SAND2013-7387C

Chemical Laboratory Safety in Developing Countries

Linda Stiles, MS, CIH, CHMM

American Society of Safety Engineers

17 September 2013

Overview of Presentation

- History of the Sandia program
- Initial outreach to developing countries
- Global chemical safety standards & approaches
- Sandia's chemical safety training curriculum
- Safety issues in developing countries
- Improvements and ongoing safety issues

International Chemical Threat Reduction Program (ICTR)

- Sandia's international programs have a long history in non-proliferation activities
- Sandia's biosecurity programs were initiated after 911
- Laboratory biosafety programs were incorporated later
- Chemical security programs were initiated ~2007
  - Sponsored by the U.S. Department of State
    - *Chemical Security Engagement Program (CSP)*

Chemical Security Engagement Program (CSP)

CSP Program Objectives:

Decrease chemical threat by:

- Raising (chemical) threat awareness globally
- Providing assistance to improve chemical safety and security best practices in laboratories
- Facilitating collaboration with CSP partners' local chemical industries to improve chemical security and decrease theft and diversion of toxic chemicals and materials
- Fostering peaceful international collaborations among chemical professionals

Initial Activities-Southeast Asia Kuala Lumpur-August 2007

- 2007–Sandia ICTR began developing a chemical safety & security program for CSP
- Sandia Labs participated in a regional chemical safety & security conference:
  - Entitled: *Chemical Safety & Security in the 21st Century*
  - Held in Kuala Lumpur, Malaysia
- Conference participants included:
  - Malaysian Chemical Industry Association
  - Air Products Malaysia
  - University of the Philippines
  - American Chemistry Council
  - Sandia National Laboratories
    - ICTR
    - Security SMEs

Initial Outreach-Southeast Asia Kuala Lumpur-August 2007

- Discussions held on security in industrial chemical facilities
- However, academic chemical safety issues were also discussed
- Philippines reported on the prevalence of chemical accidents in secondary schools
  - Dr. Irma Makalineo
    - University of the Philippines, Manila

Mercury Spill in Philippine High School

Issues noted by Philippine speaker:

- No existing guidelines for mercury spills in schools
- Lack of equipment to clean up mercury spills
- Lack of awareness among school authorities including science teachers about the hazards of mercury
- Clean up process for this school was costly and required assistance from the US EPA

Photos credit: Dr. Irma Makalinao, 2007

Chemical Spill in Manila High School

Makati school

CLEANSING THEMSELVES. Rescue workers cleanse themselves by having their suits sprayed with chemically treated water after they went inside the San Isidro National High School in Makati City following a chemical spill inside a science laboratory. (Richard Vinas)

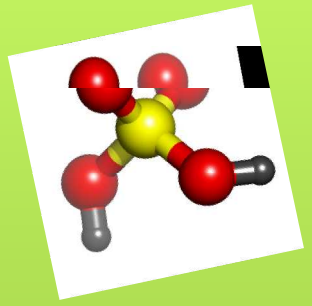
COVERING UP. Residents near the San Isidro National High School cover their noses to avoid the smell coming from the school after different toxic chemicals were accidentally spilled, releasing invisible clouds of nauseous fumes. (Richard Viñas)

Photo credit: Dr. Irma Makalinao, 2007

Chemicals Found in Manila High School

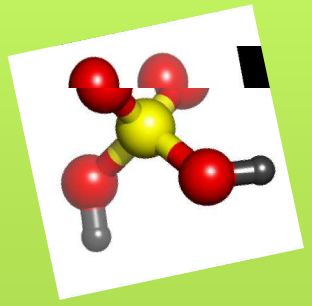
- Ammonia
- Chlorine
- Formaldehyde
- Hydrogen chloride
- Nitric acid
- Sulfur dioxide
- Sulfuric Acid
- Mercuric Chloride

Waste Drums from Makati School Remediation
Photo Credit: Dr. Irma Makalinao, 2007



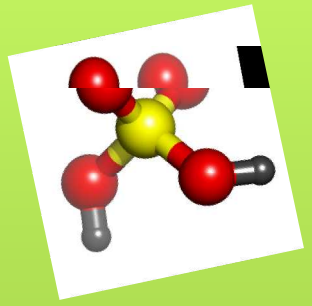
ICTR Chemical Safety & Security (CSS)Training

