

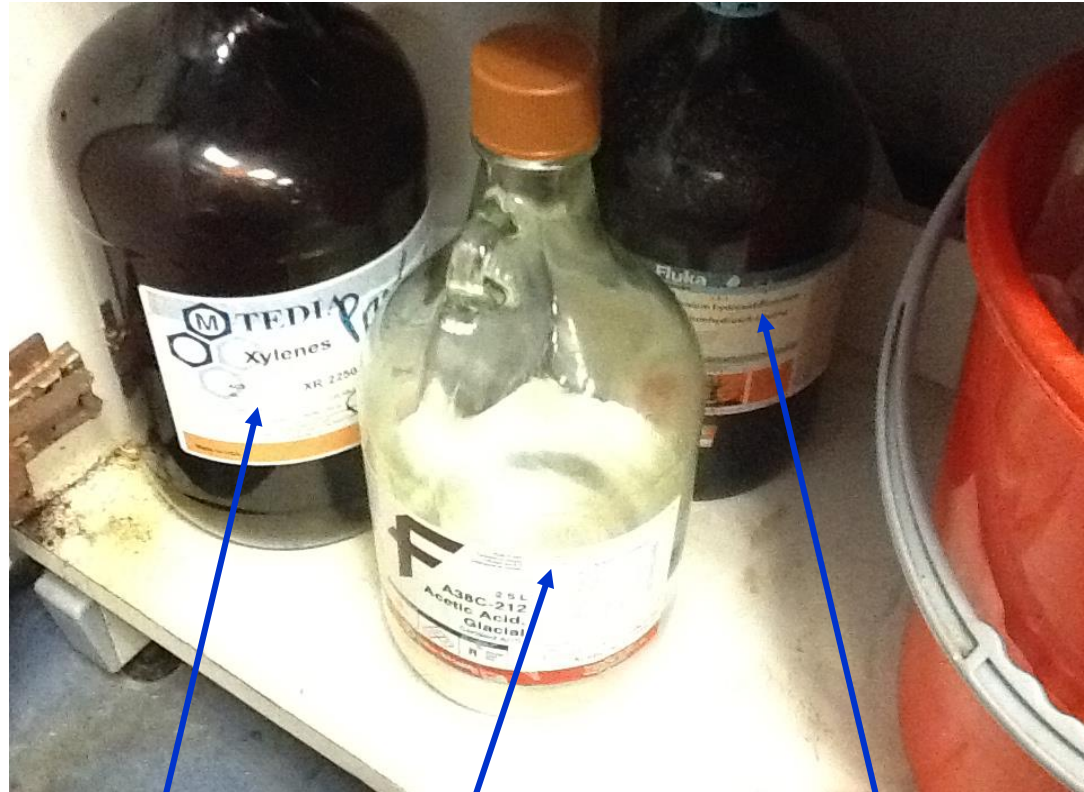
UNDERSTANDING **GHS** AND ITS IMPLEMENTATION IN NUS

CONTENTS

1. What is GHS and why GHS?
2. GHS Hazard classification (*with some technical info*)
3. Implementation
 - a. Labelling
 - b. Safety Data Sheets
4. Conclusion
5. Resources

INTRODUCTION – WHAT IS GHS?

1. The Globally Harmonised System of Classification and Labelling of Chemicals (**GHS**) is a system for **chemical classification** and **hazard communication** through **harmonised provisions** for standardised labels and safety data sheets (SDS) developed by United Nations.
 - a. Communicate using:
 - i. Product Identifier
 - ii. Pictogram
 - iii. Signal word
 - iv. Hazard statement
 - v. Precautionary statement



Xylene

Acetic Acid

Sodium Hydroxide

INTRODUCTION – WHAT IS GHS?

2. Legislative amendments to be aligned with GHS.
(WSHA Sect.16 and 5th Schedule)
→ For GHS implementation at the workplace
3. Singapore Standard on Hazard Communication for Hazardous Chemicals and Dangerous Goods (**SS 586**)
 - a) Part 1: Transport and Storage of Dangerous Goods
 - b) Part 2: Globally Harmonised System of Classification and Labelling of Chemicals – Singapore's Adaptations
 - c) Part 3: Preparation of Safety Data Sheets

INTRODUCTION

Irritant

Acute toxicity (severe)

Flammables

Skin corrosion










Carcinogens

Target organ toxicity

Serious eye damage



INTRODUCTION

Flame	Flame over circle	Exploding bomb
		
Corrosion	Gas cylinder	Skull and crossbones
		
Exclamation mark	Environment	Health hazard
		

INTRODUCTION – WHY GHS?

