New-hire Training: Prevention of Occupational Accidents

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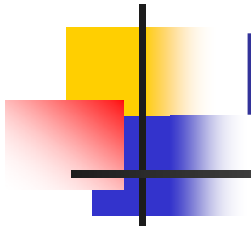
Outline

- Hazards in the work place
- Safety rights and obligation
- Occupational accidents
- Hazard communication
- Lab waste management
- Conclusion
- Test

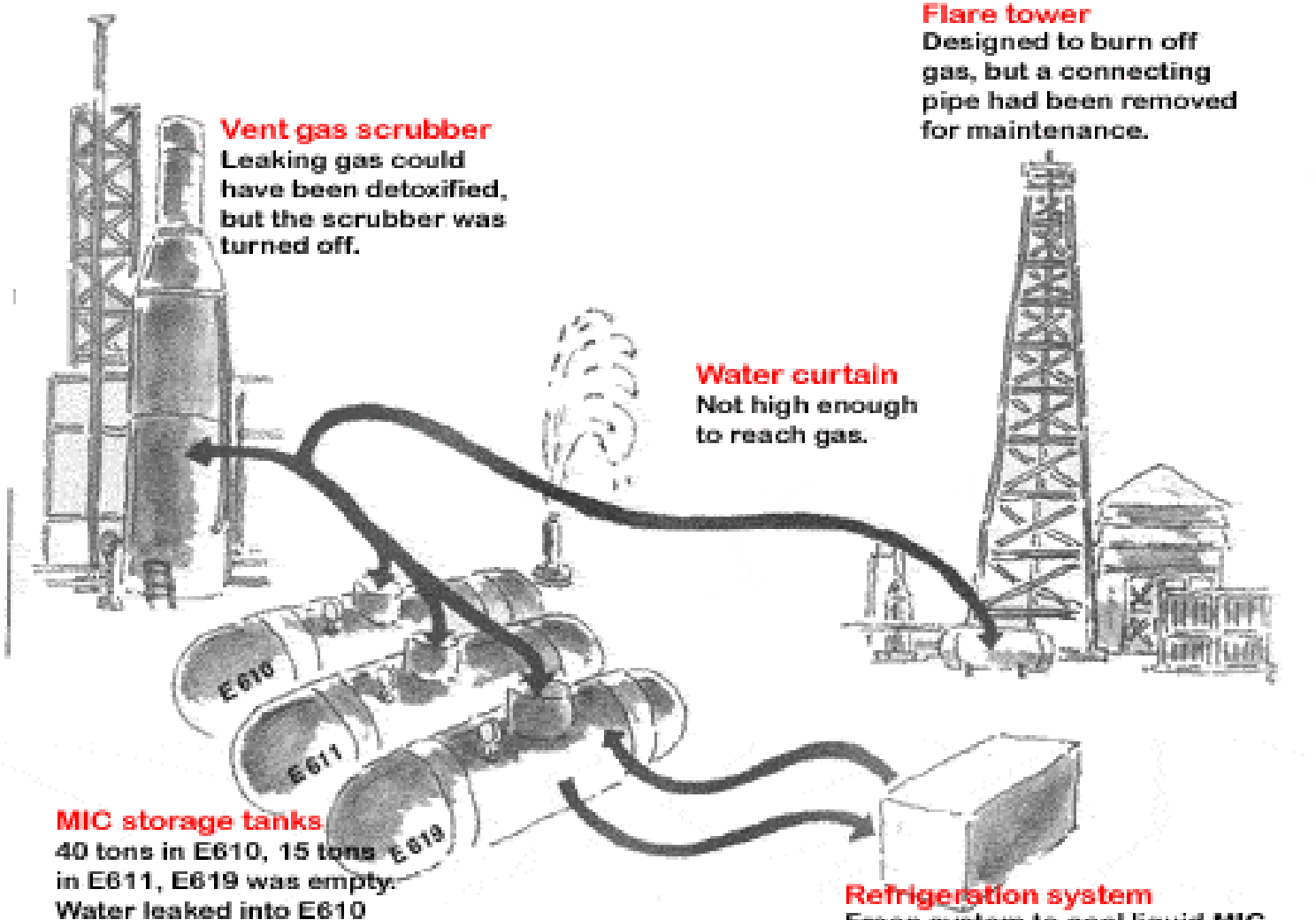
Personal Background

- Ph.D., University of Michigan at Ann Arbor, U.S.A.
- Award
  - CIEE The Best Paper, Excellent Paper Awards (2009、2010、2012、2013)
  - NCHU Outstanding Academic-industrial Coop Research, Excellent Advisor, Teaching Awards (2008-now)
  - NSC Outstanding Innovation (2007)
  - Government Scholarship: Sole grantee in Environmental Engineering in year 2000.
- Professional qualification
  - PE, Environmental Engineering (1989) and Industrial Safety Engineering (1997)
  - CPA, ISO 14000 (1996, Naville & Clark)
  - CPA, ISO 9000 (1997, Mercedes-Benz)
- Professional Expertise
  - **Bioremediation** of contaminated soils and groundwater (11 years)
  - **Environmental microbiology** and nanobiotechnology (11 years)
  - Integrated quality, environmental, safety, and health management (5 year)



Preface

- Story of DuPont
- Accidents in other countries
  - LPG explosion in Mexico
  - Mythyl-isocyante release in Bhopal, India
- Accidents in Taiwan
  - FG electronics
  - LPG explosion in Kaohsiung



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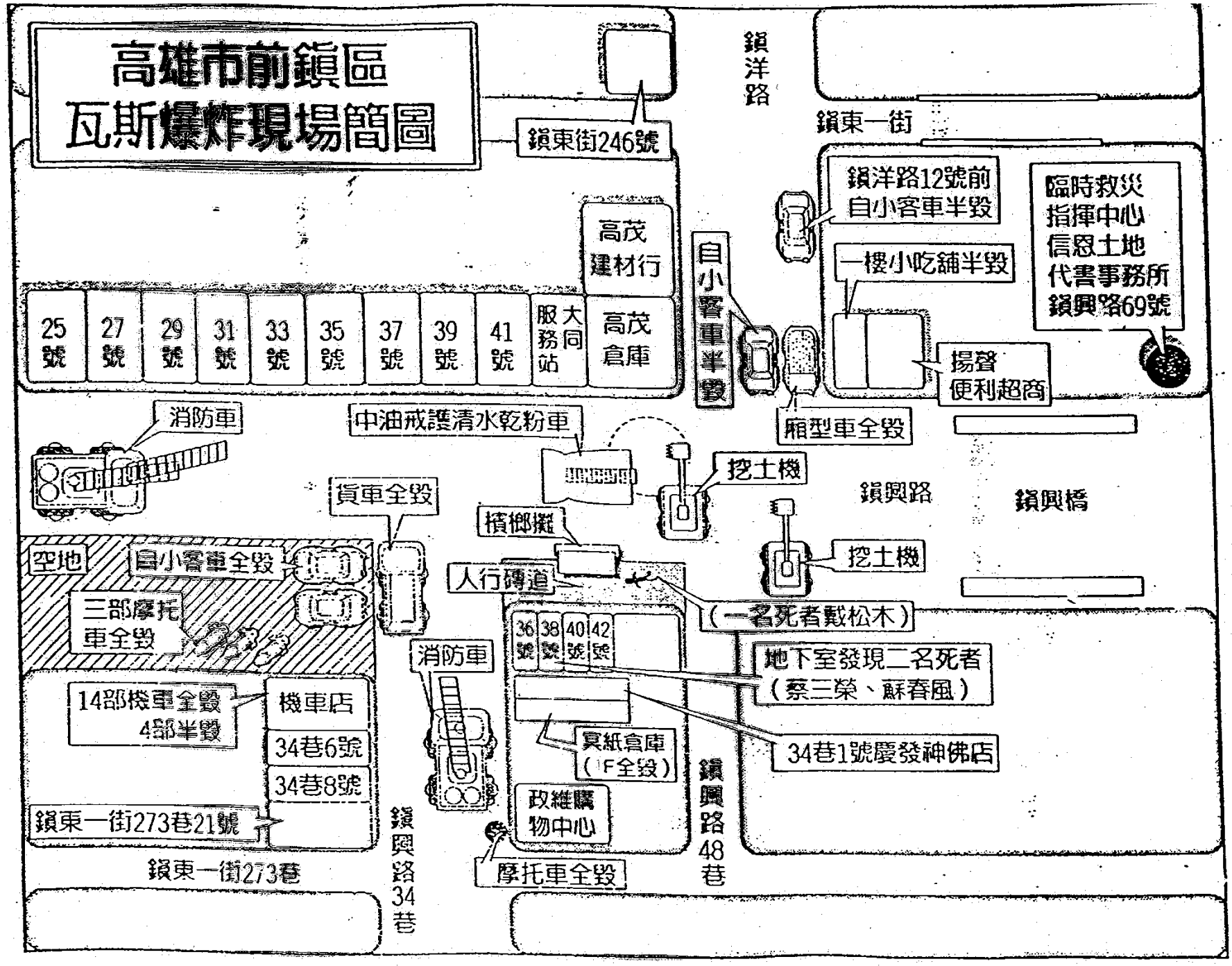

高雄市前鎮區
瓦斯爆炸現場簡圖
鎮東街246號
鎮洋路
鎮東一街
鎮洋路12號前
自小客車半毀
臨時救災
指揮中心
信恩土地
代書事務所
鎮興路69號
一樓小吃舖半毀
揚聲
便利超商
高茂
建材行
高茂
倉庫
大同
服務站
25號
27號
29號
31號
33號
35號
37號
39號
41號
自小客車半毀
廂型車全毀
消防車
中油戒護清水乾粉車
挖土機
貨車全毀
鎮興路
鎮興橋
空地
自小客車全毀
三部摩托
車全毀
人行磚道
挖土機
(一名死者戴松木)
36號
38號
40號
42號
地下室發現二名死者
(蔡三榮、蘇春風)
消防車
14部機車全毀
4部半毀
機車店
34巷6號
34巷8號
34巷1號慶發神佛店
冥紙倉庫
(F全毀)
鎮東一街273巷21號
政維購
物中心
鎮興路48巷
鎮興路34巷
摩托車全毀
鎮東一街273巷

Physical hazards

- Temperature and humidity
- Abnormal air pressure
- Noise
- Vibration
- Radiation

Temperature and Humidity

- Response to high temperature and high humidity
- Wet Bulb Globe Temperature (WBGT)
- Measurement
  - Black bulb thermometer
  - Dry bulb thermometer
  - Natural wet bulb thermometer
- 高溫作業勞工作息時間標準 (Working Hour Standards for High Temperature Operation Workers)

