely to need modification, e.g CSL 2+)

Chemical Risk Assessment

- **Flammability**
  - Concentrations of concern tend to be a few percent by volume
- **Corrosivity**
  - Particles with kinetic energy are much harder to control than vapors
- **Reactivity**
  - Requires chemical and process specific literature review
- **Toxicity**
  - Concentrations of concern range from 1000 ppm to 0.5 ppm to ALARA
- **GHS will help this process**

Chemical Protection Strategies

- **Change the chemical** – limited opportunities in the research setting
- **Engineering controls**
  - General Ventilation
  - Flammable cabinets
  - Local Ventilation
  - Chemical Hoods
- **Administrative Controls and Oversight**
  - 20% turnover/year in academic labs
- **Personal Protective Equipment**
- Traditionally, in chemistry laboratories, fume hood + PPE = “as safe as can be”

Factors to Consider in Selecting a CSL:

- **Flammability** (via MSDS):
  - check flashpoint (is it below ambient temperature?)
  - If yes, are expected airborne concentrations above LEL?
- **Corrosivity** (via pH of solutions):
  - pHs < 2 or > 10.5 require special handling
  - Consider also spattering and off-gassing from reactions
- **Reactivity** (via MSDS and literature review)
  - Check potential interactions and contamination concerns
- **Toxicity** (via MSDS and other sources)
  - Review PELs, TLVs, IDLHs and assess against anticipated concentrations
  - Consider potential interactions
  - ALARA for irreversible hazards (cancer, birth defects, sensitization)

Conceptual Chemical Safety Levels

- **CSL-1:** no ventilation (e.g. cold rooms and warm rooms)
  - Chemical uses similar to residential settings (kitchens and cleaning products)
- **CSL-2:** general ventilation (X air changes/hour)
  - Chemical uses similar to cars (gallons of flammables and assorted other chemicals)
- **CSL-3:** local ventilation (i.e. hoods)
  - Chemicals similar to hardware stores – emergency concerns is unexpected reactions
- **CSL-4:** high hazard storage or processes that require specialized procedures

Determining the CSL

Hazard	Fire	Corrosivity	Reactivity	Toxicity
CSL 1	Flashpoint below ambient	2 < pH < 10.5	No chemical changes expected in the process	All chemicals have known toxicities and TLV's > 500 ppm
CSL 2	Flashpoint near ambient, expected concentration < 10% LEL	pH <2 or pH >10.5	No known incompatibilities between chemicals being used	All chemicals have known toxicities and 10 ppm <TLV's < 500 ppm
CSL 3	Expected concentration > 10% LEL	Use of heated corrosives	Chemicals with known reactions or contamination hazards present	Unknown toxicities or OEL < 10 ppm
CSL 4			High hazard reactions in use	Irreversible toxicities require use of designated areas

But don't forget the other pieces of the control puzzle

	Facility	Personal Protective Equipment	Oversight	Emergency Response
CSL 1	Any room, no ventilation	None	Generic self inspection guidelines	Standard response
CSL 2	Ventilated lab room (X ACH)	Nitrile gloves, eye protection	General training and oversight	Fire response
CSL 3	Lab room with local ventilation (fume hood)	Appropriate gloves, eye protection, lab coats	Process specific training and protocols	Hazmat defensive response -> commercial clean-up
CSL 4	Specifically designed lab	Process specific PPE	Written SOPs and specific oversight practices	Specialized hazmat response

Implementation at the lab level: A Risk Assessment Spreadsheet

Laboratory Chemical Risk Assessment Form

complete italicized blocks

Step 1: Procedure Information

Title and Duration of Procedure:	*name and time frame*			**Lab Book Reference:**	*title and page*
Date of Assessment:	*date*	**Date of Review:**	*date*	**Date of next review:**	*date*
Risk Assessor:	*name*	**Assessment Reviewer:**	*name*	**People Potentally Affected:**	*groups of people*

Step 2: Risks Identification

Substances (used or produced) and **Concentration** (assumed 100% unless otherwise indicated)					**1. Physical Hazards**			
Chemical name	**Maximum Quantity** (ml or grams)	**Risk Statements**	**Alternative chemicals considered**	**Sources of Chemical Specific Information**		**Flammability Risk Rating**	**Reactivity Statements and/or pH**	**Reactivity Risk Rating**
2-methyl-2-butanol	9	JT Baker: 2-4-2-2	*List potential alternatives or "Not Possible"*	http://www.jtbaker.com/msds/englishhtml/a6408.htm	Flash point: 19C (66F)			
2-methyl-2-butene	10	R10		http://msds.chem.ox.ac.uk/ME/2-methyl-2-butene.html	Flash point: -45 C			
2-methyl-1-butene	10	R12 R22 R65		http://msds.chem.ox.ac.uk/ME/2-methyl-1-butene.html	Flash point: -48 C			
sulfuric acid, 6 M	6	R23 R24 R25 R35 R36 R37 R38 R49		http://msds.chem.ox.ac.uk/SU/sulfuric_acid_concentrated.html	None		Corrosive	3
5								
6								
7								
8								

Substances (used or produced) and **Concentration** (assumed 100% unless otherwise indicated)			**2. Health Hazards**					
Chemical name	**Maximum Quantity** (ml or grams)	**Risk Statements**	**Quantity ranking** (looked up from exposure potential table)	**Physical Form ranking** (enter value from exposure potential table)	**Operation ranking** (enter value from exposure potential table)	**Exposure Potential** (sum of rankings)	**Toxicity Hazard** (V,H,M,L from Risk Statements table or other information)	**Toxicity Risk Rating** (from table)
2-methyl-2-butanol	9	JT Baker: 2-4-2-2	1	1	2	4	L	1
2-methyl-2-butene	10	R10	1	1	2	4	L	1
2-methyl-1-butene	10	R12 R22 R65	1	1	2	4	L	1
sulfuric acid, 6 M	6	R23 R24 R25 R35 R36 R37 R38 R49	1	1	2	4	V	3
5								
6								
7								
8								

Other risk factors: *(e.g. use of pressurized equipment, high voltage, lasers, nano particles, etc. that may affect control strategies)*

At the Campus Level, CSL's can be used to:

- Establish an inventory of laboratory rooms in place
  - Preliminary estimate for non-chemistry buildings, 75% CSL 2 labs
- Support design standards for new and renovated lab settings.
- Improve training and emergency planning.
- Support communication between lab workers and facility and emergency support services.
- Plan for climate actions appropriate to the campus.

Next Steps

- Complete a risk assessment tool that addresses the questions of various stakeholders
- Define the boundaries between the various CSL's and where those boundaries blur
- Develop guidance documents for use of CSL's