1. Globally Harmonised System:

- a. helps to get every country on the same page for chemical standards
- b. ensures that there is consistent information and communication of chemical hazards
- c. makes it safer for all chemical users who are exposed to chemical hazards (*especially in a diverse workplace*)



GHS CLASSIFICATION

Chemicals

Physical Hazards



Health Hazards



Environmental Hazards



GHS CLASSIFICATION

Classes within the **physical** hazard group:

- a) Explosives.
- b) Flammable gases.
- c) Aerosols.
- d) Oxidizing gases.
- e) Gases under pressure.
- f) Flammable liquids.
- g) Flammable solids.
- h) Self-reactive substances and mixtures.
- i) Pyrophoric liquids.
- j) Pyrophoric solids.
- k) Self-heating substances and mixtures.
- l) Substances and mixtures which, in contact with water, emit flammable gases.
- m) Oxidizing liquids.
- n) Oxidizing solids.
- o) Organic peroxides.
- p) Corrosive to metals.
- q) Desensitised explosives

5 PICTOGRAMS TO REPRESENT THESE HAZARDS

GHS CLASSIFICATION

Classes within the **health** hazard group:

- a) Acute toxicity.
- b) Skin corrosion/irritation.
- c) Serious eye damage/eye irritation.
- d) Respiratory or skin sensitization.
- e) Germ cell mutagenicity.
- f) Carcinogenicity.
- g) Reproductive toxicity.
- h) Specific target organ toxicity - single exposure.
- i) Specific target organ toxicity - repeated exposure.
- j) Aspiration hazard.

4 PICTOGRAMS TO REPRESENT THESE HAZARDS

GHS CLASSIFICATION

Classes within the **environmental** hazard group:

- a) Hazardous to the aquatic environment (acute and chronic).
- b) Hazardous to the ozone layer

1 PICTOGRAM TO REPRESENT THESE HAZARDS

HAZARD CLASSIFICATION

(THE TECHNICAL PORTION)

PHYSICAL HAZARD CLASSES

Hazard Class	Hazard Category						
	Unstable Explosives	Div 1.1	Div 1.2	Div 1.3	Div 1.4	Div 1.5	Div 1.6
Explosive	Unstable Explosives	Div 1.1	Div 1.2	Div 1.3	Div 1.4	Div 1.5	Div 1.6
Flammable gases (including chemically unstable gases)	Flammable Gas Cat 1	Flammable Gas Cat 2	Chemically unstable Gas Cat A	Chemically unstable Gas Cat B			
Aerosols	Cat 1	Cat 2	Cat 3				
Oxidizing gases	Cat 1						
Gases under pressure	Compressed Gas	Liquefied Gas	Refrigerated Liquefied Gas	Dissolved Gas			
Flammable liquids	Cat 1	Cat 2	Cat 3	Cat 4*			
Flammable solids	Cat 1	Cat 2					
Self-reactive substances and mixtures	Type A	Type B	Type C & D	Type E & F	Type G		
Pyrophoric liquids	Cat 1						
Pyrophoric solids	Cat 1						
Self-heating substances and mixtures	Cat 1	Cat 2					
Substances and mixtures which, in contact with water, emit flammable gases	Cat 1	Cat 2	Cat 3				
Oxidizing liquids	Cat 1	Cat 2	Cat 3				
Oxidizing solids	Cat 1	Cat 2	Cat 3				
Organic peroxides	Type A	Type B	Type C & D	Type E & F	Type G		
Corrosive to metals	Cat 1						

PHYSICAL HAZARD CLASSES

Flammable liquid:

Category	Criteria
1	Flash point < 23°C and initial boiling point ≤ 35°C
2	Flash point < 23°C and initial boiling point > 35°C
3	Flash point ≥ 23°C and ≤ 60°C
4	Flash point > 60°C and ≤ 93°C

PHYSICAL HAZARD CLASSES

1. What does it mean if a flammable liquid is classified in a different category?

	Category 1	Category 2	Category 3	Category 4
Symbol	Flame	Flame	Flame	No symbol
Signal Word	Danger	Danger	Warning	Warning
Hazard Statement	Extremely flammable liquid and vapour	Highly flammable liquid and vapour	Flammable liquid and vapour	Combustible Liquid