Temperature measurement

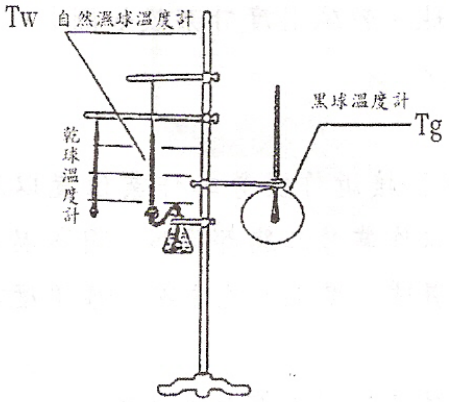


圖5.合測度熱指數測定計架設

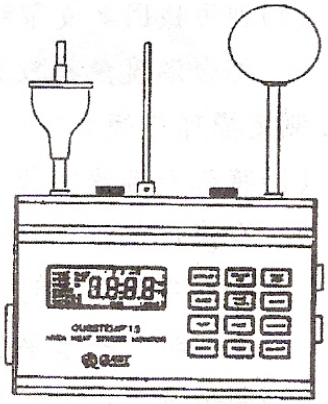


圖6.直讀式綜合溫度熱指數測定器

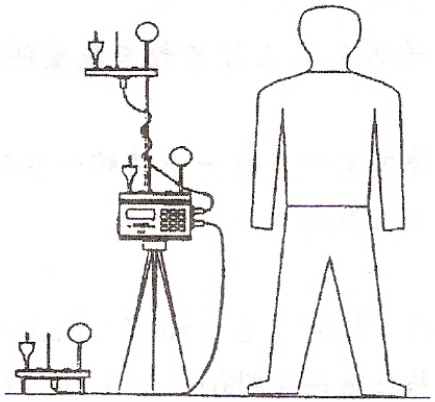
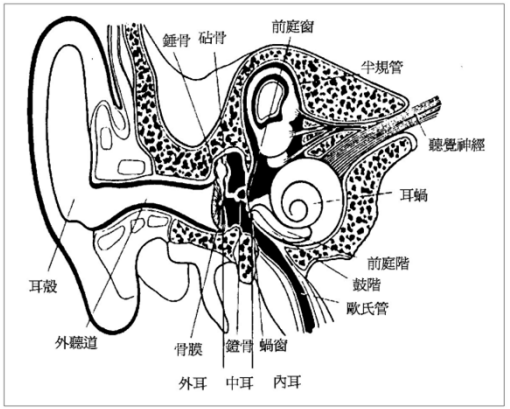


圖7.對於熱不均勻場所合溫度熱指數測定計架設

Working hour standards

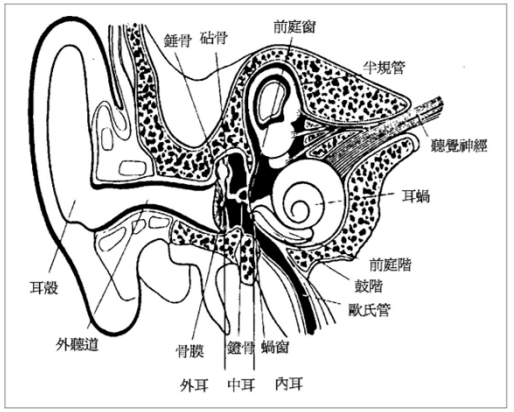
每小時作息時間比例 Ratio of work to rest		連續作業 Conti-nuous	75% work 25% rest	50% work 50% rest	25% work 75% rest
時量平均綜合度熱指數值(Time weighted WBGT, ℃)	輕工作 Light	30.6	31.4	32.2	33.0
	中度工作 Medium	28.0	29.4	31.1	32.6
	重工作 Heavy	25.9	27.9	30.0	32.1

Noise (1)

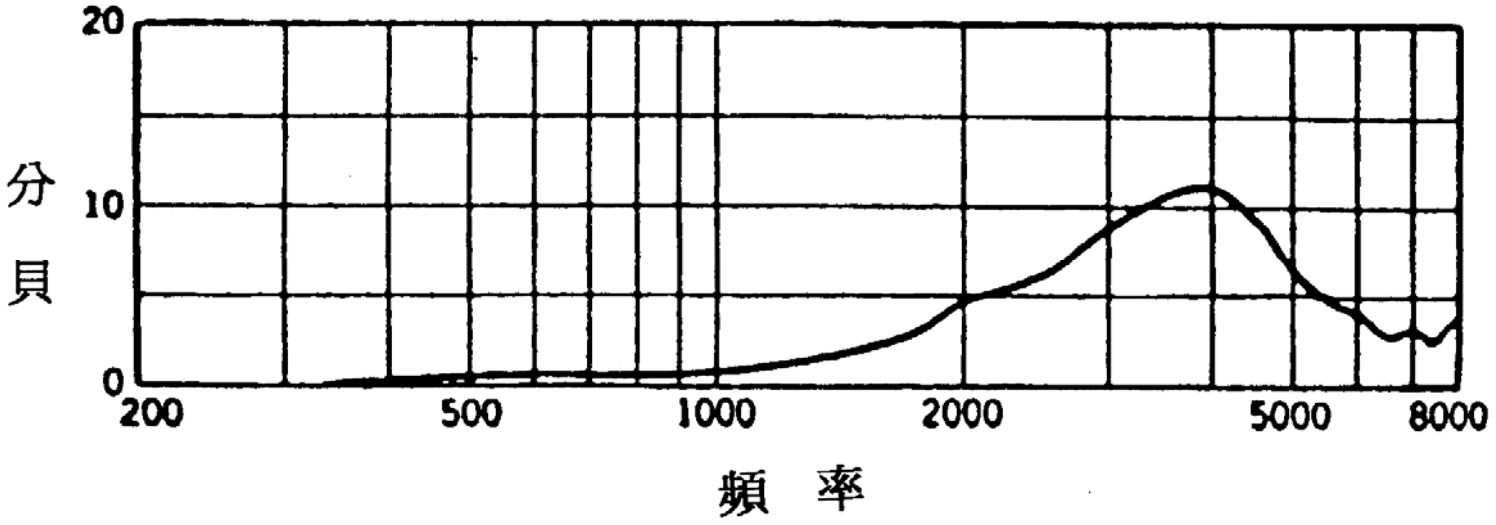


- Human listening capability: 20~20000Hz, ~4000Hz most sensitive, speaking at 500~2000Hz
- Sound wave -> Ear drum -> bones -> fluid -> energy -> sensory cells generate voltage -> nerve -> brain
- Auditory sensory cell damage usually is permanent

Noise (2)



- A weighted (A 權重): Simulating human ear response to noises.



外耳道的共振效應
（縱軸座標表示在耳膜與外耳道入口之間的音壓級差異）

Noise (3)

勞工安全衛生設施規則 Worker Safety and Health Facility Standard (2014.07.01)

第三百條：雇主對於發生噪音之工作場所，應依下列規定辦理：

勞工工作場所因機械設備所發生之聲音超過九十分貝時，雇主應採取工程控制、減少勞工噪音暴露時間，使勞工噪音暴露工作日八小時日時量平均不超過表列之規定值或相當之劑量值，且任何時間不得超過一百四十分貝之衝擊性噪音或一百十五分貝之連續性噪音；對於勞工八小時日時量平均音壓級超過八十五分貝或暴露劑量超過百分之五十時，雇主應使勞工戴用有效之耳塞、耳罩等防音防護具。

Noise source	分貝 dB
低聲說話murmuring	30 ~ 40
一般說話 conversation	60 ~ 70
吸塵器 vacuum	80
車床 metal cutting & drilling	90 ~95
印刷機、紡織機 Printing or textile machining	100
迪斯可舞廳 Disco pub	110
噴射機起飛 Jet plane taking off	120 –ear aching

Noise (4)

- Protection
  - Engineering control
  - Exposure time management
  - Personal protective equipment

Allowed exposure period (hr) 工作日容許暴露時間 (小時)	A weighted sound pressure (dB) A 權噪音音壓級 (dBA)
8	90
6	92
4	95
3	97
2	100
1	105
$\frac{1}{2}$	110
$\frac{1}{4}$ or less	115

$$\frac{\text{Time exposed to noise level 1}}{\text{allowed exposure tine at corresponding noise level}} + \frac{\text{Time exposed to noise level 2}}{\text{allowed exposure tine at corresponding noise level}} + \ldots \geq 1$$

測定勞工八小時日時量平均音壓級時，應將八十分貝以上之噪音以 增加五分貝降低容許暴露時間一半之方式納入計算。

Vibration

- Usually for workers in construction, mining, power generating, petroleum refining, etc.
- Long time exposure may result in lower backache, sciatic nerve aching, spinal system degeneration, intervertebral disk herniation, periphery circulatory dysfunction, muscle and bone damage, like white finger disease, and carpal tunnel syndrome.

Lighting

- Light cells and light meter
- Some workers need better lighting condition
  - Precision operation
  - Watch repairing
  - Microscopic observation of semi-conducting device, biological samples, etc.
  - Embroidering or knitting
  - Optical lenses processing and checking
- 精密作業勞工視機能保護設施標準 Protection standards for precision operation worker's visual function

Radiation

- Ionizing radiation
  - α、β、γ、X rays and neutron rays
  - Blood cell generation and reproduction
  - Anemia, leukemia and other cancers
- Non-ionizing radiation
  - IR、UV、Microwave、LASER

白內障**cataract**

角膜炎**keratitis**

皮膚癌**skin cancer**

蛋白凝結**protein condensation**

燒傷 **burnt**

Chemical Hazards

- Hazards associated with chemicals
- Possible Hazards
  - Toxicity
    - Carcinogenous
    - Reproductive toxicity
    - Developmental toxicity
    - Neurotoxicity
    - immunotoxicity
  - Fire and explosion
- Possible phases
  - Solid
  - Gaseous
  - Vapor and liquid

Exposure and excretion (1)

- Major routes
  - Inhalation (吸入)
  - Ingestion (食入)
  - Absorption (吸附)
- Nature and intensity of chemicals' effects
  - Concentration (濃度)
  - Form (形式)
  - Target organ (目標器官)
  - How long (half-life) (半衰期)

Exposure and excretion (2)

- Absorbed chemicals
  - Biological transformation (生物轉化)
  - Bioactivation (生物啟動)
- Principal means of excretion
  - Urine (排尿)
  - Liver (肝臟)
  - Lungs (肺臟)
  - Sweat glands (less important，汗腺:較不重要)
  - Note that GI is not a major route (注意: 腸胃道非主要排出方式)

Exposure and excretion (3)

- Effects
  - Reversible and irreversible (可逆與不可逆)
  - Could be acute or delayed: carcinogenesis (急性或延後)
  - Allergic reactions (過敏反應)
  - Other factors: species and strains, age, sex, and nutritional and hormone status. (其他因素:如性別、年齡、營養狀況及賀爾蒙狀況)
  - Physical factors: temperature, humidity, light cycles (物理因素: 溫度、濕度、日光循環)
  - Social factors (社會因素)

Exposure and excretion (4)

Table 2.1 Approximate concentrations of various chemicals required to produce death in 50 percent of exposed animals

Chemical	LD_{50} (mg/kg of body weight)
Ethyl alcohol	10,000
Sodium chloride	4,000
Ferrous sulfate	1,500
Morphine sulfate	900
Phenobarbital sodium	150
Picrotoxin	5
Strychnine sulfate	2
Nicotine	1
d-Tubocurarine	0.5
Hemicholinium-3	0.2
Tetrodotoxin	0.10
Dioxin (TCDD)	0.001
Botulinum toxin	0.00001

酒精
鹽
硫酸鐵
硫酸嗎啡
苯巴比妥

派克洛
番木鼈鹼
尼古丁
吐布苦若賴
半膽鹼-3
河豚毒素
戴奧辛
肉毒桿菌毒素

Source: C.D. Klaasen, "Principles of Toxicology," in C.D. Klaasen, Mary O. Amdur, and J. Doull, *Casarett and Doull's Toxicology: The Basic Science of Poisons*, 3rd ed. (New York: MacMillan Publishing Company, 1986), table 2-1, p. 12. Adapted with permission of The McGraw-Hill Companies.