- Sandia ICTR manager had already established relationships with academic chemists and international chemical societies
- Sandia recognized the interrelationship between chemical safety and security (CSS) in developing countries
- CSS training program would initially focus on:
  - Chemists in academia, and
  - Promote CSS training through professional chemical associations



CSS Training-Emphasized Global Safety Regulations, Standards, Organizations

- Addressed established safety regulations and regulations in developing countries if promulgated
  - EU REACH
  - U.S. OSHA
  - Philippine Occupational Safety & Health Standards
- International chemical industry & labor organizations
  - International Chemical Council Association (ICCA)
    - Responsible Care Code
  - International Labor Organization (ILO)
- International standards/approaches
  - OHSAS 18001
  - GHS
  - SAICM



EU Reach

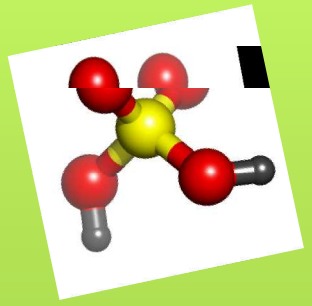
- REACH is the European Union regulation on chemicals and their safe use
  - EC 1907/2006
- The regulation requires *Registration, Evaluation, Authorization and Restriction of Chemical* substances.
- REACH Objective–to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances
- REACH places **greater responsibility on industry** to gather information on the chemical substances they produce or import
- Must register information in a central database run by the **European Chemicals Agency (ECHA).**
- REACH calls for the *progressive substitution* of the most dangerous chemicals when suitable alternatives have been identified.
- REACH provisions are being phased in over 11 years

International Chemical Council Association Responsible Care

- 2006-ICCA launched the **Responsible Care Global Charter** -International Conference on Chemicals Management in Dubai
- -Comprised of over **50** national chemical manufacturing companies
- -ICCA Responsible Care focuses on important global chemical challenges:
  - Sustainable development
  - Effective management of chemicals
  - Greater industry transparency
  - Improved consistency of Responsible Care programs around the world
  - Essential part of the UN's Strategic Approach to International Chemicals Management (SAICM).

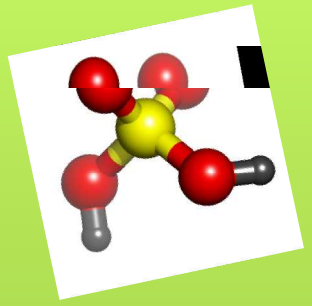
Global Responsible Care Associations

Ref: P. Lewis, Rohm and Haas



International Labor Organization (ILO)

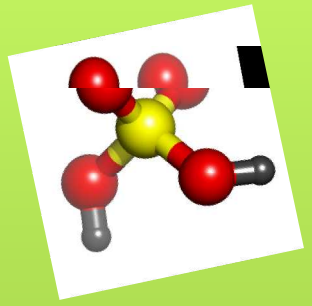
- ILO was founded in 1919
- ILO became the first specialized agency of the UN in 1946.
- The ILO Program on Safety and Health at Work and the Environment (SafeWork) aims to create worldwide awareness of the dimensions and consequences of work-related accidents, injuries and diseases.
- SafeWork's goal is to place the health and safety of all workers on the international agenda; and to stimulate and support practical action at all levels.
- Sandia training emphasizes use of:
  - ILO international chemical safety cards
    - Provide chemical safety information
    - Supplement MSDS



International Chemical Safety Cards

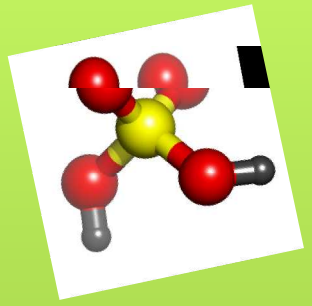
ILO Chemical Safety Cards Provide:

- Identity of the chemical;
- Fire and explosion hazards;
- Acute health hazards;
- Spillage disposal, storage and packaging;
- Preventive measures;
- Fire fighting;
- First aid;
- Classification and labeling;
- Physical & chemical properties &dangers;
- Short-term and long-term health effects;
- Regulatory information;
- Environmental data.



