Campus Occupational Safety and Health knowledge and education training promotion program of the Ministry of Education

D1 Basic concepts of personal protection and emergency response

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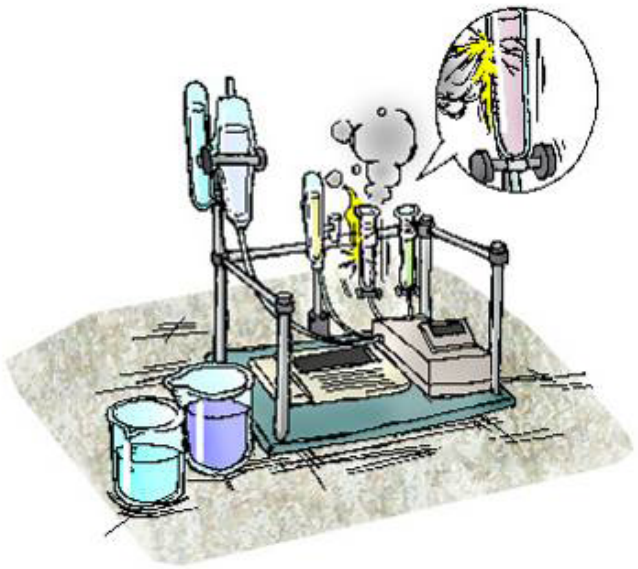
Contents

I. DISASTER CASES AND CHARACTERISTICS IN SCHOOL

Disaster cases

A student in Inorganic polymer research laboratory of a university conducted a heating experiment for the research of azo compounds and a distillation experiment for acetonitrile recovery and reuse. The student went out while the heating experiment continued under unsupervised conditions. The cooling water tube was broken and the temperature difference in the distillation vessel caused a dramatic reaction explosion. The explosion also spread to the acetone solvent container beside the experimental table and caused a fire.



Cause analysis of disaster cases

- Direct cause: chemical reaction explosion.
- Indirect cause:Unsafe conditions: (1) The evaporator tube of the distillation equipment had not been replaced; (2) There was no operator monitoring at the experimental work site; (3) Burning materials were stored near the heating experiment.
  - Unsafe actions: Did not turn off equipment before leaving the laboratory.

Cause analysis of disaster cases (cont.)

- Basic reason:
  - Unrealized safety and health education training.
  - No auto-check system
  - No safety and health work code
  - Students participating in the experiment were not informed of hazards
  - Poor health and safety management
  - Incorrect storage location of hazardous chemicals

II. PHYSICAL HAZARD

Noise

Vibration

High temperature

Ionizing radiation

Non-ionizing radiation

Abnormal air pressure

Noise

- Industrial noise: Mainly noise generated by factory machinery and power equipment. The noise of the electronics industry and light industry is about 90dB or less; the noise of the machinery industry is between 80-120 dB. Construction noise is mainly from various mechanical noises on urban construction sites.

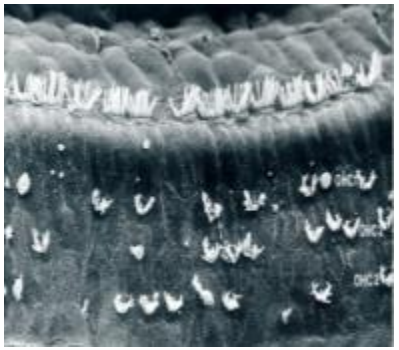
- General university laboratories: The source of noise may be people's speech.

Noise (cont.)

- Traffic noise: Mainly noise is from motor vehicles, airplanes, trains and ships. Motor vehicle noise on main traffic lines in urban areas accounts for more than 40% of urban noise sources.
- Community noise: Noise generated by mass gatherings, supermarkets, school playgrounds, household appliances and residential building structures such as water pipes, ventilation pipes, elevators or air conditioners. This type of noise is widely distributed, so the impact is greater than others.

Noise hazard

- Noise exposure to human health hazards can be divided into：
  - Auditory effects: Refers to the hearing loss and physiological effects caused by noise.
    - Sensorineural hearing loss
      - Temporary threshold shift, TTS
      - Permanent threshold shift, PTS
      - Presbycusis
    - Conductive hearing loss
  - Non-auditory effects: Refers to disorders or abnormalities caused by noise in organs or systems other than ears. Non-auditory effects are mainly caused by stimulation of the autonomic nervous system, the reticulated nervous system and the cerebral cortex.