Exposure and excretion (5)

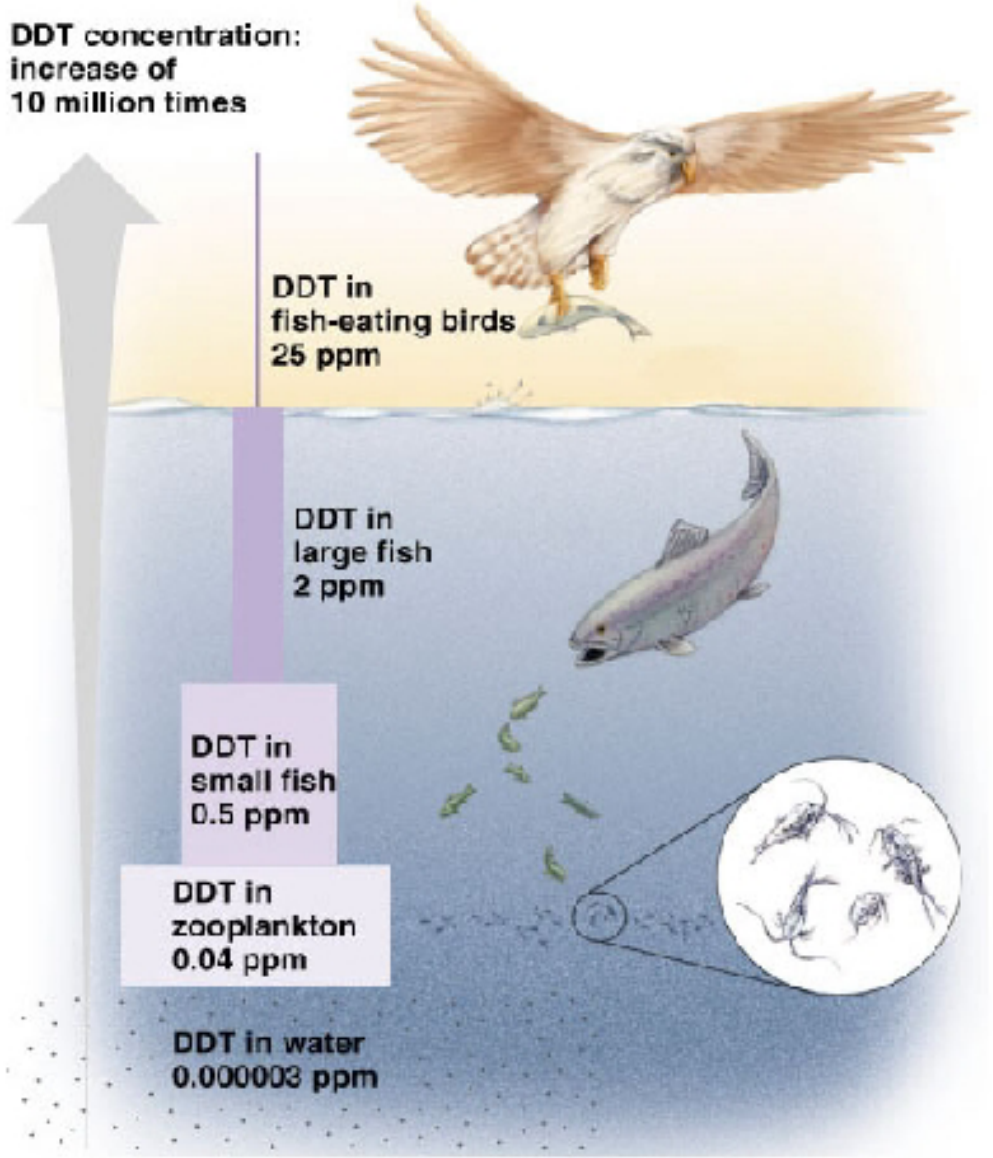
Table 2.2 Toxicity ratings

	Probable lethal dose for humans		
Toxicity rating	Dosage	For average adult	
Practically nontoxic	>15 g/kg	More than 1 quart	>946ml
Slightly toxic	5–15 g/kg	Between 1 pint and 1 quart	473-946ml
Moderately toxic	0.5–5 g/kg	Between 1 ounce and 1 pint	29.5-473ml
Very toxic	50–500 mg/kg	Between 1 teaspoon and 1 ounce	4.9-29.5ml
Extremely toxic	5–50 mg/kg	Between 7 drops and 1 teaspoon	0.35-4.9ml
Supertoxic	<5 mg/kg	A taste (less than 7 drops)	<0.35ml

Source: C.D. Klaasen, "Principles of Toxicology," in C.D. Klaasen, Mary O. Amdur, and J. Doull, *Casarett and Doull's Toxicology: The Basic Science of Poisons*, 3rd ed. (New York: Macmillan Publishing Company, 1986), table 2–2, p. 13. Adapted with permission of The McGraw-Hill Companies.

Exposure and excretion (6)

- Biological magnification

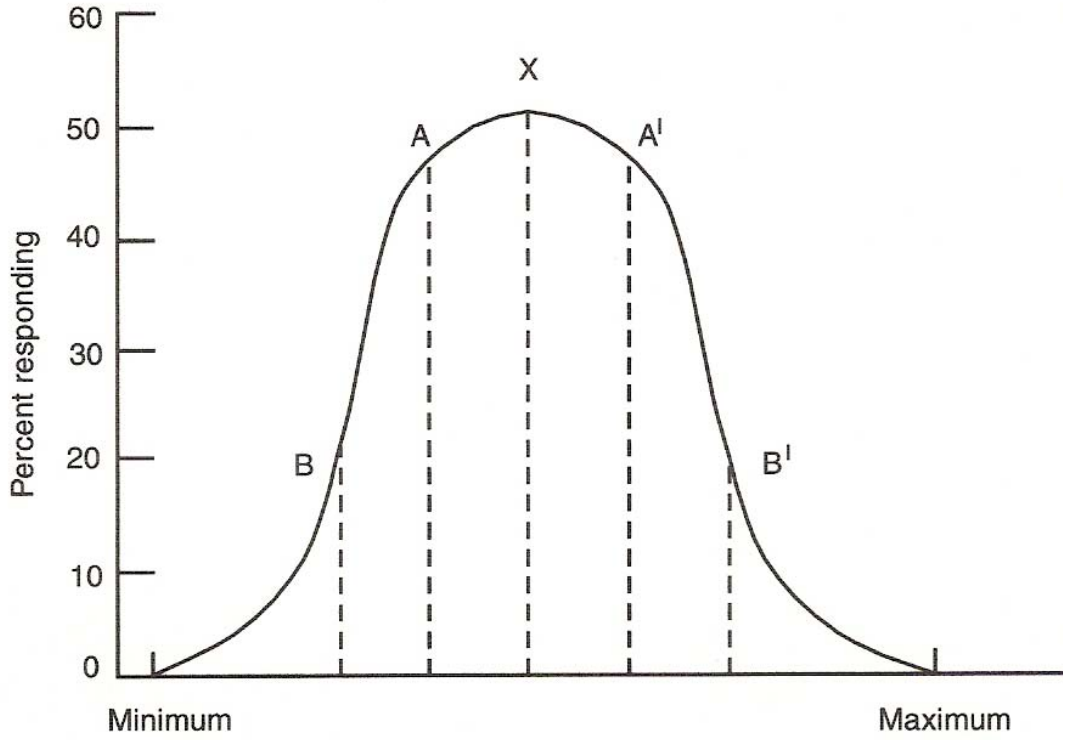


Toxicity study

- Acute toxicity studies (急毒性研究)
  - A single or several administration of the chemical within 24 hours
- Short-term toxicity studies (短期毒性研究)
  - Repeated administrations, 10% life span
  - 14-day and 28-day durations have been used
- Long-term toxicity studies (長期毒性研究)
  - Repeated administrations, entire life span