International Chemical Standards (OHSAS)

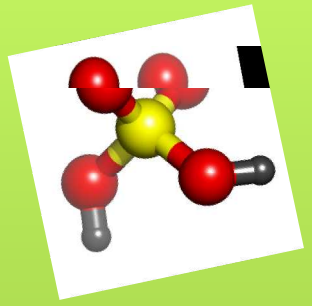
- OHSAS 18000 is an international occupational health and safety management system specification.
- OHSAS was developed in response to widespread demand for a recognized standard against which to be certified and assessed.
- It comprises two parts, 18001 and 18002.
- OHSAS 18001 is the *Occupational Health and Safety Assessment Series* for health and safety management systems.
- OHSAS 18002 provides the implementation guidelines.
- In 2005~16,000 organizations in more than 80 countries were using the OHSAS 18001 specification.
- In 2007 OHSAS updated to align better with ISO 9000 & ISO 14000
- By 2009->54,000 certificates had been issued in 116 countries to OHSAS or equivalent OHSMS standards.



The Strategic Approach to International Chemical Management (SAICM)

- SAICM is a policy framework to foster the sound management of chemicals
- Adopted at the International Conference on Chemicals Management (ICCM) on 6 February 2006 in Dubai, United Arab Emirates
- Administered through UN Environment Programs (UNEP)
- Recognizes modern society's reliance on chemicals and that chemical production one of the most globalized sectors of the world economy
- Also recognize the need to balance global economic role with:
  - Chemical industry's heavy use of water and energy
  - The potential adverse impacts of chemicals on the environment and human health.

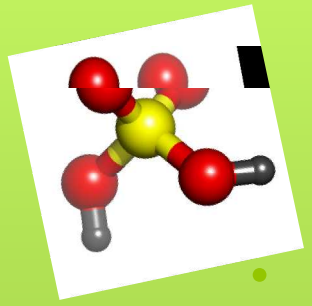
Sandia ICTR participated in the 3rd ICCM Session, 17-21 Sept 2012



Globally Harmonized System (GHS)

- Internationally agreed-upon system for classifying and labeling chemicals
- Introduced in 1992 at the UN Rio Conference
- Designed to replace diverse global classification/labeling systems
- Is required in the EU -CLP regulation
- US-Hazard Communication Standard now aligned with GHS
  - December 1, 2013-all employees must be trained in labeling and SDS format

Credit: US OSHA



Projects in Southeast Asia

- Dialogs with:
  - Government ministries in
    - Malaysia, Philippines, Indonesia
    - Assessed priorities and gaps in chemical safety and security regulations
  - International, regional and national professional chemical societies (FACS, HKI, IKM)
  - National chemical industry associations
    - SPIK, KN-RCI
  - University chemistry programs

Chemical Safety & Security Awareness Philippines-March 2008

- Two-1 day awareness courses presented at:
  - Ateneo de Manila University
  - University of San Carlos
- Established relationship with the Integrated Chemists of the Philippines
- Identified safety risks:
  - Improper storage (incompatibles)
  - No documented safety procedures, training
  - No exposure assessment
  - PPE relied on for exposure control
- Issues:
  - Chemical waste incineration prohibited in the Philippines-waste is stored on site!
  - MSDSs must be purchased through MSDS brokers, not received with chemicals!

Chemical Safety & Security Workshop Bali, August 2008

- One day workshop in concert with HKI/FACS conference
- 113 Indonesian chemists attended
- Breakout group discussion:
  - Lack of funding for safety/no enforcement of current safety regulations
  - Solid chemical waste is dumped in the environment
  - Participants stated: "Upper management needs to serve as leaders for excellent safety practices"

LEV exhausted outdoors

Photo credit: Douglas Walters

Chemical Safety & Security Workshop Bali, August 2008

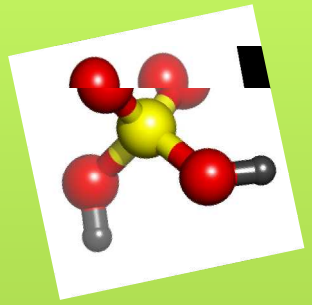
Other issues noted:

- Lack of training in maintenance of donated instrumentation/equipment
- No source of water–use rainwater for experiments
- Fume hood not operational or used for storage
- Gas cylinders not secured or capped

Photos credit: Douglas Walters

Chemical Safety & Security Workshop Malaysia-October 2008

- Two day training event
- 90 industrial and academic chemists attended
- In conjunction with Institut Kimia Malaysia (IKM) (Malaysian Chemical Society) conference



Chemical Safety & Security Workshops Malaysia-October 2008

- Performed walkthroughs of chemical labs, storage, and gas facilities at Universiti Kebangsaan Malaysia
- Laboratories, in general, demonstrated a high level of chemical safety awareness

