This paper describes objective technical results and analysis. Any subjective views or opinions that might be expressed in the paper do not necessarily represent the views of the U.S. Department of Energy or the United States Government.

SAND2019-2129C

Introduction to Chemical Security

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SAND2018-13514 TR

Global Chemical and Biological Security

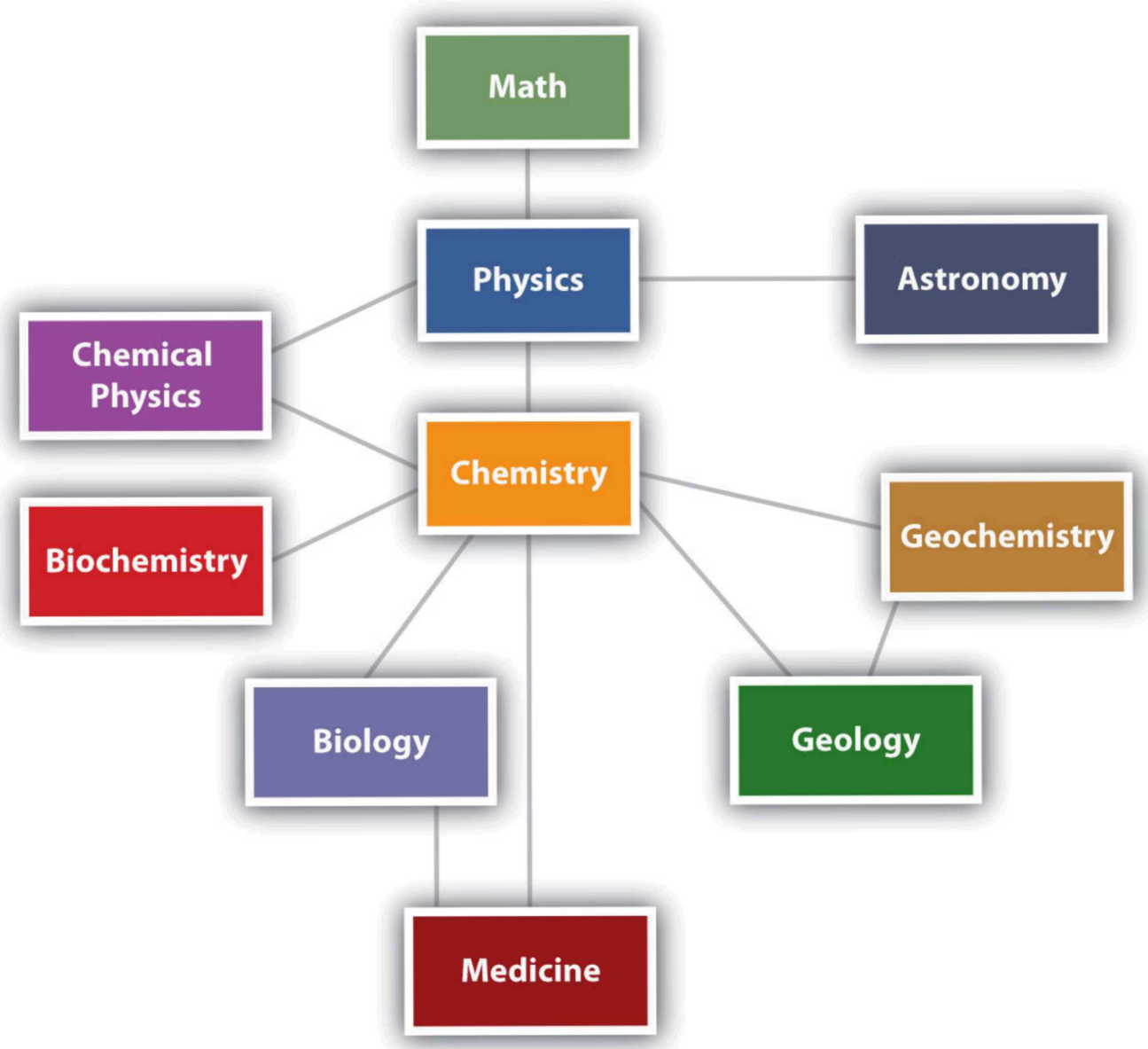
Sandia National Laboratories

Sandia National Laboratories
Albuquerque, New Mexico, USA

Nairobi, Kenya

TECHNICAL UNIVERSITY OF KENYA

"Better Living through Chemistry"