HEALTH HAZARD CLASSES

Hazard Class	Hazard Category				
Acute toxicity	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5
Skin corrosion/irritation	Cat 1A	Cat 1B	Cat 1C	Cat 2	Cat 3
Serious eye damage/eye irritation	Cat 1	Cat 2A	Cat 2B		
Respiratory or skin sensitisation	Respiratory Cat 1A	Respiratory Cat 1B	Skin Cat 1A	Skin Cat 1B	
Germ cell mutagenicity	Cat 1A	Cat 1B	Cat 2		
Carcinogenicity	Cat 1A	Cat 1B	Cat 2		
Reproductive toxicity	Cat 1A	Cat 1B	Cat 2	Lactation	
Specific target organ toxicity - single exposure	Cat 1	Cat 2	Cat 3		
Specific target organ toxicity - repeated exposure	Cat 1	Cat 2			
Aspiration hazard	Cat 1	Cat 2			

HEALTH HAZARD CLASSES

Germ Cell Mutagenicity

Category	Criteria
1A	Chemicals known to induce heritable mutations in germ cells of humans
1B	Chemicals regarded as if they induce heritable mutations in germ cells of humans
2	Chemicals which cause concern for humans owing to the possibility that they may induce heritable mutations in the germ cells of humans

HEALTH HAZARD CLASSES

CATEGORY 1: Substances known to induce heritable mutations or to be regarded as if they induce heritable mutations in the germ cells of humans

Category 1A: Substances known to induce heritable mutations in germ cells of humans

Positive evidence from human epidemiological studies.

Category 1B: Substances which should be regarded as if they induce heritable mutations in the germ cells of humans

- (a) Positive result(s) from *in vivo* heritable germ cell mutagenicity tests in mammals; or
- (b) Positive result(s) from *in vivo* somatic cell mutagenicity tests in mammals, in combination with some evidence that the substance has potential to cause mutations to germ cells. This supporting evidence may, for example, be derived from mutagenicity/genotoxic tests in germ cells *in vivo*, or by demonstrating the ability of the substance or its metabolite(s) to interact with the genetic material of germ cells; or
- (c) Positive results from tests showing mutagenic effects in the germ cells of humans, without demonstration of transmission to progeny; for example, an increase in the frequency of aneuploidy in sperm cells of exposed people.

CATEGORY 2: Substances which cause concern for humans owing to the possibility that they may induce heritable mutations in the germ cells of humans

Positive evidence obtained from experiments in mammals and/or in some cases from *in vitro* experiments, obtained from:

- (a) Somatic cell mutagenicity tests *in vivo*, in mammals; or
- (b) Other *in vivo* somatic cell genotoxicity tests which are supported by positive results from *in vitro* mutagenicity assays.

NOTE: Substances which are positive in *in vitro* mammalian mutagenicity assays, and which also show structure activity relationship to known germ cell mutagens, should be considered for classification as Category 2 mutagens.

HEALTH HAZARD CLASSES

1. What does it mean if the hazard falls into a different category?

	Category 1 (1A and 1B)	Category 2
Symbol	Health Hazard	Health Hazard
Signal Word	Danger	Warning
Hazard Statement	May cause genetic defects <i>(State route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)</i>	Suspected of causing genetic defects <i>(State route of exposure if it is conclusively proven that no other routes of exposure cause the hazard)</i>

CLASSIFICATION OF MIXTURES

1. Products bought from suppliers – rely on SDS. How about mixtures prepared by researchers?
 - a) Physical hazard classification → tested against the specified hazard parameters

Example of test criteria (Corrosive to Metals):

Category	Criteria
1	Corrosion rate on either steel or aluminium surfaces exceeding 6.25mm per year at a test temperature of 55°C when tested on both materials

CLASSIFICATION OF MIXTURES

- b) Health hazard classification → dependent on amount of test data available
- i. **Acute toxicity:** Classification of mixtures based on available Acute Toxicity Estimate (ATE) values for all relevant ingredients using the additivity formula and cross-reference with hazard-banding table

$$\frac{100}{ATE_{mix}} = \sum_n \frac{C_i}{ATE_i}$$

- ii. **Other hazard classes:** Classification of mixtures based on cut-off values