Damaged cochlear hair cells

Vibration

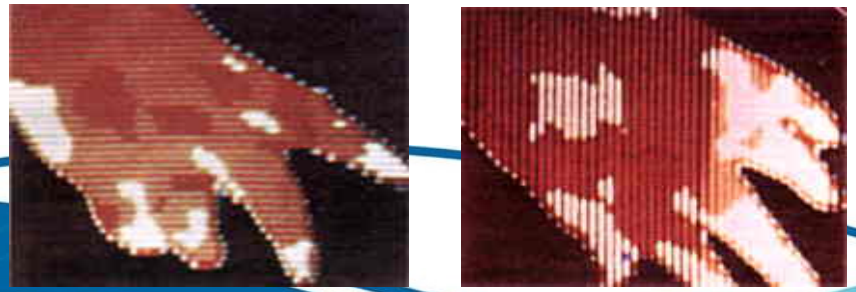
- Whole body vibration (frequency range: 1-80 Hz)
  - The entire human body is subject to vibration. Vibration is transmitted to the entire human body through the feet when standing, through the hips when sitting, and through the supporting objects when lying.
- Local vibration (frequency range: 6.3-5000 Hz)
  - Also known as hand-arm vibration. When the worker grips the hand tool while doing work, the vibration energy will be in a wave form, and will be transmitted from the vibration source to the operator's hand and arm system or even the whole body via solid medium.

Vibration hazard

- Whole body vibration:
  - Prolonged exposure to whole-body vibration greatly harms the spine and peripheral system, and to a lesser extent the digestive system, peripheral veins, sexual reproductive system and vestibular organs. There is a strong causal relationship between whole body vibration and lower back pain, sciatic menstrual pain, and degenerative changes of the spine system, such as those in lumbar intervertebral discs.

Vibration hazard (cont.)

- Local vibration:
  - Prolonged exposure can cause injuries in peripheral circulation and nervous/musculoskeletal systems (carpal tunnel syndrome)
  - Peripheral circulatory disorders mainly include the decrease in skin temperature and in recovery of skin temperature after exposure to cold; it also cause strong contraction of finger arteries, increase in finger arterial obstruction, and decrease in blood, leading to white finger disease or Raynaud's disease.



Finger thermal image: (left) normal; (right) white finger disease

Source: Labor and Occupational Safety and Health Research Institute

High temperature

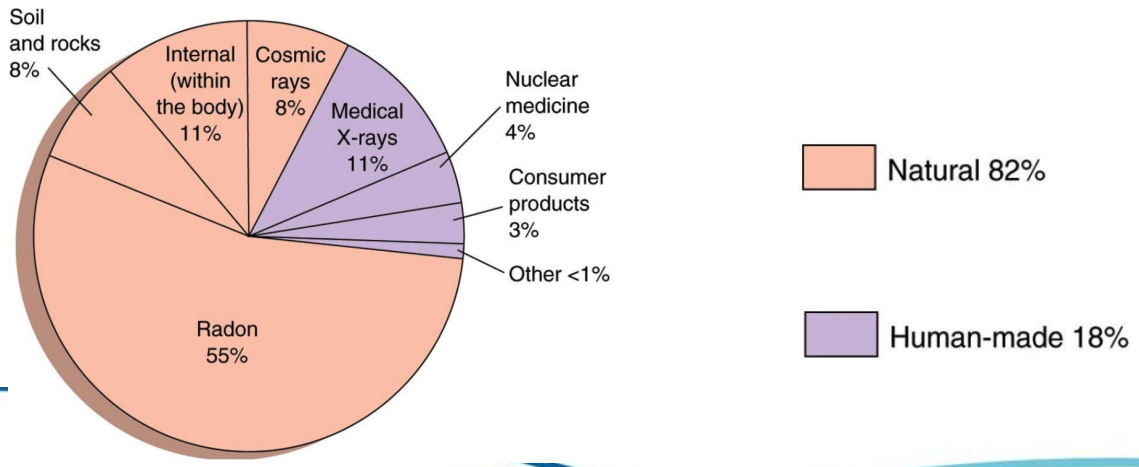
- The human body's thermal sensation to its environment is mainly affected by the following three factors:
  - Environment factor : Air temperature, relative humidity, air velocity, and radiant heat.
  - Metabolic heat : Determined by workload and work style.
  - Clothing insulation, clo : Affected by clothing material, thickness, weaving, fit, tailoring opening of the clothes, working posture and environmental factors when wearing.

High temperature hazards

- In a high temperature environment, the heat receptors in the skin are stimulated and send a message to the hypothalamus, which then sends instructions to expand blood vessels and accelerate blood flow (accelerated heartbeat), and release excessive heat from the body through breathing, perspiration, and etc.
- When the body's heat cannot be discharged through the above-mentioned ways, it will cause the body's heat to accumulate and "heat diseases", including heat cramps, heat exhaustion, and heat stroke.
- When the human body temperature exceeds 40℃, the protein structure of the enzymes in the body gradually deteriorates, losing normal metabolic functions, and eventually leading to death.

Ionizing radiation

- The source of ionizing radiation can be divided into:
  - Natural radiation: Radiation produced by cosmic rays, radioactive elements naturally present in soil and rocks.
  - Artificial radiation: Radiation for medical diagnosis and treatment, radiation from steel bars, nuclear power plants, etc.