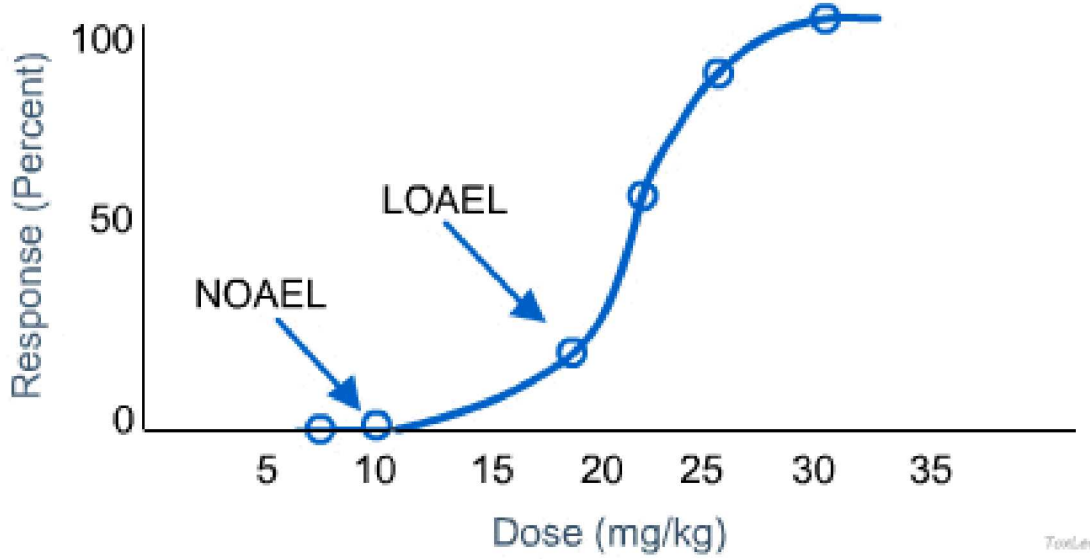

Math
Physics
Astronomy
Chemical Physics
Chemistry
Biochemistry
Geochemistry
Biology
Geology
Medicine

Individual Chemicals are Dangerous

Parcelsus (circa 1500): promoted the idea of "toxicon"

"*All substances are poisons; there is none which is not a poison. The right dose differentiates poison from a remedy.*"

Paracelsus



Casarett & Doull's. Toxicology. 7th Edition. Pg 4. McGraw Hill.

But, Better Living Comes at a Cost

Need for Chemical Safety

Pollution

Conflict

Accidents

CHEMICAL SAFETY

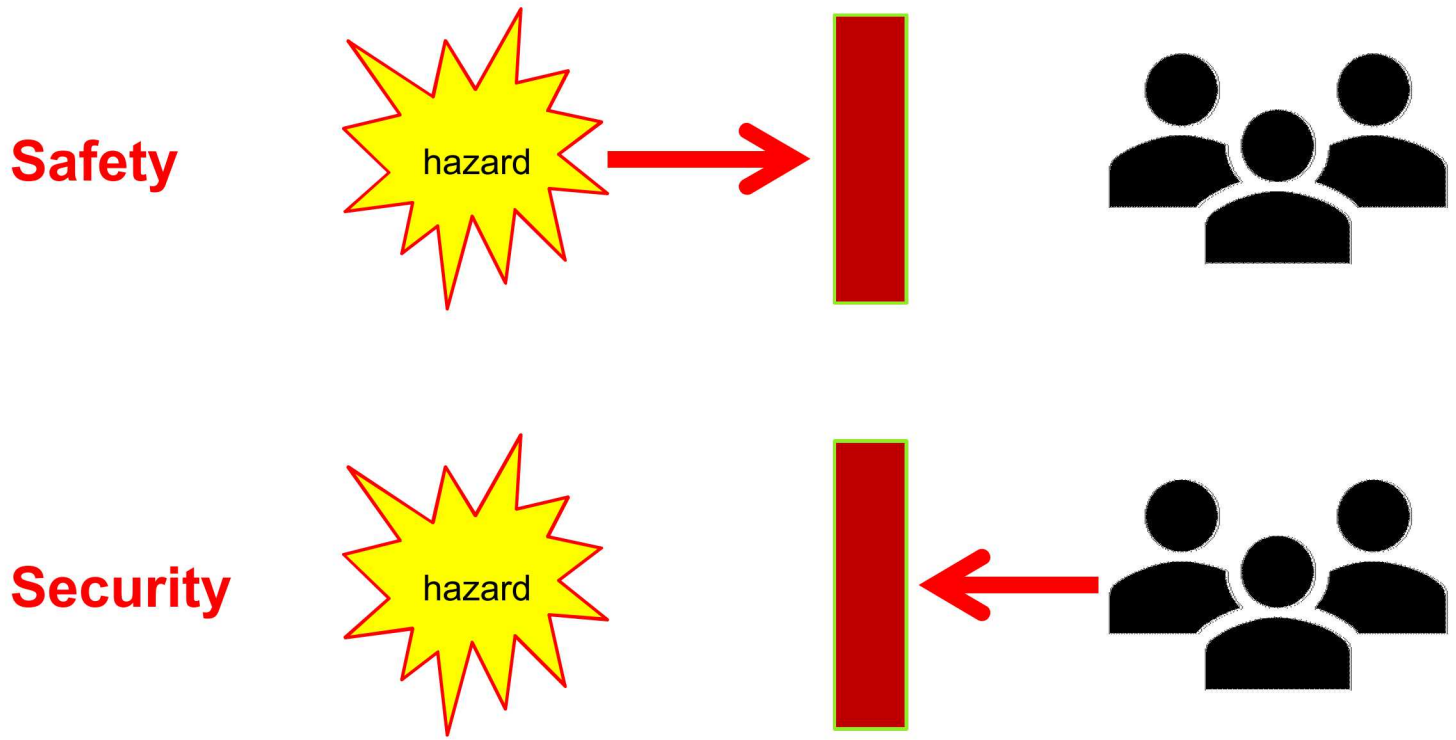
- **Chemical safety** is the application of the best practices for handling chemicals and chemistry processes to minimize risk, whether to a person, facility, or community.