ACUTE TOXICITY CLASSIFICATION

Exposure route	Category 1	Category 2	Category 3	Category 4	Category 5
Oral (mg/kg bodyweight) <i>See notes (a) and (b)</i>	$ATE \leq 5$	$5 < ATE \leq 50$	$50 < ATE \leq 300$	$300 < ATE \leq 2000$	$2000 < ATE \leq 5000$ <i>See detailed criteria in Note (g)</i>
Dermal (mg/kg bodyweight) <i>See notes (a) and (b)</i>	$ATE \leq 50$	$50 < ATE \leq 200$	$200 < ATE \leq 1000$	$1000 < ATE \leq 2000$	
Gases (ppmV) <i>See notes (a), (b) and (c)</i>	$ATE \leq 100$	$100 < ATE \leq 500$	$500 < ATE \leq 2500$	$2500 < ATE \leq 20000$	<i>See detailed criteria in Note (g)</i>
Vapours (mg/l) <i>See notes (a), (b), (c), (d) and (e)</i>	$ATE \leq 0.5$	$0.5 < ATE \leq 2.0$	$2.0 < ATE \leq 10.0$	$10.0 < ATE \leq 20.0$	
Dusts and Mists (mg/l) <i>See notes (a), (b), (c) and (f)</i>	$ATE \leq 0.05$	$0.05 < ATE \leq 0.5$	$0.5 < ATE \leq 1.0$	$1.0 < ATE \leq 5.0$	

CLASSIFICATION OF MIXTURES

Other health hazard classes

If mixed/diluted with a substance which has an equivalent or lower hazard category classification than the least hazardous original ingredient substance, the new mixture may be classified as equivalent to the original.

(retain initial classification or based on cut-off value)

Example of mixtures containing carcinogens:

Ingredient classified as:	Generic concentration limits triggering classification of a mixture as	
	Cat 1 Carcinogen	Cat 2 Carcinogen
Cat 1 Carcinogen	≥ 0.1%	-
Cat 2 Carcinogen	-	≥ 1.0%

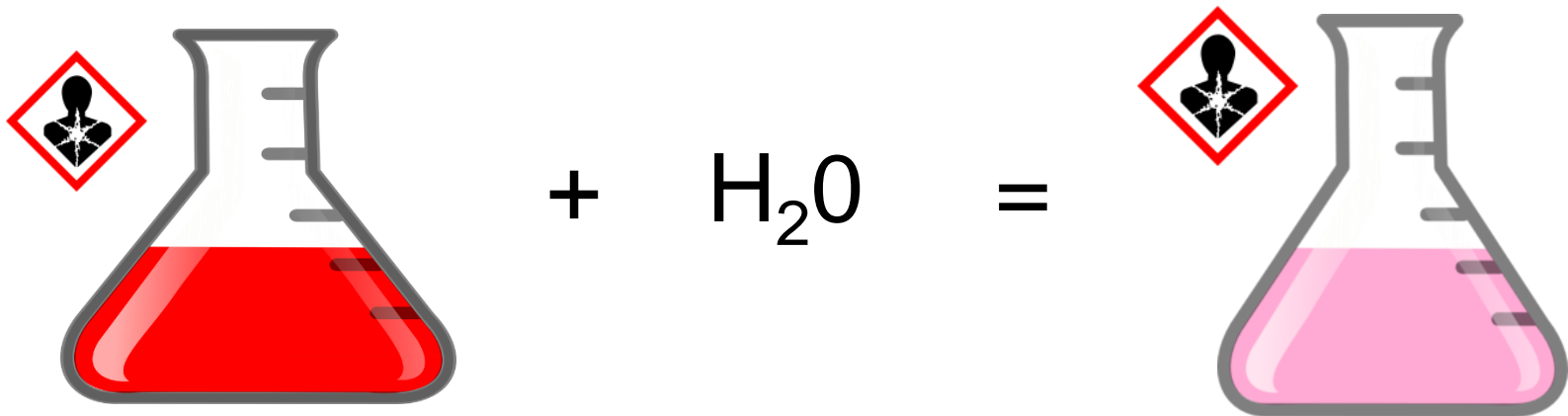
CLASSIFICATION OF MIXTURES

- c) Environmental hazard classification → dependent on amount of test data available
- i. **Additivity formula:** Concentration and LC50 or EC50 of ingredients