Non-ionizing radiation

- Non-ionizing radiation refers to electromagnetic waves with a frequency less than 3×10^{15} Hz

Type	Wavelength (frequency)	Source
Partial UV	200 - 400 nm (7.5×10^{5} - 1.5×10^{6} GHz)	(1) Natural environment: sunlight (2) Industrial process: incandescent lamps, electric welding/arc, mosquito lamps, etc.
Visible light	400 - 700 nm (4×10^{5} - 7.5×10^{5} GHz)	(1) Natural environment: sunlight (2) Industrial products: laser products
Infrared	700 nm - 1 mm (300 GHz - 4×10^{5} GHz)	(1) Natural environment: sunlight (2) Workplace environment: drying operations
Microwave	1 mm -1 m (300 MHz - 300 GHz)	It can be encountered everywhere in the daily life environment, mostly caused by man. Widely used in radio broadcasting, radar communication, satellite communication, medical treatment and industrial production
Radio frequency radiation	1 m - 100 km (3 kHz - 300 MHz)	
Very low frequency electro-magnetic field	1,000 - 10,000 km (30 - 300 Hz)	The main outdoor sources are modern 50/60 Hz power systems, such as substations, high-voltage transmission lines, and distribution lines. The main indoor sources are household appliances and the power distribution system inside the building itself (such as power distribution lines in the walls).

(Note：nm＝10^{-9} m；mm＝10^{-3} m；km＝10^{3} m；kHz＝10^{3} Hz；MHz＝10^{6} Hz；GHz＝10^{9} Hz)

Abnormal atmospheric pressure

- Hazard of abnormal atmospheric pressure-decompression sickness
  - Large amount of inert gas (nitrogen or helium) dissolved in body tissue when breathing high-pressure mixed gas or air. It forms bubbles when you rise rapidly or does not decompress according to the normal procedure, which blocks the interstitial spaces, capillaries, joints and even the cranial nervous system, causing various symptoms.

Abnormal atmospheric pressure (cont.)

- Type I: Itchy skin, redness and blood stasis, fatigue, skin rash, local subcutaneous emphysema and joint pain.
- Type II: Air bubbles fill the nervous, respiratory, and cardiovascular systems, etc., causing headaches, dizziness, nausea, vomiting, crooked tongue, oblique mouth, speech disorders, confusion, coma, convulsions, and death.

III. IDENTIFICATION OF CHEMICAL HAZARDS

Chemical substance control measures

Chemical substance container labeling

Safety Data Sheet (SDS)

SDS

- The safety data sheet (SDS) should list content items including:

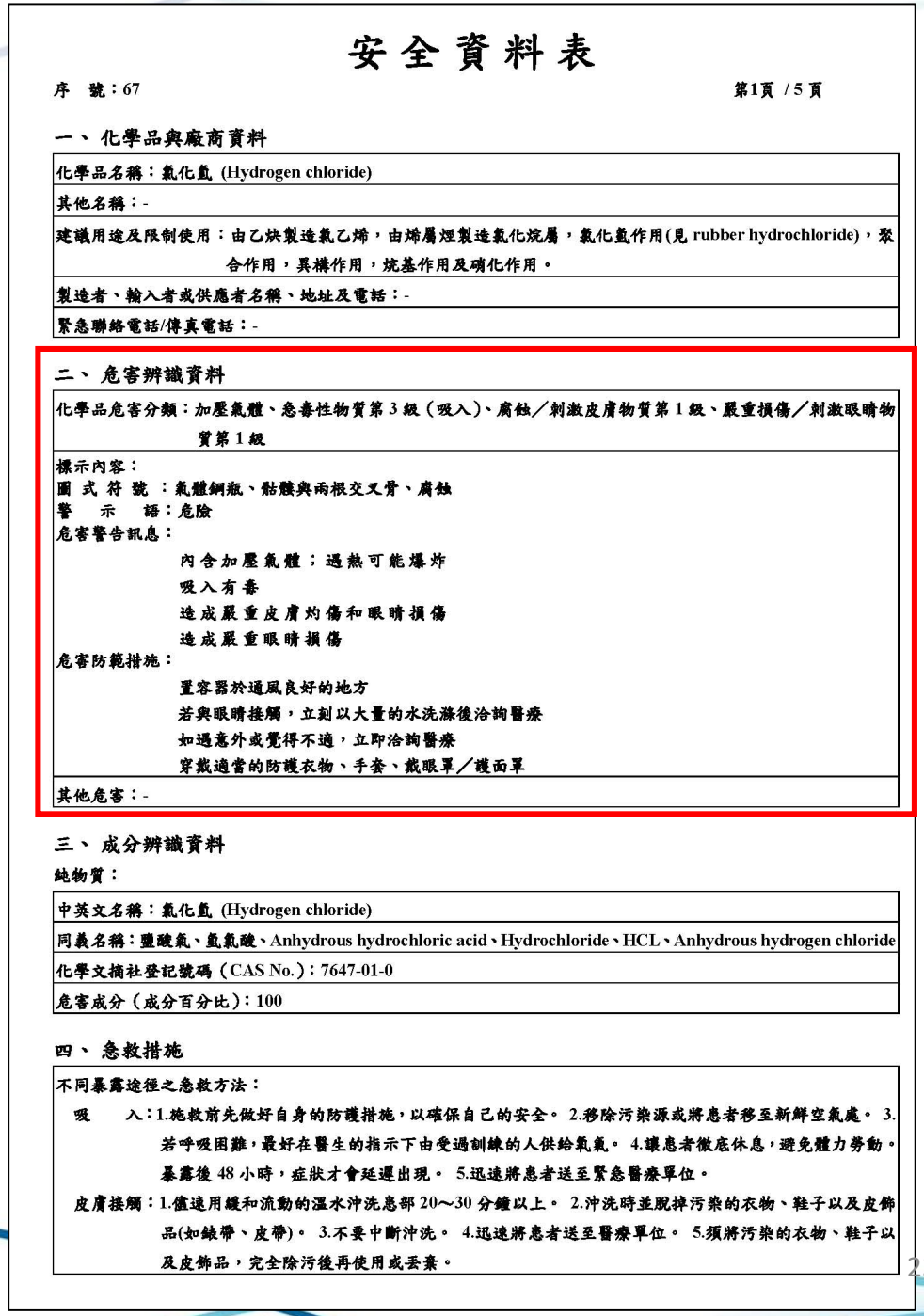
1. Item and vendor information
2. Hazard identification data
3. Composition information
4. First aid measures
5. Fire fighting measures
6. Leak handling methods
7. Safe handling and storage methods
8. Exposure precautions /personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicity data
12. Ecological information
13. Disposal methods
14. Shipping Information
15. Regulatory information
16. Other Information