- However, the chemicals that CHEMICAL SAFETY protects us from may be used by malicious people to attack us or our environment

- This brings in the need for CHEMICAL SECURITY

WHAT IS CHEMICAL SECURITY?

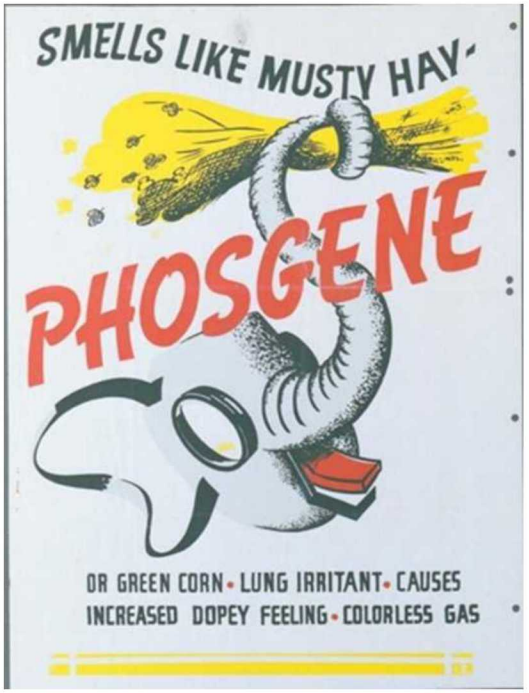
Protecting Chemicals from People with ill intent or limited knowledge of chemistry



Malicious application of Chemicals

Poisoning of Socrates 399BC

Suspected use of the Root of Hemlock



World War 1815
Second Battle of Ypres (1915)

Fritz Haber

- Best known for nitrogen fixation technology which led to Nobel Prize in Chemistry (1918)
- Haber Process

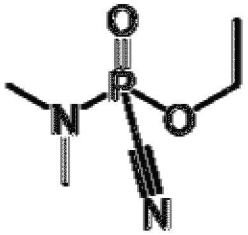
$$\underbrace{N_2 + 3H_2}_{\Delta H^\circ = -91.8\,kJ} \longrightarrow \underbrace{2NH_3}_{\Delta H^\circ = -45.8\,kJ\cdot mol^{-1}}$$

- Haber also played a role in the development of Germany's chemical weapons programs
- Contributed to the use of chlorine-gas in the Battle of Ypres
- His wife, also a chemist, committed suicide because of Fritz Haber's role in chlorine-gas campaigns

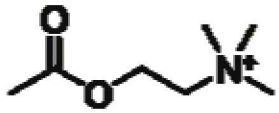
Chemical Weapons—Designed to Kill (1937)

- Tabun (organophosphate nerve agent) developed by Gerhard Schrader by accident in 1936

- Led to development of organophosphate nerve agents for military purposes



Tabun
(slow hydrolysis)



Acetylcholine
(fast hydrolysis)

- Tabun mimics the behaviour of the neurotransmitter acetylcholine

Nerve Agents Used in War

Iraq-Iran War: Iraq used nerve agent (Tabun) in warfare 1984 against Iran

Chemical Weapons—Non-State Actors

Aum Shinrikyo: nerve gas attacks in Matsumoto (1994) and Tokyo Subway System (1995)

Suspected chemical weapons attack in the Damascus suburbs on August 21, 2013 and Khan Shaykhun in 2017

Chemical Weapons—Still A Threat Today

Kim Jong-nam, February 13, 2017
*alleged assassinated with **VX***

Investigator Novel Baswedan (Senior Corruption Eradication Commission (KPK)) - **Acid attack (HCl)**, injuring left eye and face, North Jarkata in 2018