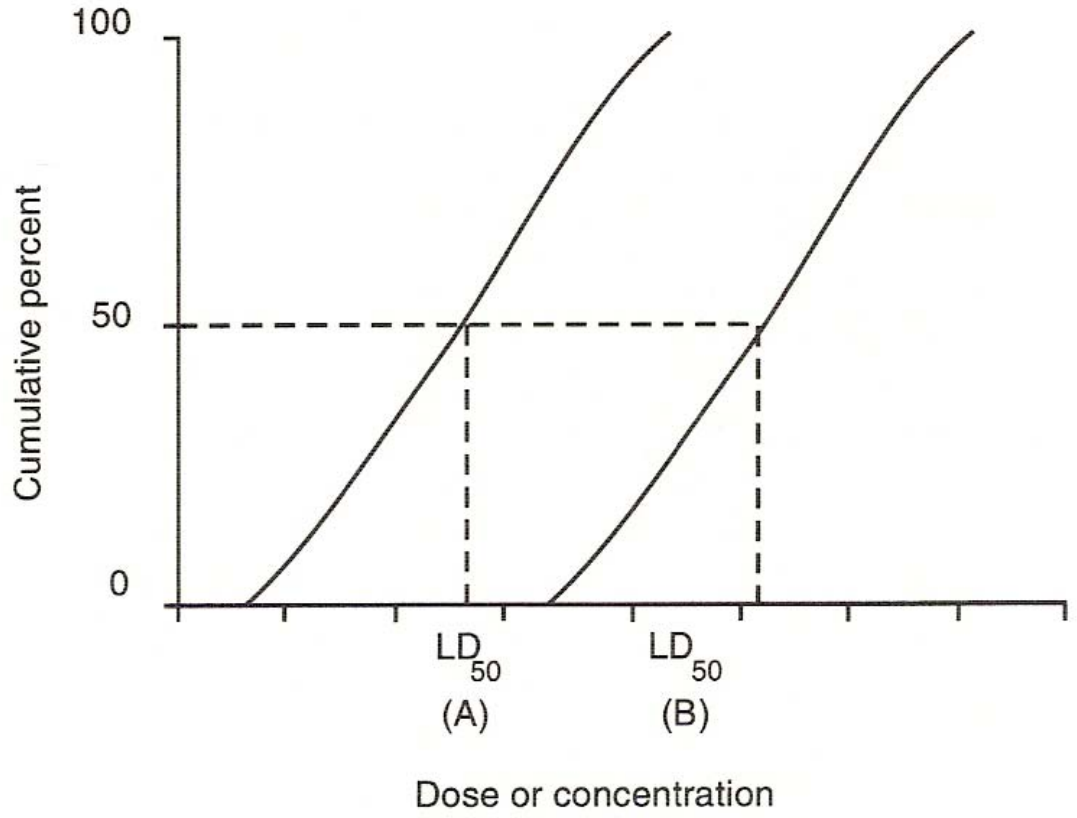
Acute toxicity test

- Gaussian distribution 高斯分佈 (常態分佈)

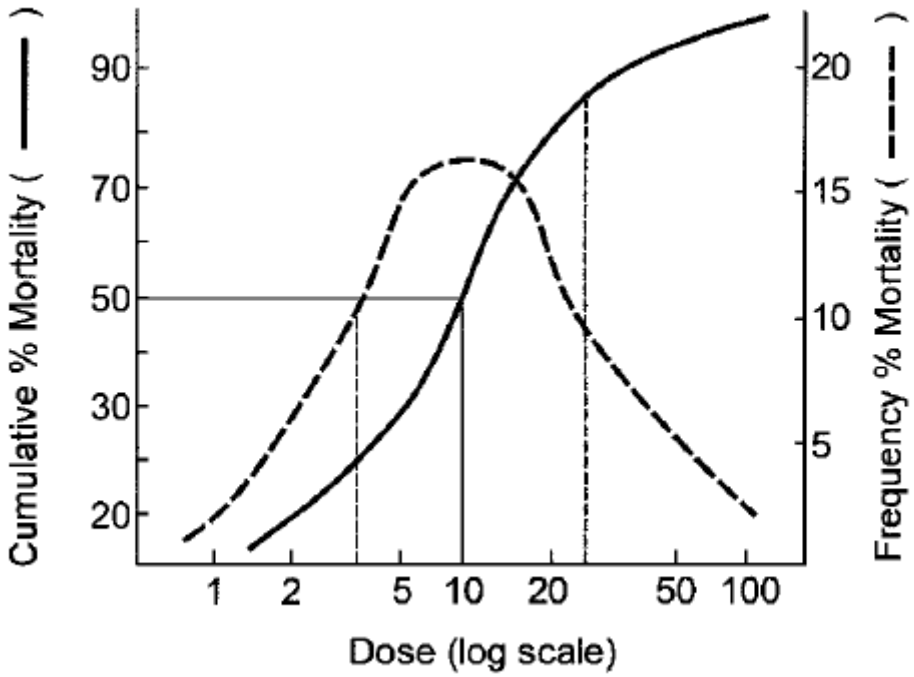


Acute toxicity study

- Cumulative percentage 累積百分比



Acute toxicity study



- LD_{50}: Lethal dose for half of the exposed population within a certain period of time.半數致死劑量
- Synergistic and antagonistic effects (加乘與擷抗)

Short-term and long-term testing

- Short-term 短期
  - For more realistic situation
  - Usually two or more species
  - Most often rats and dogs
  - Three levels of doses
- Long-term 長期
  - “Acceptable intake”, “ no observed adverse effect level”
  - Body weight, body size, food consumption
  - Lab tests: hematological tests
  - Postmortem examination: histological examinations, may measure the size of different organs.

Outcomes 毒性測試結果

- Typical
  - Target organs (目標器官)
  - Effects (效果)
  - Dose-effect and dose-response relationships 劑量反應關係
  - Maximum tolerated dose 最大容許劑量
  - Some may not be observed
    - Reproduction (生殖)
    - Disease (疾病)
    - Decreased longevity (壽命減短)

Endpoints

- Carcinogenesis 致癌性
  - Initiator and promoter
  - Activation of mutation of oncogenes or the inactivation of suppressor genes
  - Ames test
- Reproductive toxicity 生殖毒性
- Developmental toxicity 發育毒性
  - Embryo, fetal death, growth retardation, malformation
- Neurotoxicity 神經毒性
  - Cognitive, sensory, motor impairment
- Immunotoxicity 免疫毒性
  - Suppress the immune function: AIDS
  - Chemical AIDS

Thalidomide tragedy

- 1957 to 1962 in UK, Canada, Germany, Japan
- USA is not affected because FDA did not approve its usage
- Prevented morning sickness
- 12,000 babies who survived, with phocomelia (flipper-like arms or legs)

Standards

- Threshold limit values (TLVs): permissible air borne contaminant levels in the workplace established by ACGIH
- Ceiling value
  - Not to exceed at any time
- Short-term exposure limit (STEL)
  - Not to exceed 15 minutes more than four times a day
- Time weighted average (TWA)
  - For normal 8-hour day, 40-hour week.
- Biological exposure index (BEI)
  - Example: acetone in urine, lead in blood

Biological hazards

- Including microorganisms, parasite, insects, animal, plants and derived products or wastes.
  - Possible hazards
  - Exposure routes
  - Protection equipments or procedure
  - Emergency preparedness
- Please consult Biotechnology Center in NCHU
  - Phone: 04-2284-0450~0451

Ergonomic hazards

- Lack of appropriate human-machine interface.
- Example
  - Improper position: lower backache, muscle damage and bone damage
  - Long-term loading: spinal damage
  - Highly repetitive motion: carpal tunnel syndrome
  - Long-term standing: feet aching, varicosity (靜脈曲張)

Your rights

- Labor Safety and Health Act: Article 30
  - **If a labor discovers that his/her enterprise is in violation of this Law or other related safety and health regulations, the labor may appeal this violation to the employer, the competent authority or the appropriate inspection agencies**.
- Labor Safety and Health Act: Article 25
  - **The employers shall prepare, in consultation with labor representatives, appropriate safety and health work rules.**
  - After sending to inspection agencies for record keeping, the rules shall be posted and enforced.
  - The labors shall effectively obey the rules mentioned in the preceding paragraph.

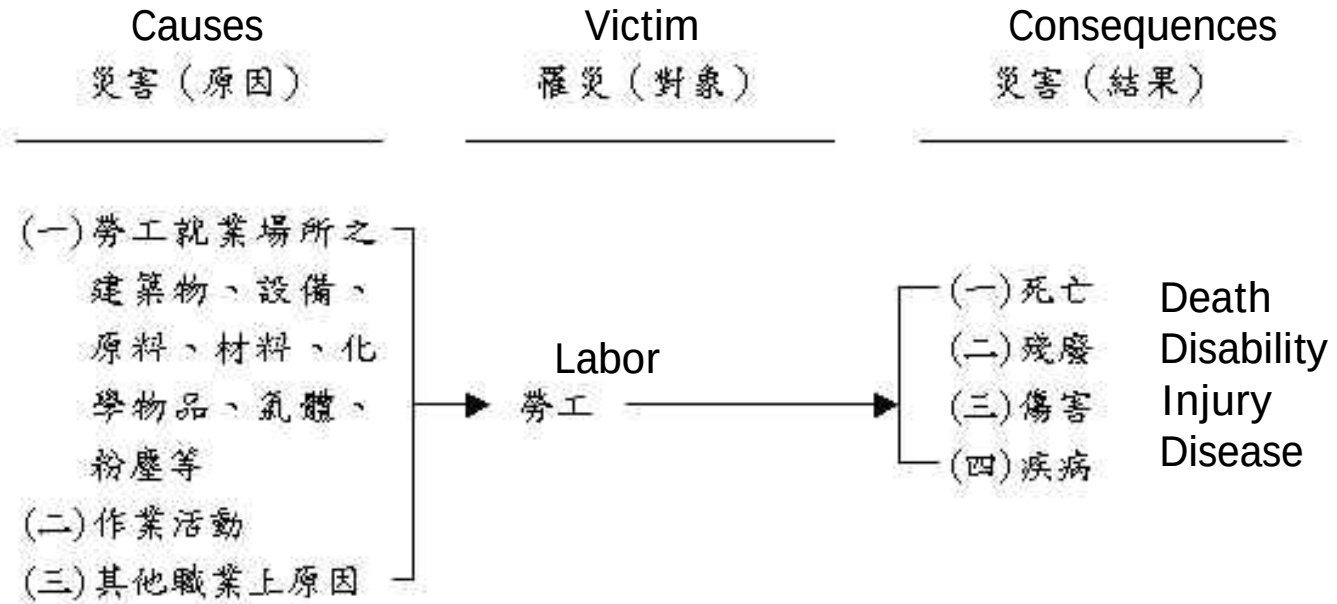
Your obligations

1. To follow the lab SH rules
2. To report the improper SH measures in your lab
3. To follow the lab SOP
4. To report incidents, including near-misses
5. To maintain sound hygienic working habits and safety working attitude
6. To maintain the tidiness of your lab and proper use of protective equipments
7. To help new hires to understanding SH rules and SOPs in your lab
8. To wear personal protective equipments in accordance with the lab SH rules