SDS

Take hydrogen fluoride (HF) as an example

2. Hazard identification data

- Classification of chemical hazards.
- Labeling content: including graphical symbols, warning words, hazard warning messages, hazard prevention measures and other hazards.
- Other hazards that are not classifiable (such as dust explosion hazards) or hazards not covered by the global harmonization system.



安全資料表

序　號：67　　第1頁 / 5 頁

一、化學品與廠商資料

化學品名稱：氯化氫 (Hydrogen chloride)
其他名稱：-
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製造者、輸入者或供應者名稱、地址及電話：-
緊急聯絡電話/傳真電話：-

二、危害辨識資料

化學品危害分類：加壓氣體、急毒性物質第 3 級（吸入）、腐蝕／刺激皮膚物質第 1 級、嚴重損傷／刺激眼睛物質第 1 級
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其他危害：-

三、成分辨識資料

純物質：

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化學文摘社登記號碼（CAS No.）：7647-01-0
危害成分（成分百分比）：100

四、急救措施

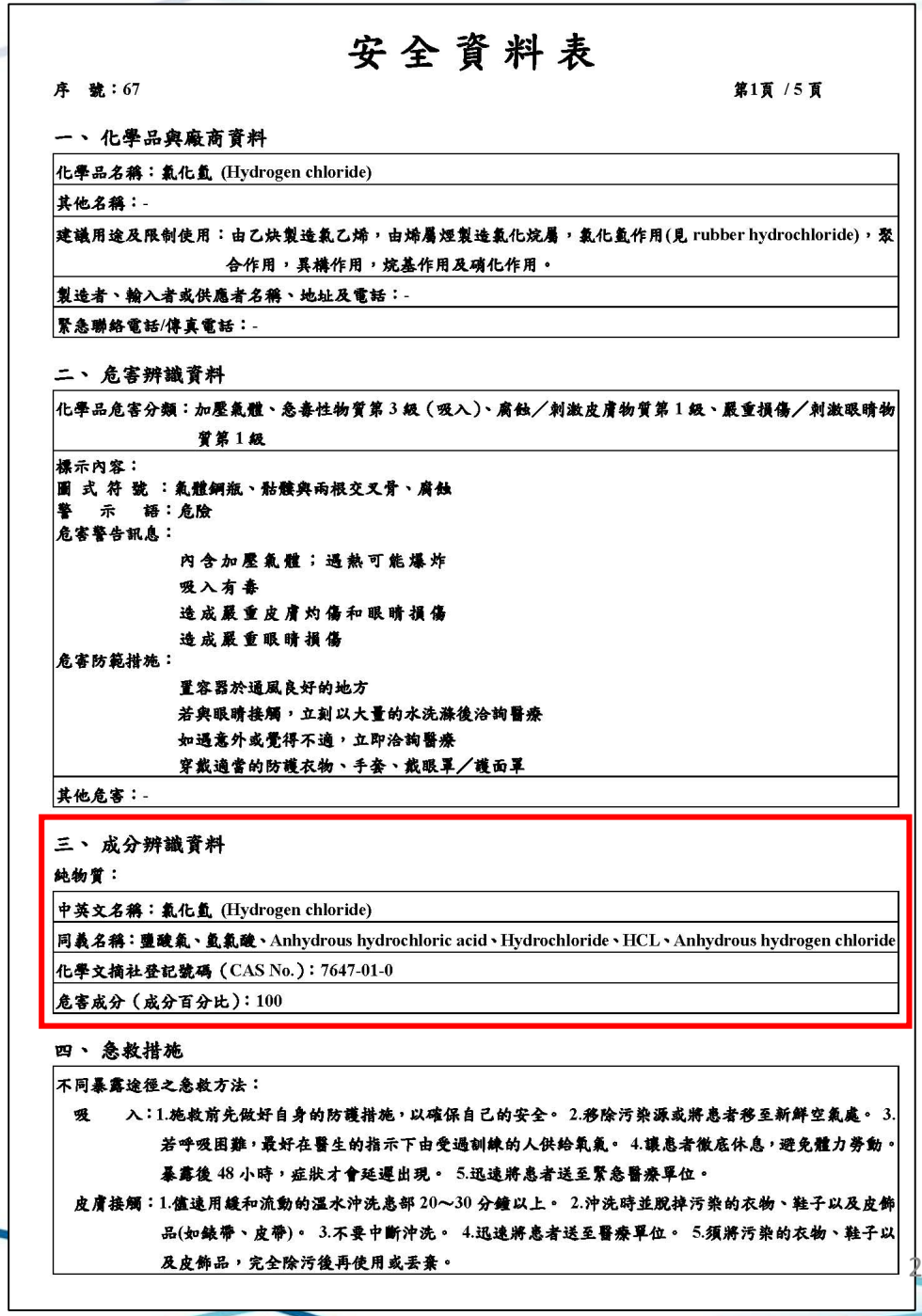