EXPLOSIVE CHEMICALS

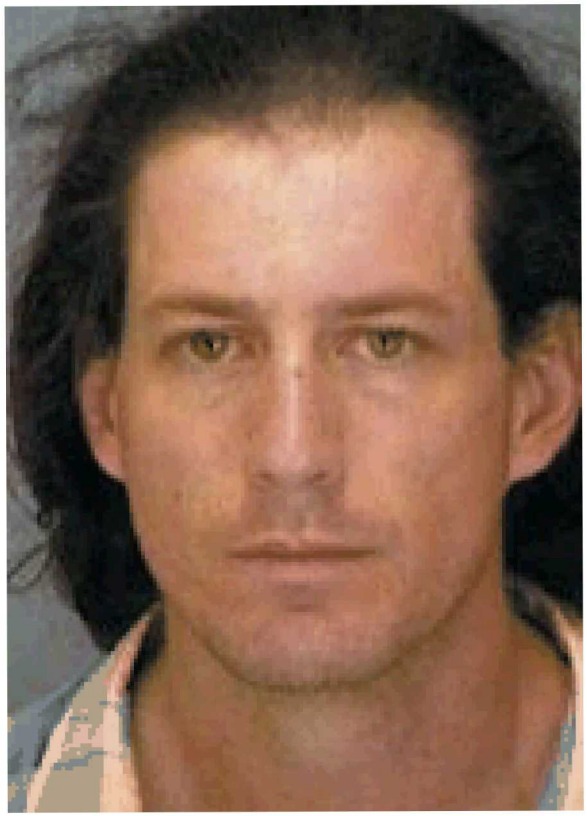
Date	Location
1995	Oklahoma City Bombing
1998	US Embassy, Nairobi
2000	Paris Bombing
2015	Found in Bomb Factory in Barcelona, Spain
2016	Brussels Bombings
2017	Bombing at Manchester Arena, London

Illicit Drug Production—Dual-Use Lab Reagents

- Opioids and acetic anhydride
- Pseudoephedrine and methamphetamine
- Ethanol
- Fentanyl
- Others

Illicit Drug Production—Methamphetamines

Image of a methamphetamine lab

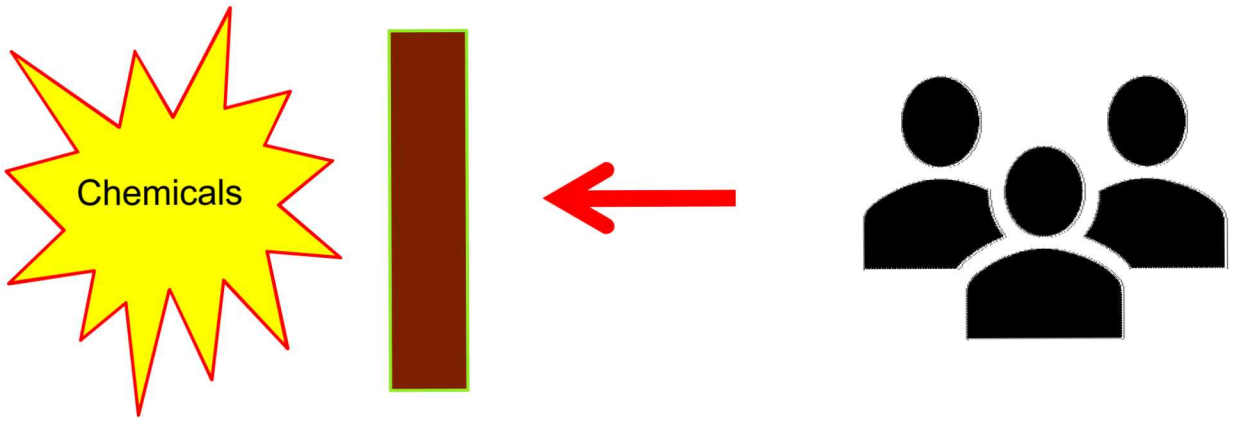


2008, UC Merced, Student Stole
~$10k in chemicals to make meth

What is Chemical Security?

Protecting Chemicals from People (with ill intent or limited knowledge of chemistry)

Chemical Security



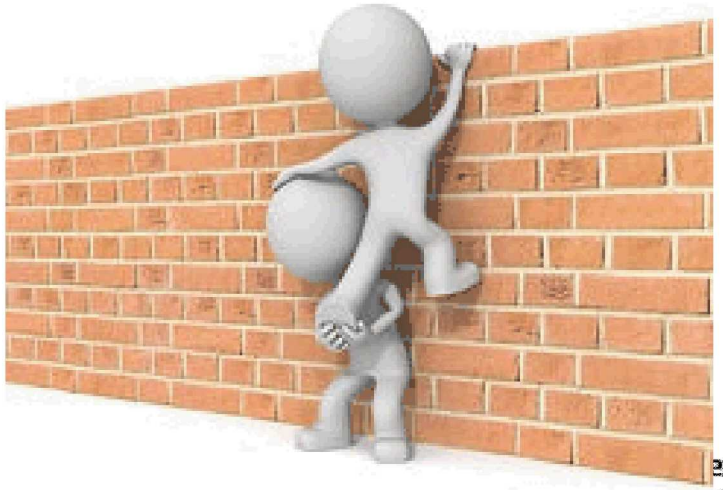
Who are we protecting chemicals from?