Occupational accident

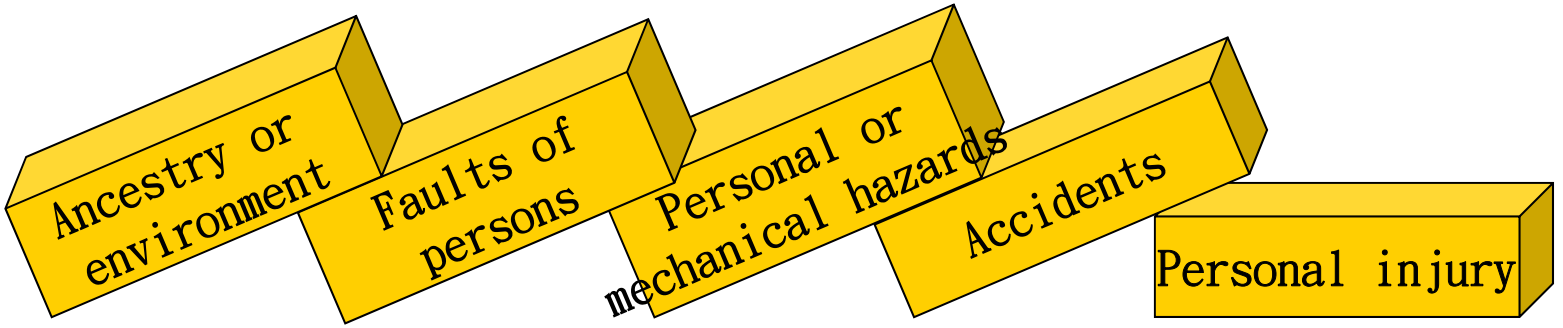
- The term "occupational accident" as used in this Act shall mean any disease, injury, disability, or death caused by buildings, equipment, raw materials, materials, chemicals, gases, vapors, dusts, etc., in the place of employment, or as a result of the performing on duty, or because of other occupational causes. **(LSHA:2)**

1. Buildings, equipment, raw materials, materials, chemicals, gases, vapors, dusts, etc.,
2. Operative activities
3. Other occupational reasons

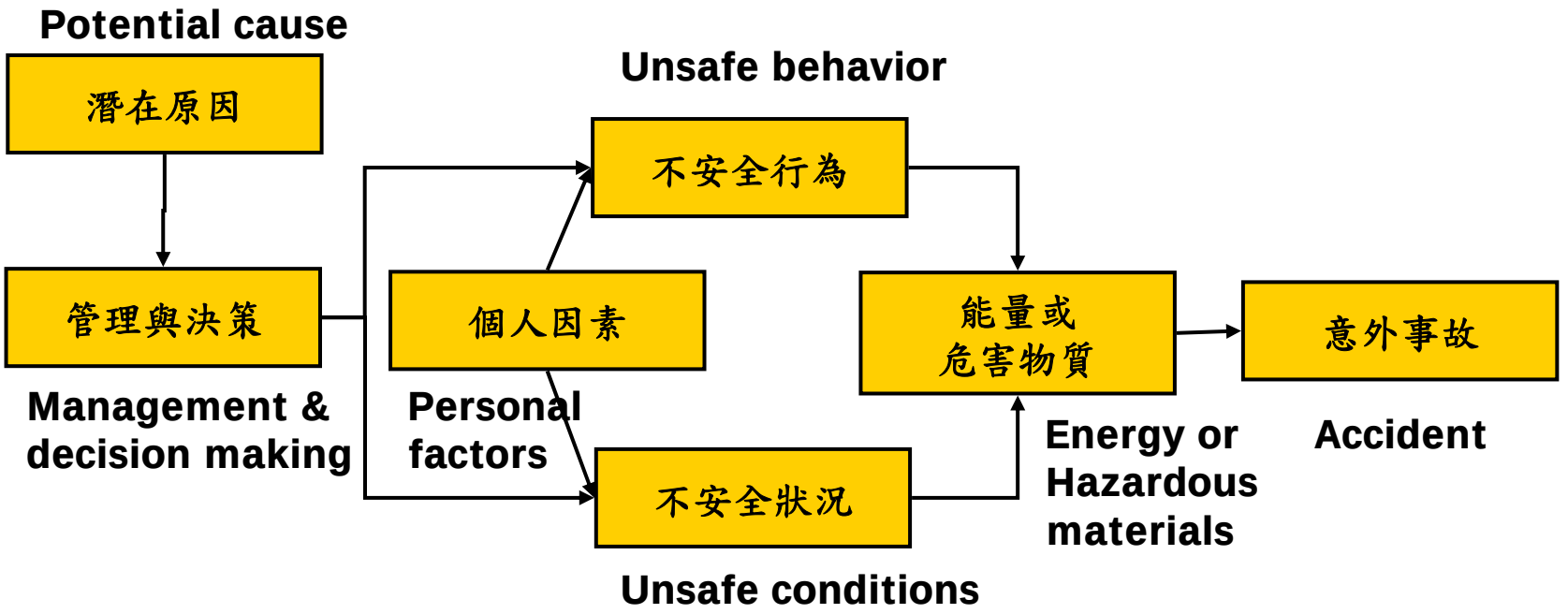


Accidents

- Definition: Accident is that occurrence of a sequence of events which usually produces unintended injury, death, or property damage
- Domino Theory by H.W. Heinrich



Accident and its causes



根本原因 → 次要原因 → 間接原因 → 直接原因 → 結果

Root cause | Secondary cause | Indirect cause | Direct cause | Consequence

Examples for unsafe conditions

- Improper support or protective measures
- Defective tools, facility, or utensil
- Crowded workplace
- Improper warning device
- Fire and explosion hazards
- Untidy workplace
- Strong noise
- Insufficient lighting
- Insufficient ventilation
- Radiation exposure

Examples for unsafe behaviors

- Operating a machine at improper speeds
- Operating a machine without authorization
- Use of defective equipment
- Use of failed safety device
- Without wearing PPE
- Leave the device unattended or at wrong place
- Standing at wrong place
- Lifting up loads in improper ways
- Fixing machine without turning off
- Fixing machine which is still in motion
- Running and playing at workplace
- Taking drinks with alcoholic content
- Working while on heavy medication

Prevention of occupation accidents

- Safe facility
- Safety test and checking
- Maintain the tidiness of workplace
- Use of personal protective equipment in the right way

Hazard Communication

- Increase safety awareness
- Workers' rights to know
- Enhance safety management
- Accordance
  - Employer shall conduct exposure monitoring in those job sites designated by the competent authority of the central government, and shall also label dangerous substances and hazardous substances with necessary precautionary safety and health warnings. (LSHA:7)
  - **Regulations of Hazard Communication on Dangerous and Harmful Materials**

An HF accident

Exposure to 40 % HF after 3 days (ulcer)

Exposure to 5 % HF Afer 1 week (necrosis)

Exposure to HF vapor -> rash

Accidents happened in labs

- 1997/12– A master student mistakenly drank brominated propylene and died (Chemical Eng. Lab)
- 1998/7 – CH_3SH leak -> more than 10 students hospitalized (Atomic lab)
- 1998/10 – A students was electrocuted to death (Electric Eng. Lab)
- 1999/6 -- An explosion occurred when a technician pour waste solvent into a bucket containing waste acid.

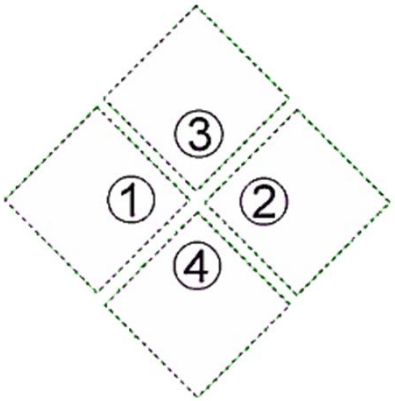
Definitions

- Dangerous：explosive、inflammatory (易燃固體、自燃物質、禁水性物質)、oxidant、flammable gas and others
- Harmful：carcinogenic, toxic, reproductively toxic, corrosive, neuron toxic, sensitizers, toxic to kidney, liver, and blood cell synthesis, and others

標 示 Labeling

- Following Chinese National Standards (CNS)
- Labeling
- Rhombus shaped
- Size is flexible and the words should be legible

圖示 Graphic presentation



有二種以上圖式時，請按阿拉伯數字排列之。

名稱 Name：

主要成分 Major component(s)：

危害警告訊息Hazard warning：

危害防範措施Protection measures：

製造商或供應商Vendor or supplier：

(1)名稱Name

(2)地址Address

(3)電話Pnone

※更詳細的資料，請參考物質安全資料表

Categories of hazardous materials
危害性物質分類一覽表

第一類　爆炸物

第二類　氣體

2.1 組易燃氣體　2.2組 非易燃氣體　2.3組 毒性氣體

第三類 易燃液體

Categories of hazardous materials
危害性物質分類一覽表(續)

第四類 易燃固體
自燃物質
禁水性物質

4.1組 易燃固體

4.2組 自燃物質

4.3組禁水性物質

第五類 氧化性物質

有機過氧化物

5.1 組 氧化性物質

5.2組 有機過氧化物

第六類 毒性物質

6.1組毒性物質I及II分組

Categories of hazardous materials
危害性物質分類一覽表(續)

第七類 放射性物質

第八類 腐蝕性物質

第九類 其它危險物質

Graphic for identification
識別危險性的圖式

直覺四大工具Four intuitive tools:

- 顏色 color
- 象徵符號 Symbol
- 數字 Number
- **中文 Chinese**

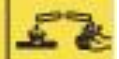
Example: Hydrofluoric acid (HF)

圖示分類：8, 6.1 (Primary：Corrosive)
(Secondary：Toxic)

名稱：氟化氫 HF
主要成份：氟化氫 HF
危害警告訊息：1.吸入有毒 Toxic for inhaling
2.會引起嚴重灼傷 May cause serious burnt
3.刺激呼吸系統 Irritate respiratory system
危害防範措施：Protective measures
1.置於陰涼且通風良好處，緊蓋容器Store with good ventilation
2.配戴護目鏡、口罩、手套 Wear goggles, mask, and gloves
3.勿與鹼混合 Don't mix with alkaline materials
製造商或供應商：(1)名稱Name
(2)地址Address
(3)電話Phone
*更詳細的資料，請參考物質安全資料表For details, please refer to MSDS

New labeling system: GHS

- *Globally Harmonized System* of Classification and Labeling of Chemicals (GHS)
- 9 categories -> 3 categories and 27 subcategories
- All in one color format

危害性	爆炸物	易燃氣體	易燃氣膠	氧化性氣體	加壓氣體	易燃液體	易燃固體	自反應物質	發火性液體	發火性固體	自熱物質	禁水性物質	氧化性液體	氧化性固體	有機過氧化物	金屬腐蝕物
GHS制度象徵符號																
目前法令象徵符號	 1	 2.1	 2.1	 5.1	 2.2	 3	 4.1	 4.1	 4.2	 4.2	 4.2	 4.3	 5.1	 5.1	 5.2	 8

危害性	急毒性物質	腐蝕／刺激皮膚物質	物質嚴重損傷／刺激眼睛	物質呼吸道或皮膚過敏	物質生殖細胞致突變性	致癌物質	生殖毒性物質	毒性物質－單一暴露特定標的器官系統	毒性物質－重複暴露特定標的器官系統	吸入性危害物質	水環境之危害物質
GHS制度象徵符號											
目前法令象徵符號	 6.1	 8	 8	—	—	—	—	—	—	—	—