Photo credit: Douglas Walters

Chemical Safety & Security Workshops Malaysia-October 2008

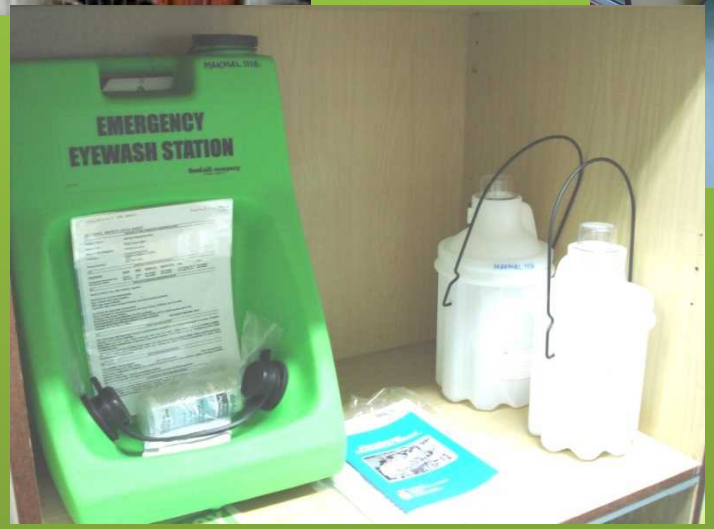


Photo credit: Douglas Walters

Chemical Safety & Security Workshops Malaysia-October 2008: Gas Cylinder Issues

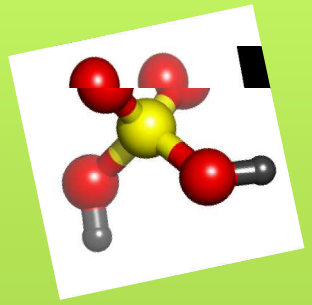
Photo credit: Douglas Walters

Chemical Safety & Security Workshops Malaysia-October 2008: Ventilation Issues

Photo credit: Douglas Walters

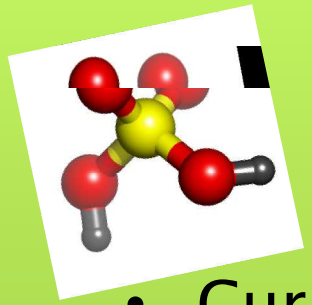
Chemical Safety & Security Workshops Malaysia-October 2008: Storage Issues

Photo credit: Douglas Walters



Chemical Safety & Security Workshops Philippines-October 2008

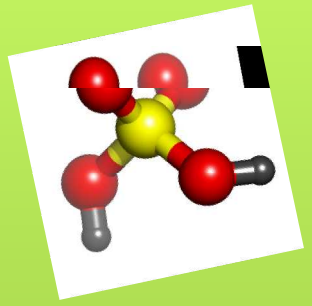
- 2 day training workshop
  - 39 academic chemists from Mindanao
- University of San Carlos labs
  - Chemical storage improved
  - Eyewashes/showers installed
  - Identified areas needing improvement:
    - How to id toxicity of chemicals
    - How to treat exposure of chemists
    - Emergency Response training
- Walked through chemical supply warehouse in Cebu: issues identified
  - -No grounding of solvents during transfer procedures
  - -Breathing protection consisted of cloth wrapped over the face



ICTR CSS Curriculum~2010

- Curriculum expanded from 1-day awareness training
- Five-day CSS officer training developed
- Introduced safety concepts based on industrial hygiene principles

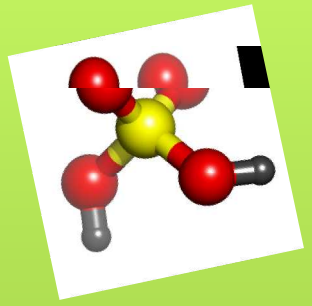
1. Identify hazards
   - Chemical, biological, physical, electrical, pressure, mechanical etc.
2. Evaluate exposure to hazards
3. Control exposure to hazards



ICTR CSS Curriculum

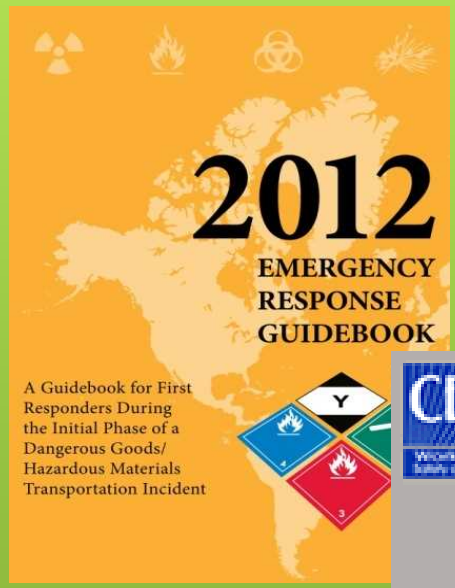
1. Examine Jobs and Processes
2. Identify Hazards
3. Evaluate Safety Risks
4. Are Risks Acceptable?