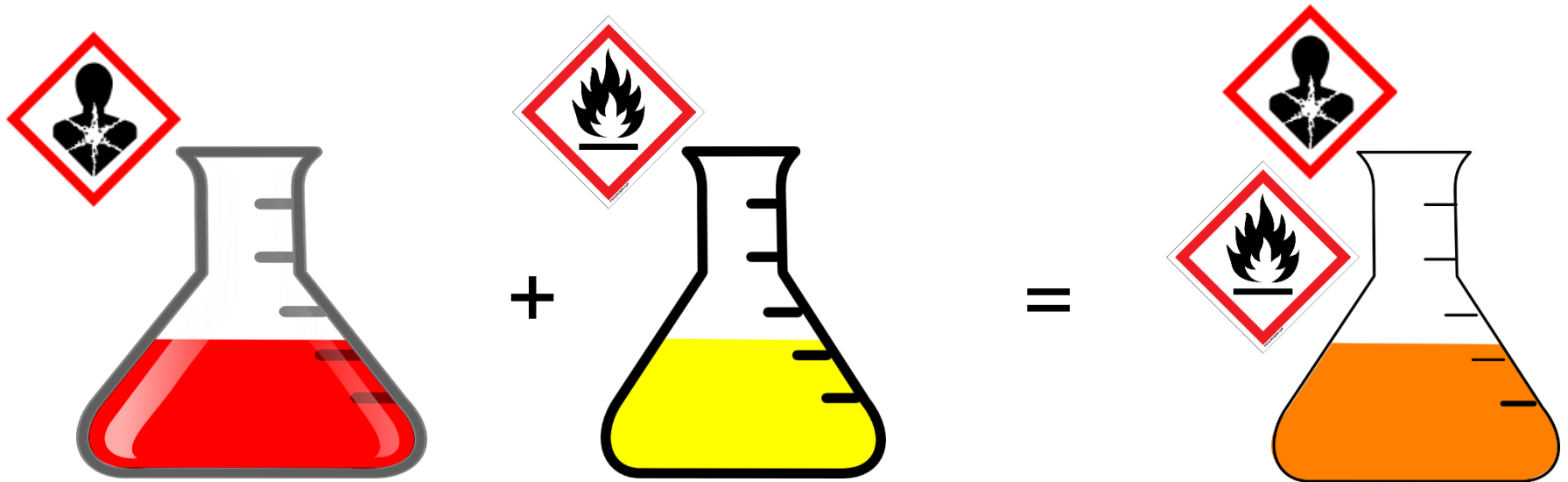
$$\frac{100}{ATE_{mix}} = \sum_n \frac{C_i}{ATE_i}$$

CLASSIFICATION OF MIXTURES

Example:



CLASSIFICATION OF MIXTURES



IMPLEMENTATION –

WHAT YOU NEED TO KNOW

GHS LABELLING

Workplace Safety and Health (General Provisions) Regulations

Section 42 (Warning Labels) of the stipulates that it shall be the duty of the occupier of a workplace in which there is **any container of hazardous substances** to ensure that, as far as reasonably practicable, every such container **is affixed with one or more labels** that are in accordance with:

- (1) any **Singapore Standard** relating to the classification and labelling of hazardous substances; or
- (2) such other standards, codes of practice or guidance relating to the classification and labelling of hazardous substances as issued or approved by the Council.


GHS LABELLING

1. Enable users to know
 - a. the identities of the chemicals, and
 - b. the hazards involved.

2. Prevent unintentional mixing of incompatible chemicals


GHS LABELLING

1. Product Identifier
2. Pictogram
3. Signal word
4. Hazard statement
5. Precautionary statement
(learn more about hazard and precautionary statements in Annex 3 of the GHS Booklet)
6. Supplementary information
7. Supplier information



1 ISOBUTYL ALCOHOL

CAS Number: 78-83-1
DOT Number: UN 112


2 

3 **DANGER**


4 Highly flammable liquid and vapor. Causes serious eye damage. May cause drowsiness and dizziness.

5 Keep away from heat/sparks/open flames/hot surfaces. No smoking. Avoid breathing fumes/mist/vapors/spray. Wear protective gloves/protective clothing/eye protection/face protection. **IF IN EYES:** Rinse cautiously with water for several minutes. Remove contact lenses if present. Continue rinsing.

Fill Weight: 123.45 lbs. Lot No.: 6305051700 **6** See SDS for further information

Gross Weight: 145.60 lbs. 

Fill Date: 10/9/2013

7 IMPRINT ENTERPRISES  SINCE 1975 555 N. Commons Dr. * Aurora, IL. 60504 * 800.433.4512 * www.imprint-e.com

What should I do if my bottle is **small** ??

REDUCED WORKPLACE LABELLING

SS586 Part 2, Section 6.3

Where a full GHS label is not practicable, a workplace label shall be used.