不同暴露途徑之急救方法： 吸　　入：1.施救前先做好自身的防護措施，以確保自己的安全。 2.移除污染源或將患者移至新鮮空氣處。 3.若呼吸困難，最好在醫生的指示下由受過訓練的人供給氧氣。 4.讓患者徹底休息，避免體力勞動。暴露後 48 小時，症狀才會延遲出現。 5.迅速將患者送至緊急醫療單位。 皮膚接觸：1.儘速用緩和流動的溫水沖洗患部 20～30 分鐘以上。 2.沖洗時並脫掉污染的衣物、鞋子以及皮飾品(如錶帶、皮帶)。 3.不要中斷沖洗。 4.迅速將患者送至醫療單位。 5.須將污染的衣物、鞋子以及皮飾品，完全除污後再使用或丟棄。

SDS

Take hydrogen fluoride (HF) as an example

3. Composition information

- Pure substances: Chinese and English names, synonymous names, CAS No., and hazardous ingredients.
- Mixture: chemical substance name and concentration or concentration range (component percentage)



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SDS

Take hydrogen fluoride (HF) as an example

4. First aid measures

- First aid methods of different exposure routes, the most important symptoms and harmful effects, protection and tips for first aid personnel.

安全資料表

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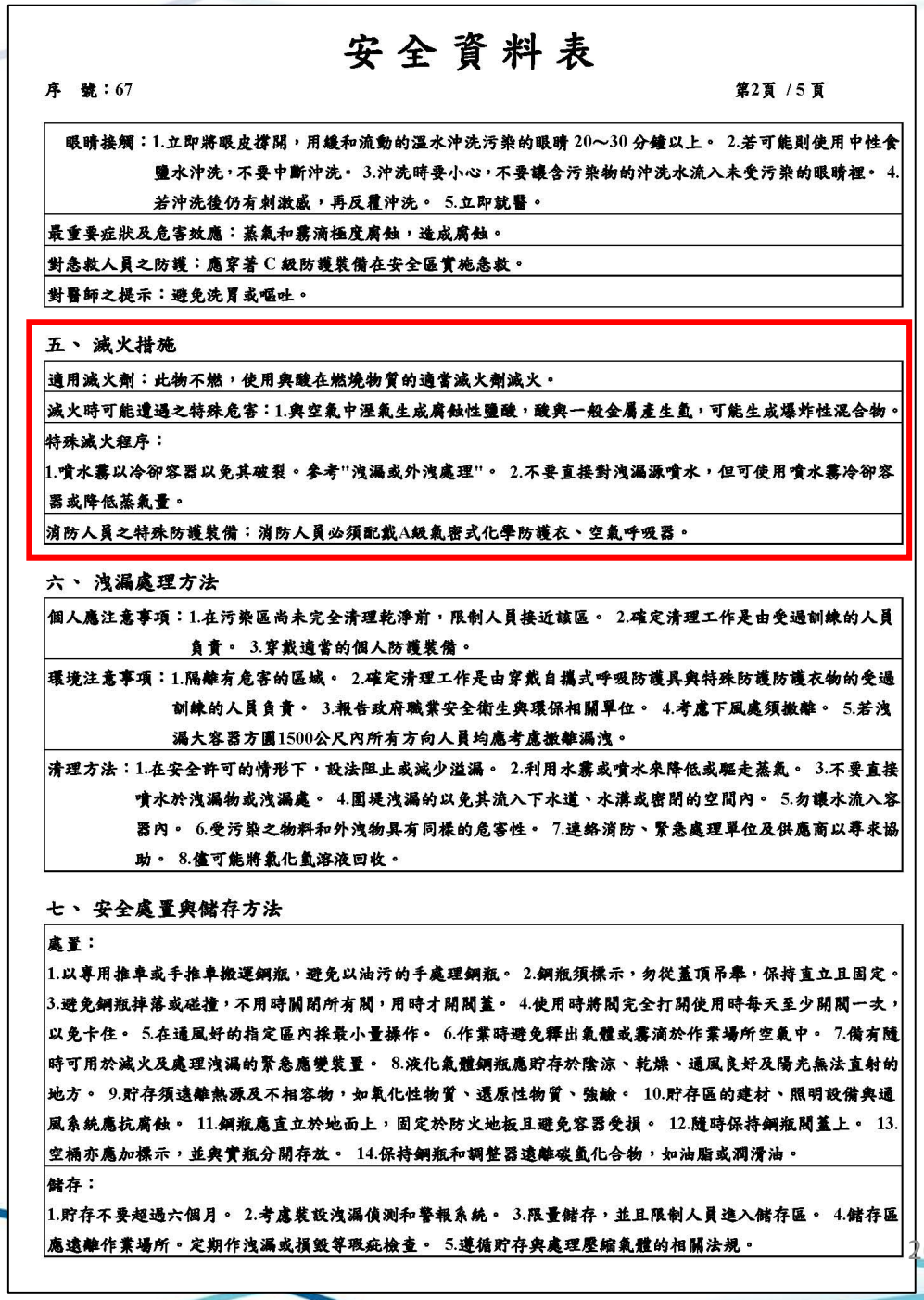
SDS