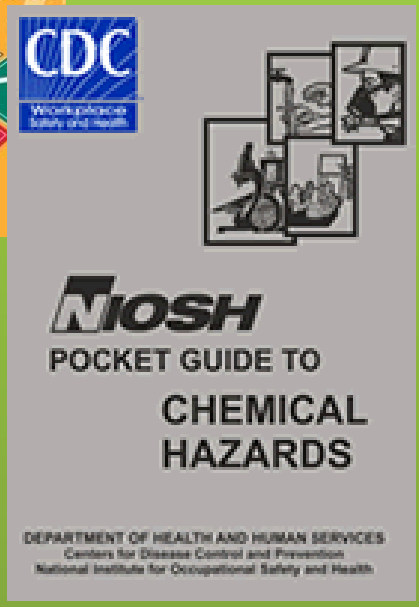
- Yes → Proceed with work and 6. Follow up with periodic repeat of steps 1-5
- No → 5. Implement Additional Control Measures → 1. Examine Jobs and Processes

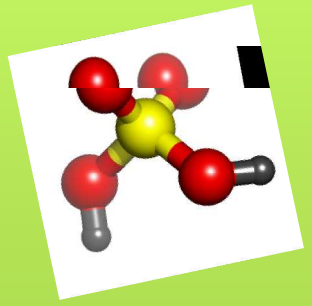


ICTR CSS Curriculum: Identify hazards

- Identify chemical, physical, other hazards
- (M)SDS
- ILO chemical safety cards
- Manufacturer information
- Online resources
  - Toxnet
    - **http://toxnet.nlm.nih.gov**
  - NIOSH Pocket Guide
  - Emergency Response Guidebook
    - **http://www.phmsa.dot.gov/hazmat/library/erg**





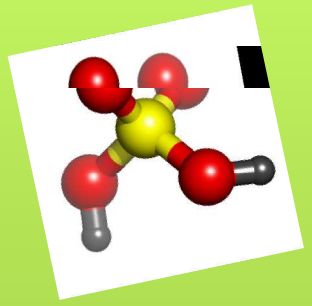


ICTR CSS Curriculum: Evaluate hazards-pathways

Source

Path

Receiver



ICTR CSS Curriculum: Evaluate hazards-routes of exposure

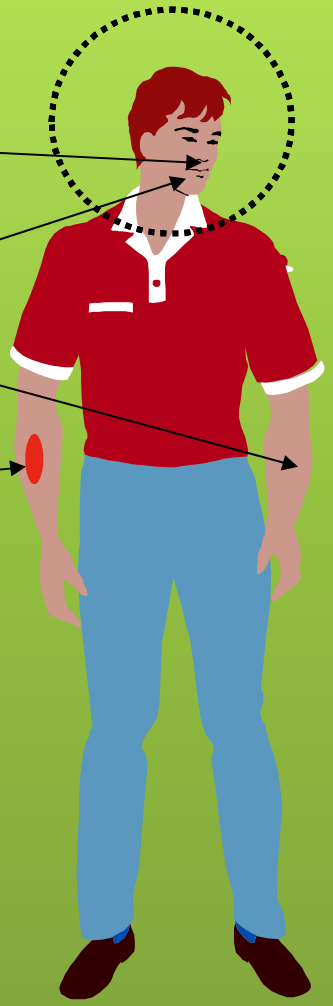
Inhalation*

Absorption

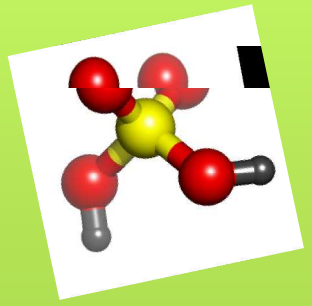
Ingestion

Injection

Eyes



*Most important route of entry



ICTR CSS Curriculum: Evaluate hazards

- Toxicology principles
- Exposure versus dose
- Exposure assessment/qualitative and quantitative
- Concepts of air sampling
- Exposure standards
  - OSHA PELS/ACGIH TLVs
  - Indicative OEL Values (IOELVs)
  - European Union Reach
    - Worker derived no-effect levels