Types of threats

- Insiders
  - Often the most difficult to protect against
- Outsiders
- Collusion

Motivation of Threats

- Ideology
  - Terrorism or Activism
- Financial
- Coercion
- Others (Limited or no knowledge of chemistry)



Threats to Hospitals

Hospitals often have less security than government or commercial facilities

- Buildings and labs are more open, less secured
- Many transient people
- Many chemicals and equipment spread out in hospital buildings and labs

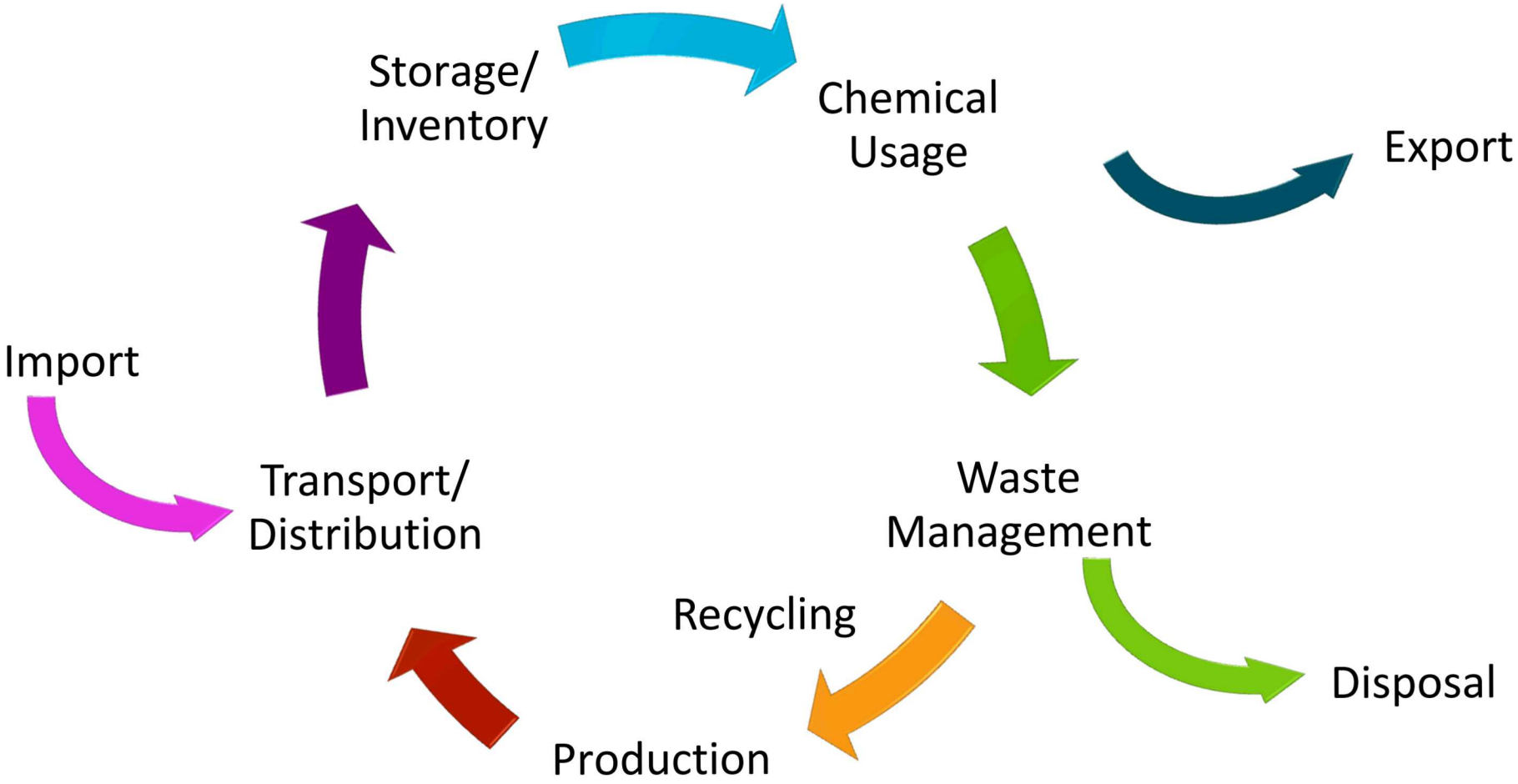
<u>Threats exist from</u>

- Terrorist groups and other extremists
- Protestors
- Criminal gangs
- Patients
- Internal personnel (insider threats)