How to label and store chemicals

Highly pressurized device and containers高壓氣體設備及容器

- Major parts: cap, valve, and cylinder
- Valve is the most vulnerable part
- Pay extra attention to flammable gas (like H_2) and toxic gases (like AsH_3, PH_3)
- Fasten cylinders to the wall or other proper fixtures all the time

Color identification

我國容器檢查基準就高壓氣體之種類及性質，分別依下表之規定顏色塗敷於該容器外面（以絕熱材被覆時，為於該絕熱材料之外面）之易見處所，其大小應佔該容器表面積二分之一以上或寬度30公分以上之色帶表示。

高壓氣體種類 Type	塗色 Color
氧 **Oxygen**	黑色
氫 **Hydrogen**	紅色
二氧化碳 **Carbon Dioxide**	綠色
氨 **Ammonia**	白色
氯 **Chlorine**	黃色
乙炔 **Ethylene**	褐色
其他種類之氣體 **Others**	灰色

Cylinder fastening

Accidents associated with cylinders
氣體鋼瓶災害事故類型

- High pressure caused failure
  - Cannot hold the pressure
  - Reaction between oxygen and oils
  - Mixing of gases
  - Over-refilled
- Fire or explosion by flammable gases
- Poisoned by toxic gases
- Suffocation by inhaling inert gases

Accident: gas mixing

- Description：On 1995.10.13, at 10:50, in chemical plant, a contractor worker is using oxygen and ethylene to cut metal tube and the oxygen cylinder exploded.
- Loss：The welder died and his colleague was seriously injured. One worker of the chemical plant was slightly injured.
- Prevention：Add anti-backflow device (like a check valve) to prevent gas from mixing.

Accident: Fire and explosion

- Description：In 1994, a pressurized gas vendor used motorcycle to transport a cylinder filled with ethylene. The cylinder exploded during the transportation.
- Loss：The worker died. Motorcycle was destroyed.
- Prevention：Ethylene cylinder should always be kept upright. Otherwise the solvent to dissolve ethylene in the cylinder may dissolve the sealant of the cylinder valve and cause leaks.

Accident: toxic gas leakage

- Description：1991. 10.24. 8AM. 110 wasted chlorine gas cylinders of the drinking water company was not properly stored. One cylinder started to leak and mixed with rain water. HCl was formed and corroded other cylinders and more cylinders started to leak.
- Loss: No significant injury. The company was fined by the EPA for NT$1,000,000.
- Prevention：Cylinders should be stored in a proper storage facility.

Accidents: suffocation

- **Jun/18/2000** A high-tech company had a nitrogen release accident, one person was suffocated to death. Two other persons found abnormal situation of nitrogen and went to check and also died.
- **Aug/14/2000** An young engineer was suffocated to death while maintaining a CVD instrument. He mistakenly linked his breathing compressed air cylinder adapter to nitrogen cylinder.

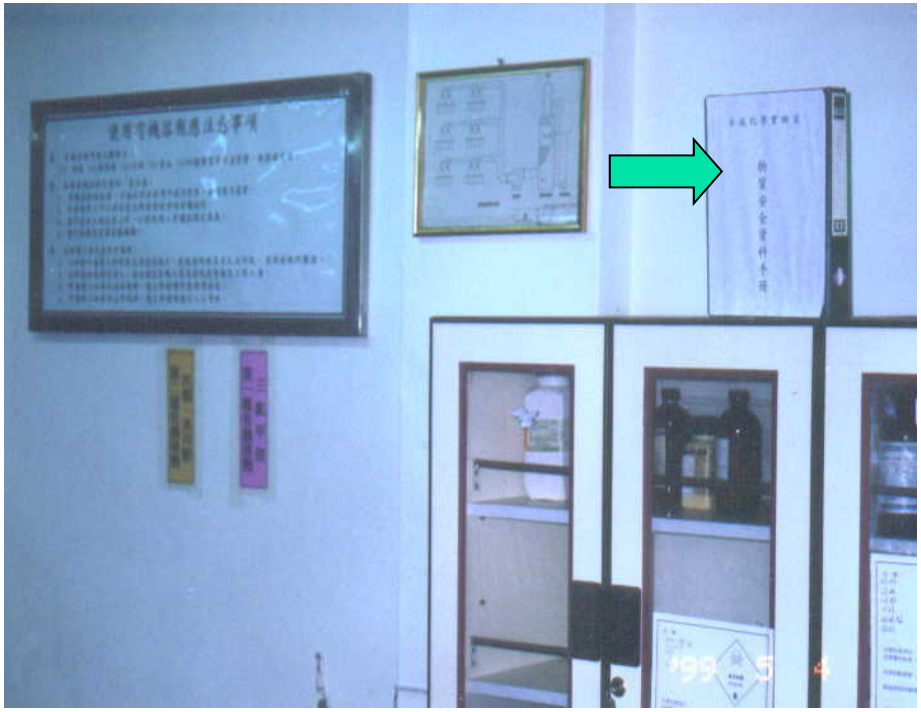
Accident prevention associated with gas cylinders

- Routine training and education
- Cylinder maintenance and routine check
- Using proper accessories
- Label and color identificaiton
- Proper transportation and storage
- No mix refill/recharge without disposal
- Fire and flammable management
- Anti-explosion electrics
- Pure oxygen should not be mixed with oily materials

安全資料表內容
Safety Data Sheet (SDS)

- Information you can find in SDS

Where to put your MSDS



Fire fighting

- Proper extinguisher
- Special hazard in fire fighting
- Special procedure in fire fighting
- Special protective equipment

Fire

- Fire and explosion is a chemical chain reaction

燃燒三角錐原理

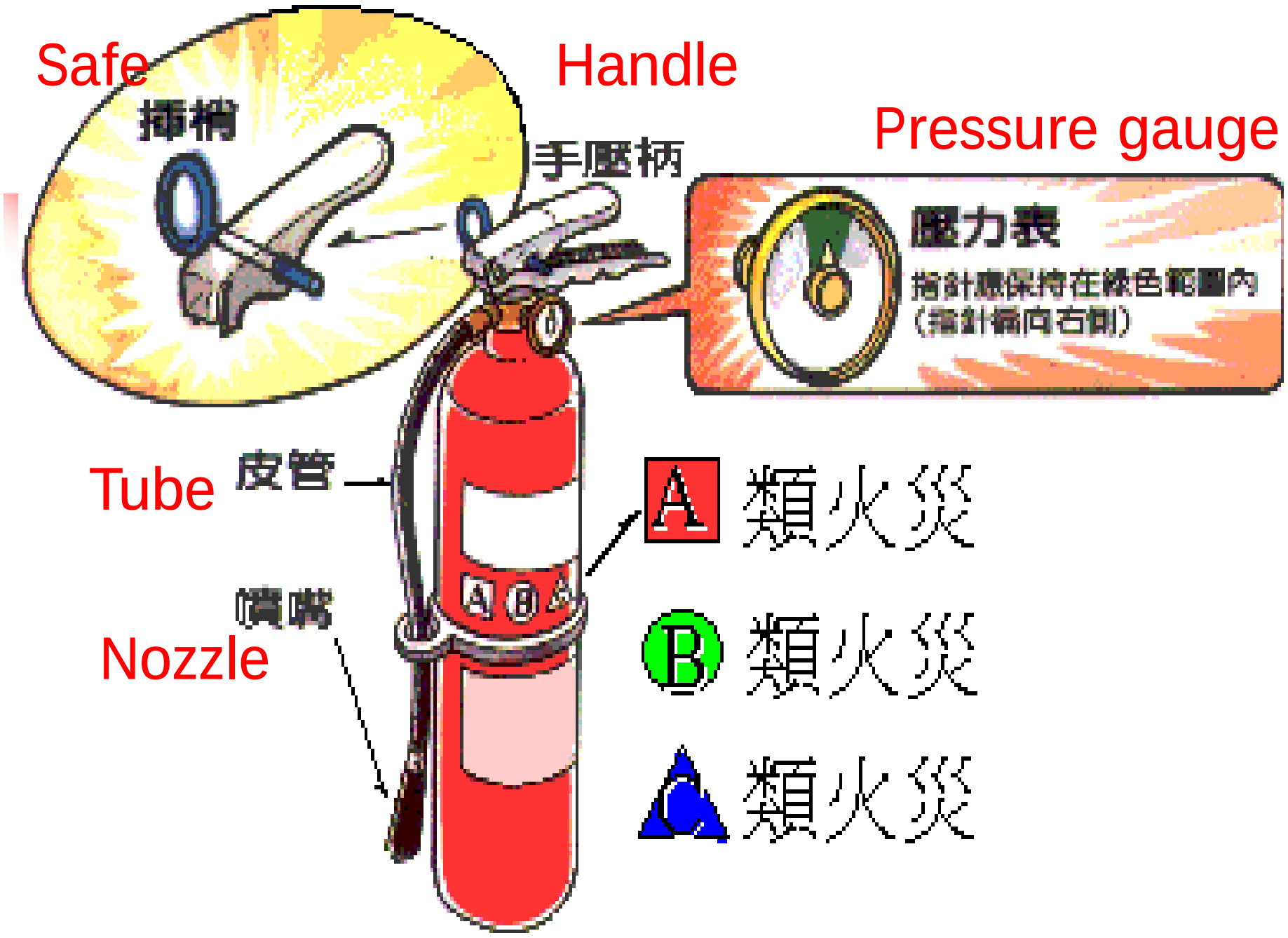
- Four elements
  - Fuel
  - Oxygen
  - Temperature
  - Chain reaction

How to put out the fire

- Principle: Cancel one of the four elements
- Methods
  - Isolation：removal of the flammables
  - Cooling：Reduce the temperature。
  - Suffocation：isolation of oxygen from others。
  - Suppression ：Removal of radical to stop the chain reaction

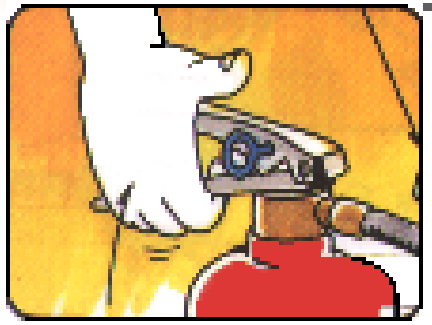
Categories of fires

- Type A: Common fire
- Type B: Caused by petroleum products, flammable oils, liquids or paints.
- Type C: Caused by electric devices or facilities
- Type D: Cause by metal (Li, Na, K, Mg, etc) or LNG