ICTR CSS Curriculum: Implement Controls

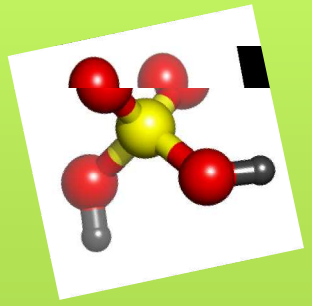
Photo credit: Douglas Walters

- Engineering controls
  - enclosure / isolation
  - ventilation / LEV
- Administrative controls
- Personal Protective Equipment (PPE)

ICTR CSS Curriculum: Engineering Controls

- Focus on laboratory fume hoods and local exhaust ventilation
- Emphasis on capture velocity assessment, hood maintenance, and proper use

Photo credit: Douglas Walters



ICTR CSS Curriculum: Engineering Controls

- Locate hood away from potential cross drafts
  - Diffusers, doors, windows, traffic
- Check hood is working properly before starting
- Check for containment
- Avoid clutter
- Do not use for storage
- Sash height at 12-18 “
- Work 6” in from sash
  - and in center

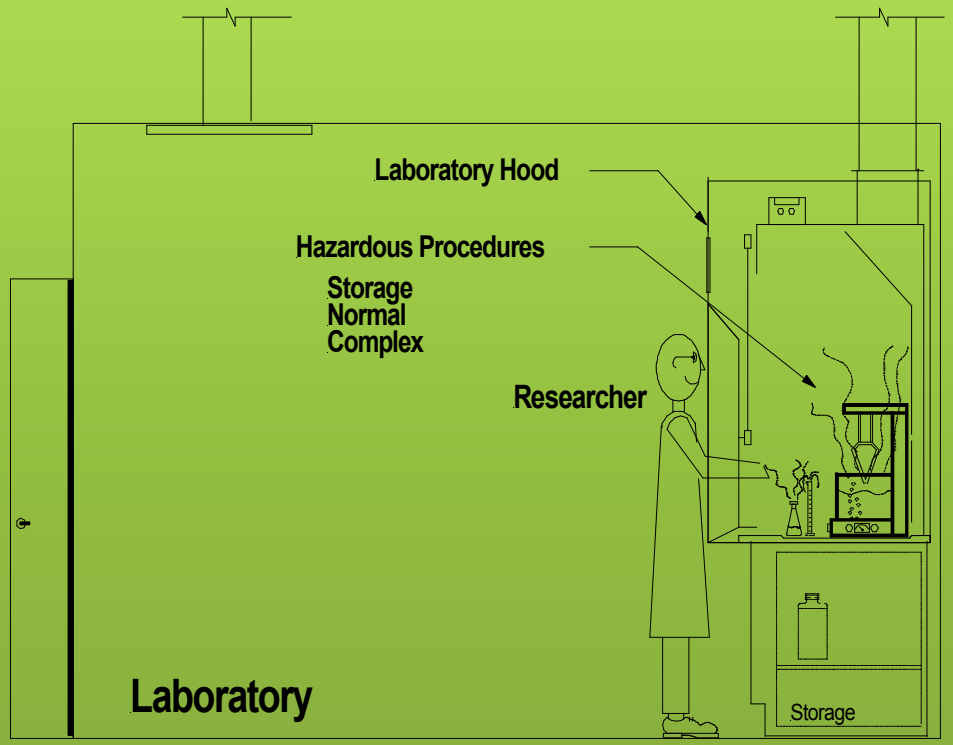
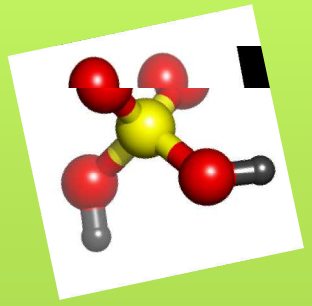