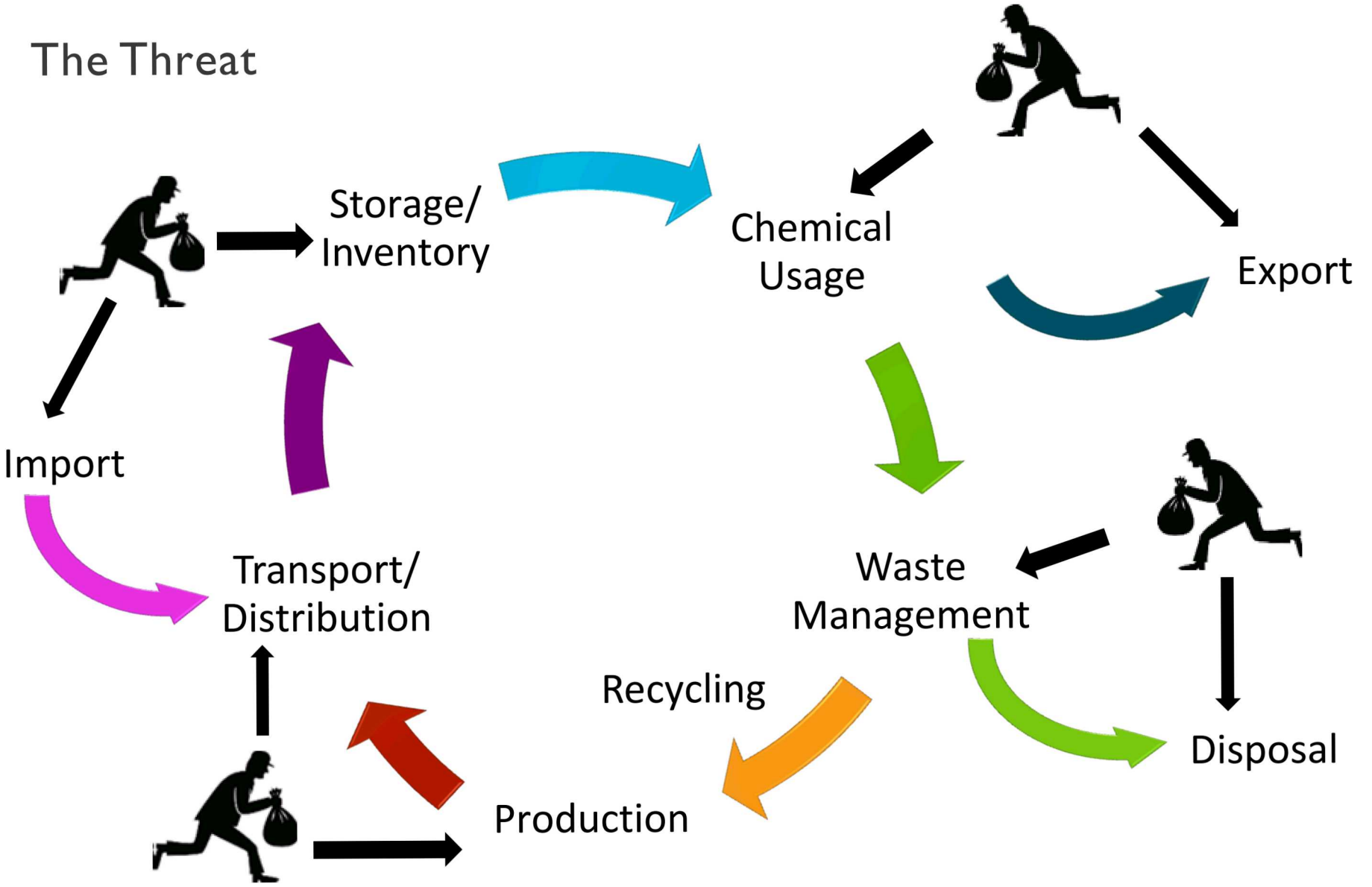
Some Chemicals Found in Hospitals

Chloroform	Isoflurane	Pseudoephedrine
Ethylene	Nitrous oxide	Ammonia
Ethylene Oxide	Sevoflurane	Fentanyls
Glutaraldehyde	Desflurane	
Xylene	Chlorine and other bleaches	
Formaldehyde	iodophoes	
Glycol ethers	ortho-benzyl-parachlorophenol (Clorox)	
Hydrogen peroxide	Quaternary ammonium compounds	
Peracetic acid (peroxyacetic acid (PAA))	Ketamine	
Orthophenylphenol (Amphyl)	Lysergic acid	