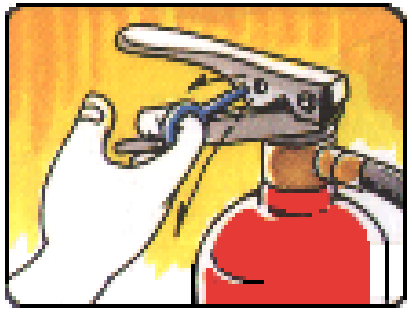

Safe
插梢
Handle
手壓柄
Pressure gauge
壓力表
指針應保持在綠色範圍內
(指針偏向右側)
Tube
皮管
噴嘴
Nozzle
A 類火災
B 類火災
類火災

滅火器使用說明

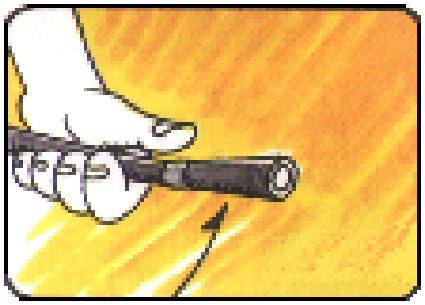
How to use the extinguisher



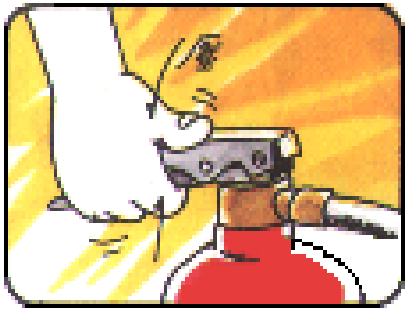
1.提起滅火器
Lift up



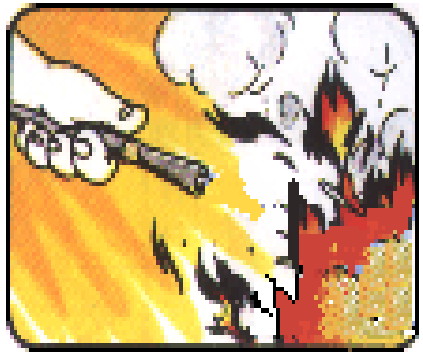
2.拉開安全插
Pull out safe



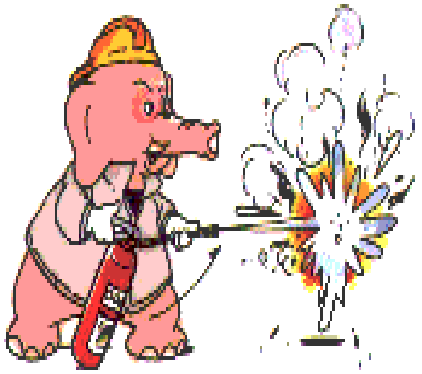
3.握住皮管，朝向火苗
Aim to the fire



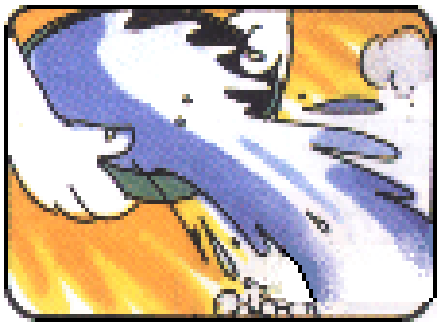
4.用力握下手壓柄
Press the handle



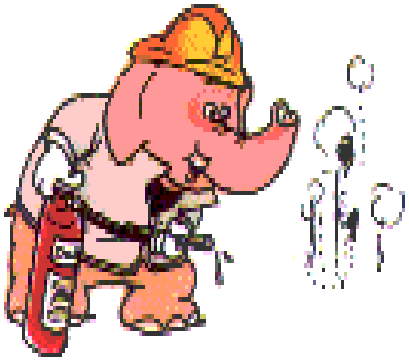
5.朝向火源根部噴
Spread to the root of the fire



6.左右移動掃射
Sweeping motion



7.熄滅後用水冷卻餘燼
Make sure the fire is all out



8.保持監控確定熄滅
Monitor the situation for a certain period

Chemical management

- Purpose
  - Chemical identification and location
  - Emergency response
  - Exchange
- Emphasis
  - Quantity control
  - Record keeping
  - Labeling and MSDS updating
  - Routine check

Storage cabinet for the flammables

- 易燃品存放櫃的動力抽風管應裝在下方的出口(如右櫃)。裝在上方出口(如左櫃)是錯誤的，因為絕大部份(乙醚除外)易燃性液體的蒸汽此空氣重會沉降在櫃內的底部。
- 抽風管必須是金屬管。

Personal protective equipment (PPE)

Body part	PPE
Head	Safety helmet
Ear	Ear plugs, ear hood
Eyes	Safety google
Hands	Gloves
Feet	Safety boots
Body	Safety clothing: Common, anti-heat, anti-cold, anti- static, insulant, corrosion-proof
Fall	Safety rope
Respiratory sys	Dust respirator
	resporator)
	Gas mask
	Supplied air respirator
	Self-contained breathing appaatus