Take hydrogen fluoride (HF) as an example

5. Fire fighting measures

- Applicable fire extinguishing agents, special hazards caused by chemicals during fire extinguishing, special protective equipment for firefighters and matters needing attention.



安全資料表

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眼睛接觸：1.立即將眼皮撐開，用緩和流動的溫水沖洗污染的眼睛 20～30 分鐘以上。 2.若可能則使用中性食鹽水沖洗，不要中斷沖洗。 3.沖洗時要小心，不要讓含污染物的沖洗水流入未受污染的眼睛裡。 4.若沖洗後仍有刺激感，再反覆沖洗。 5.立即就醫。
最重要症狀及危害效應：蒸氣和霧滴極度腐蝕，造成腐蝕。
對急救人員之防護：應穿著 C 級防護裝備在安全區實施急救。
對醫師之提示：避免洗胃或嘔吐。

五、 滅火措施

適用滅火劑：此物不燃，使用與酸在燃燒物質的適當滅火劑滅火。
滅火時可能遭遇之特殊危害：1.與空氣中溼氣生成腐蝕性鹽酸，酸與一般金屬產生氫，可能生成爆炸性混合物。
特殊滅火程序： 1.噴水霧以冷卻容器以免其破裂。參考"洩漏或外洩處理"。 2.不要直接對洩漏源噴水，但可使用噴水霧冷卻容器或降低蒸氣量。
消防人員之特殊防護裝備：消防人員必須配戴A級氣密式化學防護衣、空氣呼吸器。

六、 洩漏處理方法

個人應注意事項：1.在污染區尚未完全清理乾淨前，限制人員接近該區。 2.確定清理工作是由受過訓練的人員負責。 3.穿戴適當的個人防護裝備。
環境注意事項：1.隔離有危害的區域。 2.確定清理工作是由穿戴自攜式呼吸防護具與特殊防護防護衣物的受過訓練的人員負責。 3.報告政府職業安全衛生與環保相關單位。 4.考慮下風處須撤離。 5.若洩漏大容器方圓1500公尺內所有方向人員均應考慮撤離漏洩。
清理方法：1.在安全許可的情形下，設法阻止或減少溢漏。 2.利用水霧或噴水來降低或驅走蒸氣。 3.不要直接噴水於洩漏物或洩漏處。 4.圍堤洩漏的以免其流入下水道、水溝或密閉的空間內。 5.勿讓水流入容器內。 6.受污染之物料和外洩物具有同樣的危害性。 7.連絡消防、緊急處理單位及供應商以尋求協助。 8.儘可能將氣化氫溶液回收。