Chemical Life Cycle: Procurement to Disposal

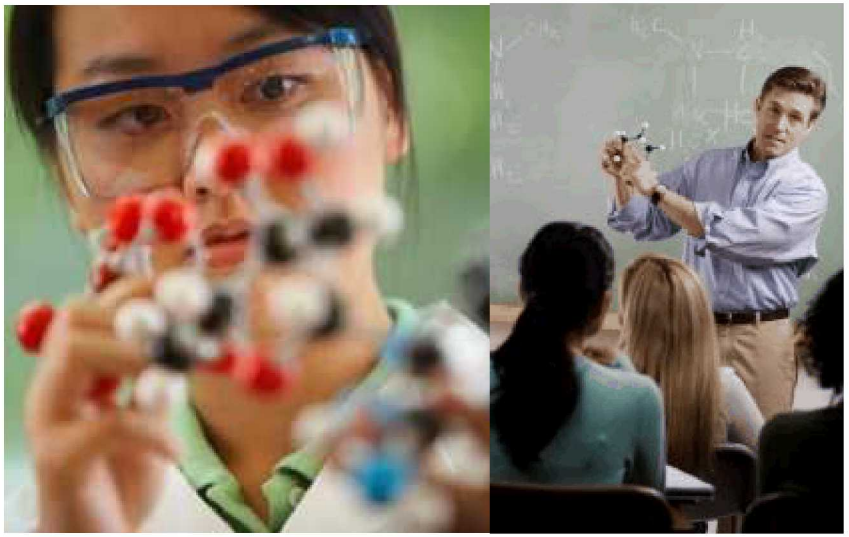


The Threat


Storage/
Inventory
Chemical
Usage
Export
Import
Transport/
Distribution
Waste
Management
Recycling
Disposal
Production

Dual Use Expertise

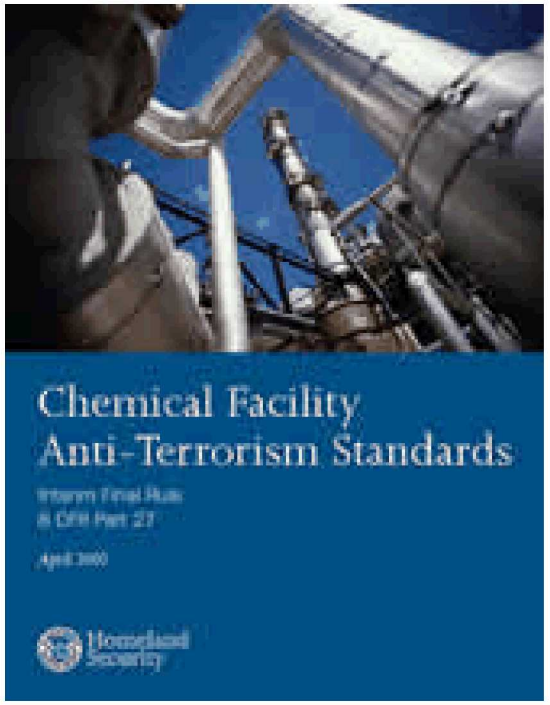
- The expertise of scientists and workers in the lab is also coveted and can be misused
  - Professors
  - Graduate students
  - Technologists
  - Facilities / stock room workers
  - Administration / other personnel



- Personnel reliability should be a consideration when managing people in the lab

Chemical expertise also needs to be considered and secured

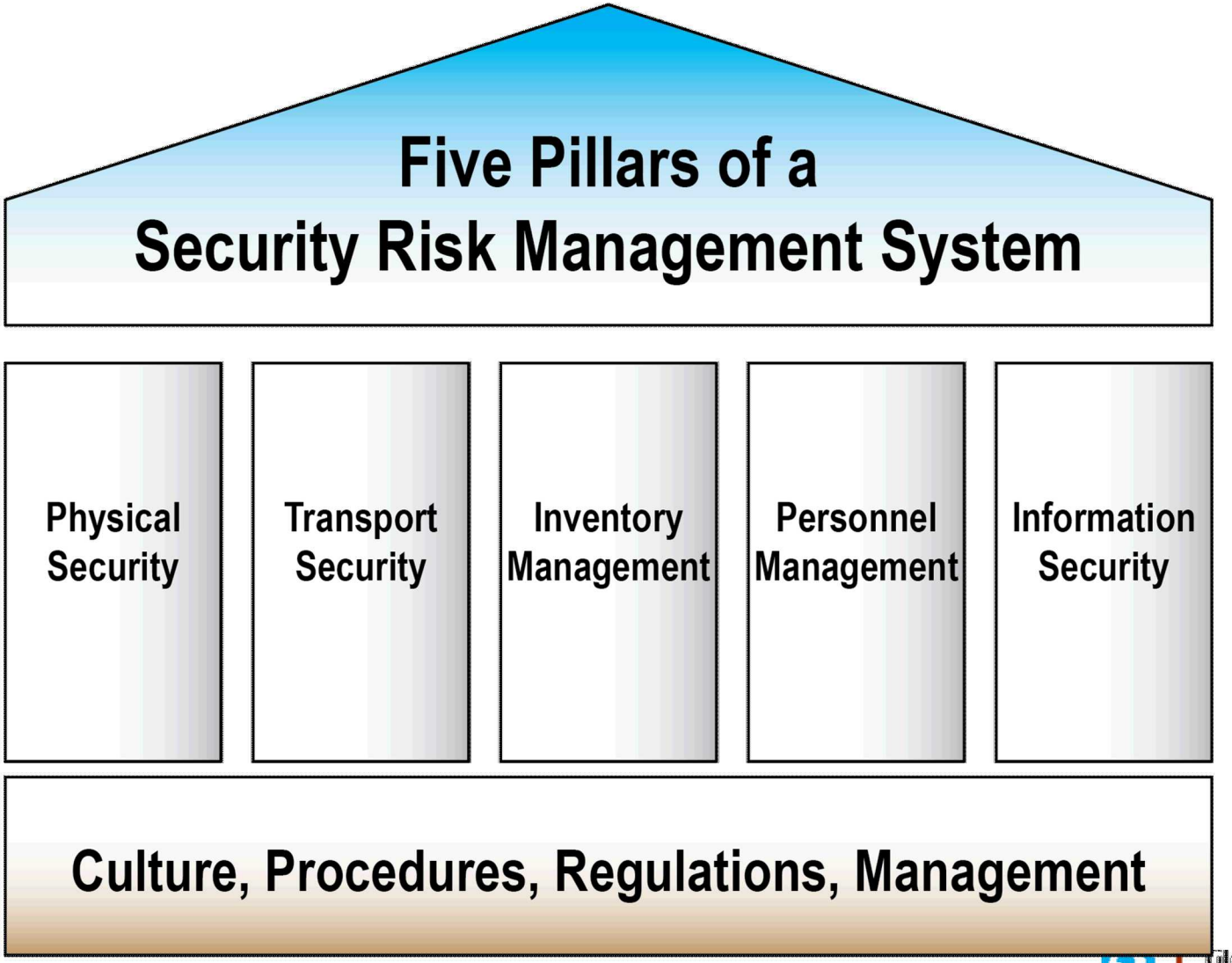
How Do We Stop Illicit Usage of Chemicals?