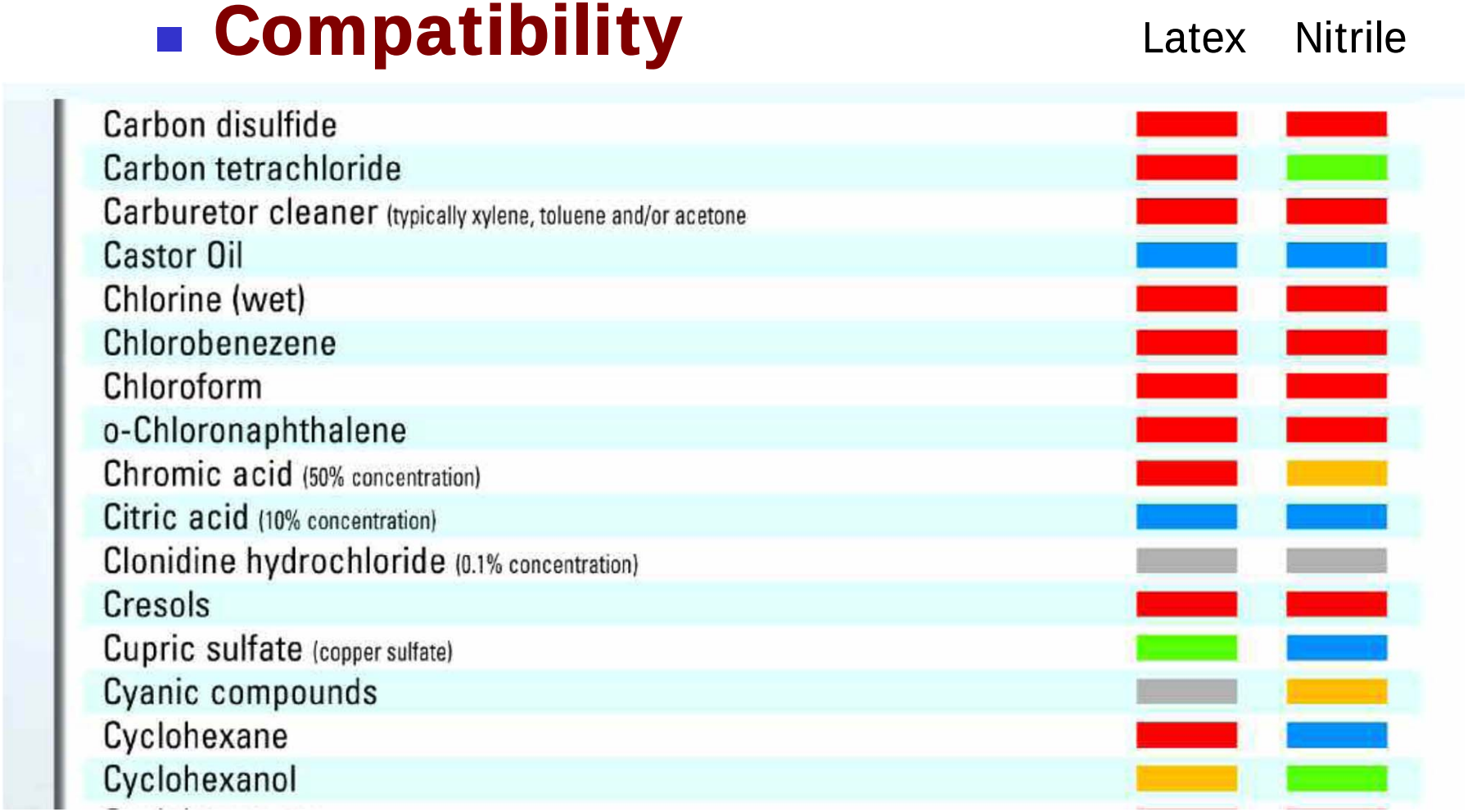
Breathing apparatus

正壓檢點
Positive pressure check

負壓檢點
Negative pressure check

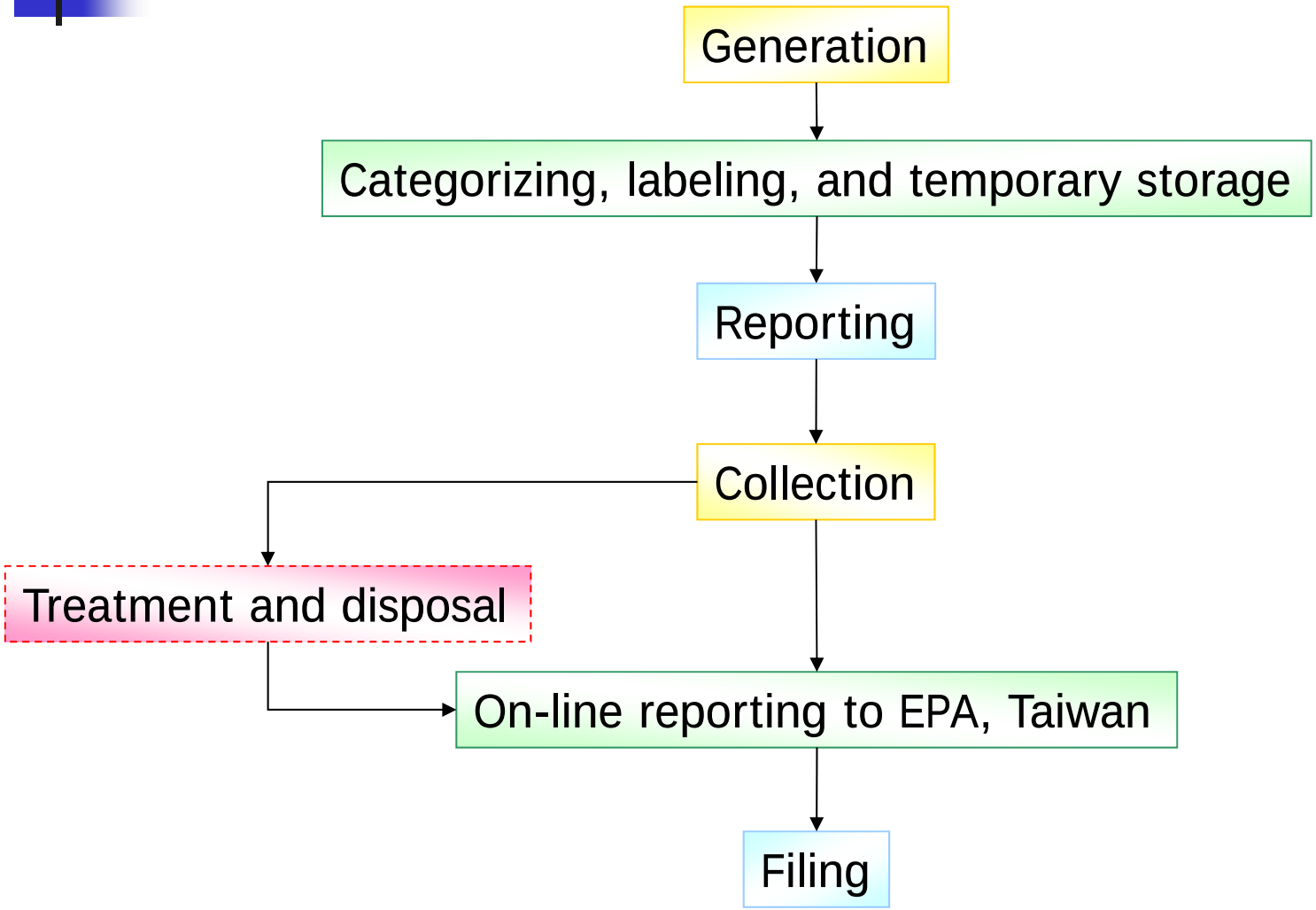
Gloves

- **Compatibility**

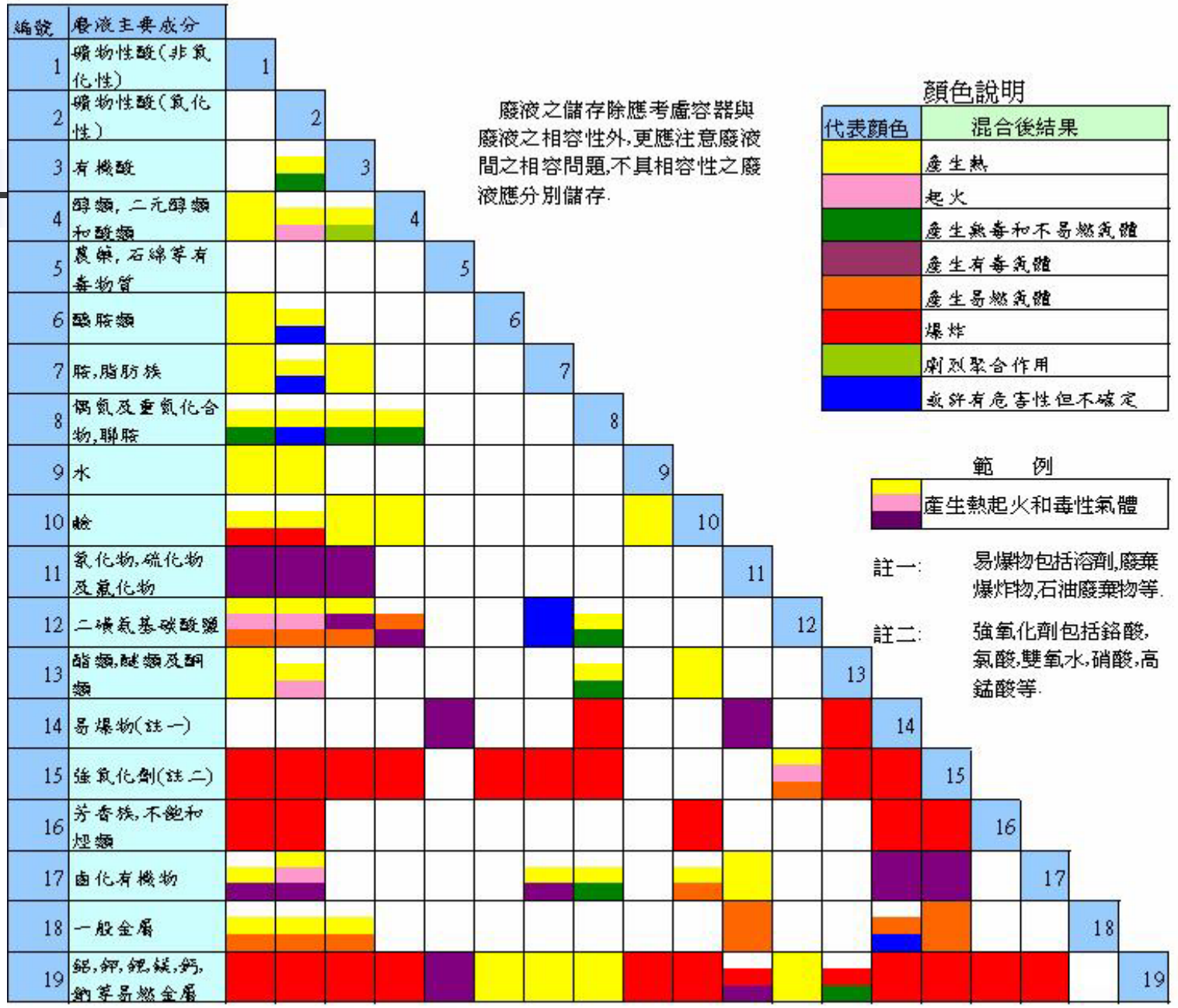


	Latex	Nitrile
Carbon disulfide		
Carbon tetrachloride		
Carburetor cleaner (typically xylene, toluene and/or acetone		
Castor Oil		
Chlorine (wet)		
Chlorobenezene		
Chloroform		
o-Chloronaphthalene		
Chromic acid (50% concentration)		
Citric acid (10% concentration)		
Clonidine hydrochloride (0.1% concentration)		
Cresols		
Cupric sulfate (copper sulfate)		
Cyanic compounds		
Cyclohexane		
Cyclohexanol		

Waste management



Compatibility of lab wastes



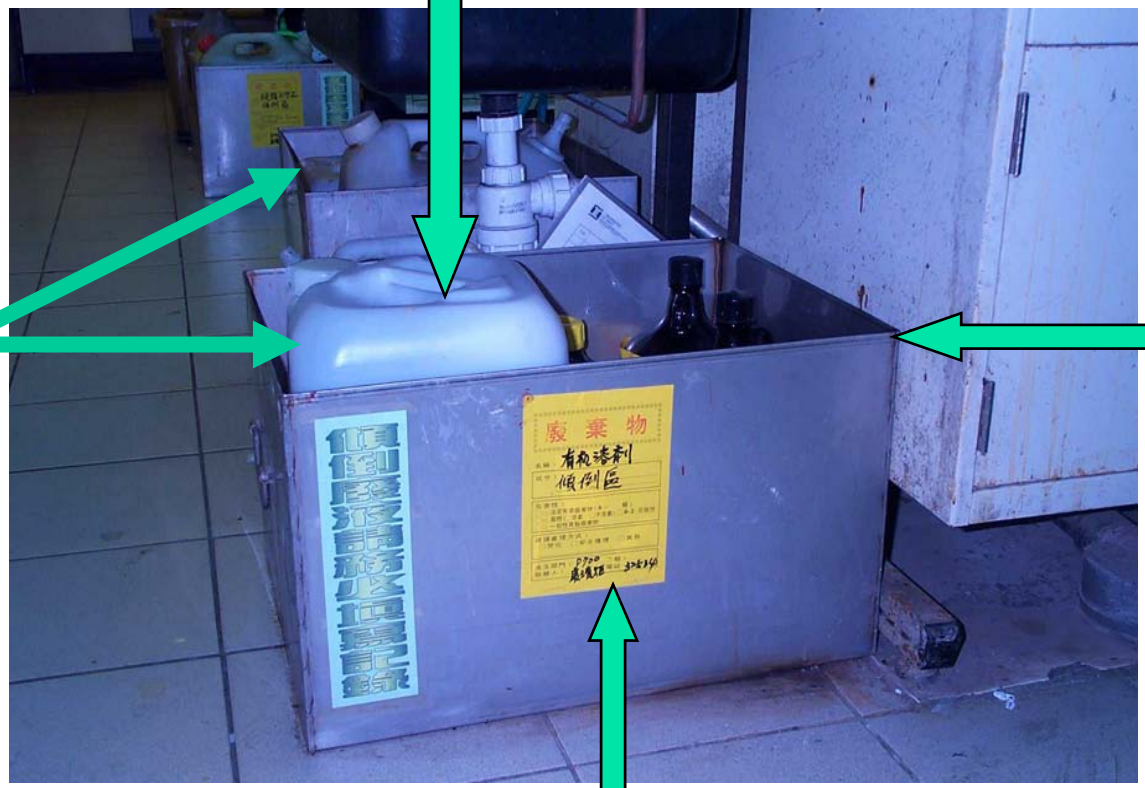
Accident: Waste Explosion

- Description：waste container went exploded in a hood in a chemical lab in a research institute. Alkaline waste was poured into a waste solvent container and started a chemical reaction. The container exploded after 38 minutes.
- Loss: no injury. The hood was totally destroyed and the ceiling was partially destroyed.
- Prevention: carry out the SH rules and compatibility check

The exploded hood

Temporary storage

Close the cap all the time.
Can add a valve on the cap.



Incompatible wastes should be stored separately

Anti-overflow (1.1X)

Waste labeling

Conclusion

- Prevention of occupation accidents need efforts from the employer, employee, and government.
- Acquire correct SH knowledge
- Follow your lab SH rules
- Maintain good working schedules. Do not work under exhausted physical condition.

May you have a safe stay at NCHU.

CEPOSH, NCHU

Location: at the 2nd floor of Hui-Sun Auditorium

Extension: 589

Website: http://safety.nchu.edu.tw/newweb/

References

- 教育部之「進入實(試)驗場所安全衛生注意事項」
- 工業技術研究院之危害通識課程資料
- 勞工安全衛生法令
- http://laws.cla.gov.tw/Eng/Default.asp