(applicable for hazardous chemicals used in laboratories)

A workplace label shall consist of:

- Product identifier, and
- Pictogram(s)



SAFETY DATA SHEET

1. Required by WSH (General Provisions) Regulations section 43 and SS586 Part 3
2. Enable users to
 - a. Understand the hazards of the chemicals,
 - b. Assess the risk involved in handling them, and
 - c. Take precautionary measures
3. 16 sections in a prescribed sequence

SAFETY DATA SHEET


1. *Identification*
2. *Hazards identification*
3. *Composition / information on ingredients*
4. *First aid measures*
5. *Fire fighting measures*
6. *Accidental release measures*
7. *Handling and storage*
8. *Exposure controls / personal protection*
9. *Physical and chemical properties*
10. *Stability and reactivity*
11. *Toxicological information*
12. *Ecological information*
13. *Disposal considerations*
14. *Transport information*
15. *Regulatory information*
16. *Other information of importance to safety and health*

HOW CAN GHS HELP ME?

SOME OBSERVATIONS



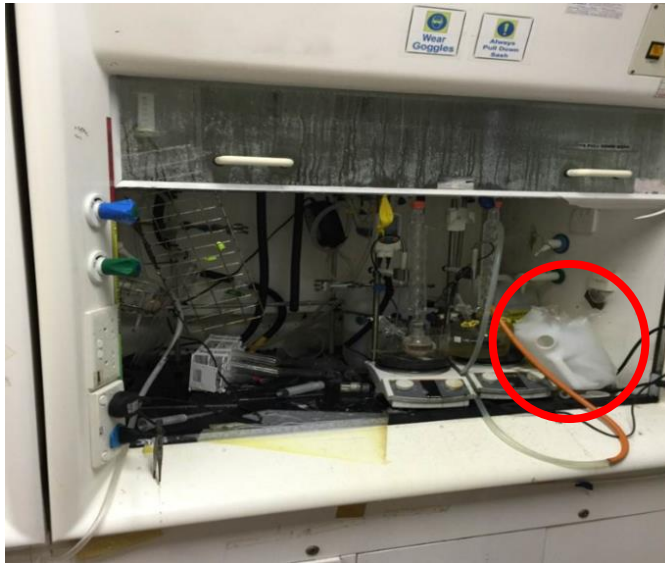
CASE STUDY 1

1. Cornell University (published as a letter in a ACS publication [here](#))
2. A graduate student was cleaning glass frits with a freshly prepared mixture of concentrated H_2SO_4 and 30% H_2O_2 . 
3. The cleaning operation was to be followed by washing with deionized water and finally acetone

CASE STUDY 1

4. A **violent explosion** occurred, which shattered the heavy walled filter flask and caused **multiple cuts** in the face, chest, and forearms of the student.
 - a) A partially lowered hood sash and appropriate PPE (safety glasses, lab coat, and heavy rubber gloves) provided some protection, but could not prevent the infliction of serious injuries.
 5. Inadvertent mixing of the highly oxidizing H_2SO_4 and H_2O_2 mixture with an acetone residue was the cause of this accident.
-

CASE STUDY 2



1. Incident in NUS

- a. Read about the incident in NUS Safety and Health News – [June 2015](#)

CASE STUDY 2

1. A graduate student was using aqua regia (1 part HNO_3 : 3 parts HCl) for the cleaning of apparatus.
2. Poured waste into a plastic container previously used for acetone.
3. Placed uncapped container in fumehood and continue working.
4. After about 10 minutes, the container ruptured and the contents splashed onto his face and left arm.

Inorganic acids + organic solvents =



CASE STUDY 3

A UC Berkeley researcher was preparing a sample for microscopy. After he had cleaned the sample with isopropanol, he poured the extra isopropanol into a container for unwanted chemicals labeled “isopropanol”. There was an immediate chemical reaction that caused the plastic container to rupture and spray the mixture around the area. He was later surprised to learn that the container actually held concentrated nitric acid in the form of spent copper etchant.

[Read about the incident here](#)

CONCLUSION

- 1) Singapore Standards 586 prescribe the implementation of the GHS.
- 2) In laboratories, a reduced workplace label is sufficient. The label must indicate:
 - a) Product identifier (*chemical name, in English*)
 - b) GHS pictogram(s)

RESOURCES

1. [GHS Booklet](#) (7th edition by UNECE)
2. [GHS Introduction Booklet](#) (by WSHC)

THANK YOU