OPCW

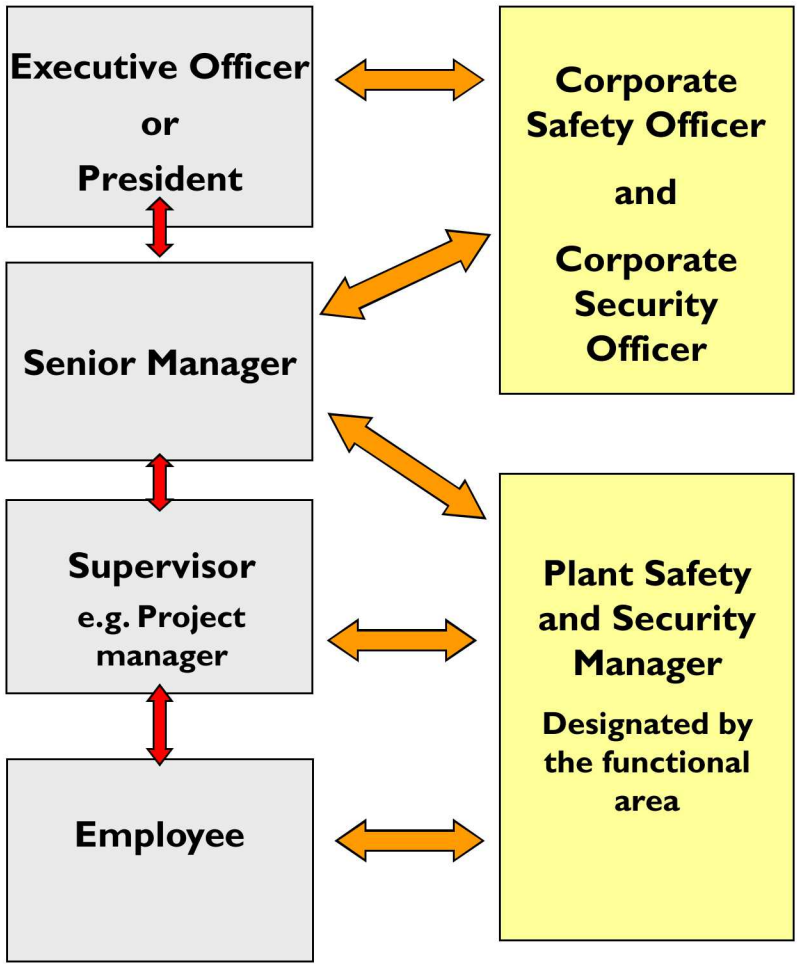
OPCW 1997-2017 YEARS

Regulations Are Just One Piece of the Solution



Chemical Safety and Security Culture

- Should exist at all levels of the organization
- Top management sets policy, provides resources
- Workers must understand and implement
- Many organizational interactions are important



Final Thoughts and Comments

- Unfortunately, chemicals have been and will continue to be misused by individuals and groups with malicious intent
- We need to be concerned with
  - Chemicals of Concern – especially dual-use chemicals
  - Equipment
  - Expertise
- A proper understanding of the hazards and threats will help determine the risk – and the proper precautions can then be considered

Questions?