七、 安全處置與儲存方法

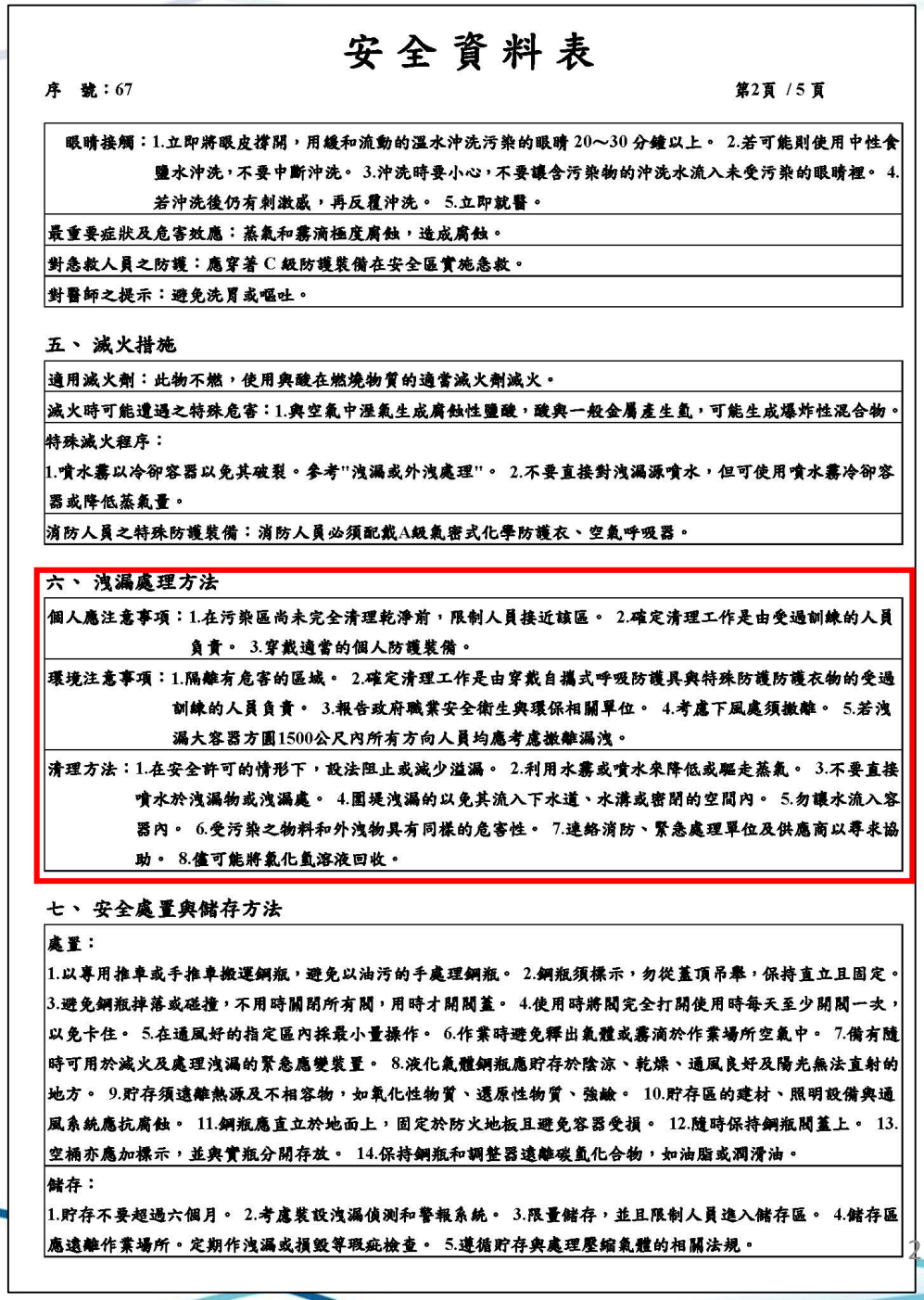
處置： 1.以專用推車或手推車搬運鋼瓶，避免以油污的手處理鋼瓶。 2.鋼瓶須標示，勿從蓋頂吊舉，保持直立且固定。 3.避免鋼瓶掉落或碰撞，不用時關閉所有閥，用時才開閥蓋。 4.使用時將閥完全打開使用時每天至少開閥一次，以免卡住。 5.在通風好的指定區內採最小量操作。 6.作業時避免釋出氣體或霧滴於作業場所空氣中。 7.備有隨時可用於滅火及處理洩漏的緊急應變裝置。 8.液化氣體鋼瓶應貯存於陰涼、乾燥、通風良好及陽光無法直射的地方。 9.貯存須遠離熱源及不相容物，如氧化性物質、還原性物質、強鹼。 10.貯存區的建材、照明設備與通風系統應抗腐蝕。 11.鋼瓶應直立於地面上，固定於防火地板且避免容器受損。 12.隨時保持鋼瓶閥蓋上。 13.空桶亦應加標示，並與實瓶分開存放。 14.保持鋼瓶和調整器遠離碳氫化合物，如油脂或潤滑油。
儲存： 1.貯存不要超過六個月。 2.考慮裝設洩漏偵測和警報系統。 3.限量儲存，並且限制人員進入儲存區。 4.儲存區應遠離作業場所。定期作洩漏或損毀等瑕疵檢查。 5.遵循貯存與處理壓縮氣體的相關法規。

SDS

Take hydrogen fluoride (HF) as an example

6. Leak handling methods

- Matters personnel should pay attention to, protective equipment and emergency response procedures.
- Environmental considerations.
- Methods and materials for cleaning up.