Figure: JCHAS Jan/Feb 2004

ICTR CSS Curriculum: Engineering Controls

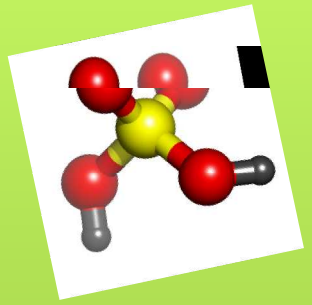
Hood exhaust should not be blocked or deflected downward, but should exhaust straight up

Photo credit: Douglas Walters



ICTR CSS Curriculum: Administrative Controls

- Chemistry departments need an overarching ***policy document***
  - Policy endorsed by management
- Standard operating procedures
- Safety policy documents, such as:
  - Safety glasses/PPE requirements
  - No mouth pipetting
  - Training requirements
  - Maintenance/inspection schedules
    - Fire extinguishers
    - Safety showers
- Scheduled regular inspections/audits



ICTR CSS Curriculum: Personal Protective Equipment

Guidance on:

- Eye protection
- Gloves (appropriate for laboratory use)
- Laboratory coats
- Respirators (discouraged)
- Closed toe shoes (hot climates)

ICTR CSS Curriculum: Personal Protective Equipment

1

2

3

4

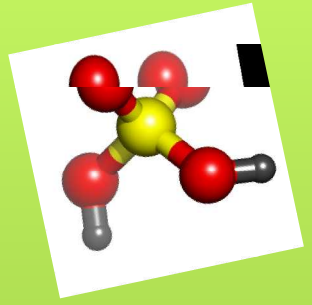
5

6

Demonstration of proper glove doffing

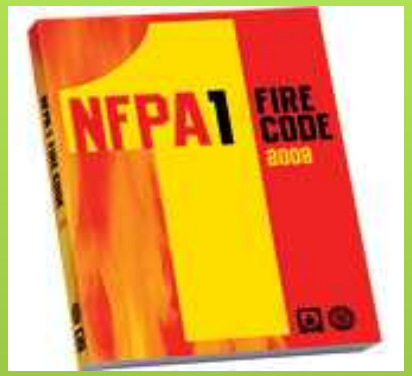
ICTR CSS Curriculum: Personal Protective Equipment

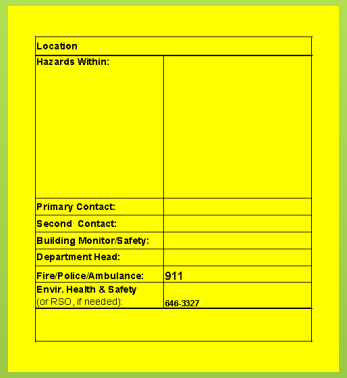
Improper use of filtering face piece use in Cambodia



ICTR CSS Curriculum: Emergency Planning/Response

- Written evacuation plan and maps
- Evacuation drills
  - Assembly locations
- Egress–Life safety
- Equipment inspection & maintenance
  - Extinguishers
  - Emergency lighting, alarms, detectors
- Fire extinguisher training





Location	
Hazards Within:	
Primary Contact:	
Second Contact:	
Building Monitor/Safety:	
Department Head:	
Fire/Police/Ambulance:	911
Envir. Health & Safety (or RSO, if needed):	646-3327

ICTR CSS Curriculum: Emergency Planning/Response

Chemistry Department Hallway

Photo credit: Douglas Walters

ICTR CSS Curriculum: Emergency Planning/Response

Fire Extinguisher Training in
Bangkok, Thailand

Chemical Safety & Security Workshops Indonesia-June 2013

We still have a long way to go!

Photo credit: Linda Stiles

Chemical Safety & Security Workshops Indonesia-June 2013

We still have a long way to go!

Photo credit: Linda Stiles

Chemical Safety & Security Workshops Indonesia-June 2013

We still have a long way to go!

Photo credit: Linda Stiles

Chemical Safety & Security Workshops Indonesia-June 2013

But we are making progress!

Photo credit: Linda Stiles

Chemical Safety & Security Workshops Indonesia-June 2013

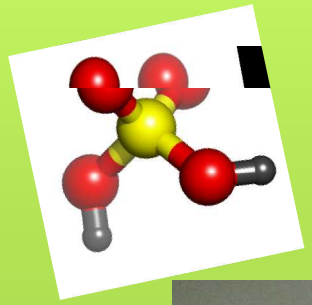
But we are making progress!

Photo credit: Linda Stiles

Chemical Safety & Security Workshops Indonesia-June 2013

But we are making progress!

Photo credit: Linda Stiles



And we meet some fantastic and enthusiastic people!