安全資料表

序　號：67　　第2頁 / 5 頁

眼睛接觸：1.立即將眼皮撐開，用緩和流動的溫水沖洗污染的眼睛 20～30 分鐘以上。 2.若可能則使用中性食鹽水沖洗，不要中斷沖洗。 3.沖洗時要小心，不要讓含污染物的沖洗水流入未受污染的眼睛裡。 4.若沖洗後仍有刺激感，再反覆沖洗。 5.立即就醫。
最重要症狀及危害效應：蒸氣和霧滴極度腐蝕，造成腐蝕。
對急救人員之防護：應穿著 C 級防護裝備在安全區實施急救。
對醫師之提示：避免洗胃或嘔吐。

五、 滅火措施

適用滅火劑：此物不燃，使用與酸在燃燒物質的適當滅火劑滅火。
滅火時可能遭遇之特殊危害：1.與空氣中溼氣生成腐蝕性鹽酸，酸與一般金屬產生氫，可能生成爆炸性混合物。
特殊滅火程序： 1.噴水霧以冷卻容器以免其破裂。參考"洩漏或外洩處理"。 2.不要直接對洩漏源噴水，但可使用噴水霧冷卻容器或降低蒸氣量。
消防人員之特殊防護裝備：消防人員必須配戴A級氣密式化學防護衣、空氣呼吸器。

六、 洩漏處理方法

個人應注意事項：1.在污染區尚未完全清理乾淨前，限制人員接近該區。 2.確定清理工作是由受過訓練的人員負責。 3.穿戴適當的個人防護裝備。
環境注意事項：1.隔離有危害的區域。 2.確定清理工作是由穿戴自攜式呼吸防護具與特殊防護防護衣物的受過訓練的人員負責。 3.報告政府職業安全衛生與環保相關單位。 4.考慮下風處須撤離。 5.若洩漏大容器方圓1500公尺內所有方向人員均應考慮撤離漏洩。
清理方法：1.在安全許可的情形下，設法阻止或減少溢漏。 2.利用水霧或噴水來降低或驅走蒸氣。 3.不要直接噴水於洩漏物或洩漏處。 4.圍堤洩漏的以免其流入下水道、水溝或密閉的空間內。 5.勿讓水流入容器內。 6.受污染之物料和外洩物具有同樣的危害性。 7.連絡消防、緊急處理單位及供應商以尋求協助。 8.儘可能將氣化氫溶液回收。

七、 安全處置與儲存方法

處置： 1.以專用推車或手推車搬運鋼瓶，避免以油污的手處理鋼瓶。 2.鋼瓶須標示，勿從蓋頂吊舉，保持直立且固定。 3.避免鋼瓶掉落或碰撞，不用時關閉所有閥，用時才開閥蓋。 4.使用時將閥完全打開使用時每天至少開閥一次，以免卡住。 5.在通風好的指定區內採最小量操作。 6.作業時避免釋出氣體或霧滴於作業場所空氣中。 7.備有隨時可用於滅火及處理洩漏的緊急應變裝置。 8.液化氣體鋼瓶應貯存於陰涼、乾燥、通風良好及陽光無法直射的地方。 9.貯存須遠離熱源及不相容物，如氧化性物質、還原性物質、強鹼。 10.貯存區的建材、照明設備與通風系統應抗腐蝕。 11.鋼瓶應直立於地面上，固定於防火地板且避免容器受損。 12.隨時保持鋼瓶閥蓋上。 13.空桶亦應加標示，並與實瓶分開存放。 14.保持鋼瓶和調整器遠離碳氫化合物，如油脂或潤滑油。
儲存： 1.貯存不要超過六個月。 2.考慮裝設洩漏偵測和警報系統。 3.限量儲存，並且限制人員進入儲存區。 4.儲存區應遠離作業場所。定期作洩漏或損毀等瑕疵檢查。 5.遵循貯存與處理壓縮氣體的相關法規。

SDS

Take hydrogen fluoride (HF) as an example

7. Safe handling and storage methods

- Precautions for safe disposal.
- Conditions for safe storage, including any incompatibilities.

安 全 資 料 表

序　號：67　　第2頁 / 5 頁

眼睛接觸：1.立即將眼皮撐開，用緩和流動的溫水沖洗污染的眼睛 20～30 分鐘以上。 2.若可能則使用中性食鹽水沖洗，不要中斷沖洗。 3.沖洗時要小心，不要讓含污染物的沖洗水流入未受污染的眼睛裡。 4.若沖洗後仍有刺激感，再反覆沖洗。 5.立即就醫。
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對急救人員之防護：應穿著 C 級防護裝備在安全區實施急救。
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特殊滅火程序： 1.噴水霧以冷卻容器以免其破裂。參考"洩漏或外洩處理"。 2.不要直接對洩漏源噴水，但可使用噴水霧冷卻容器或降低蒸氣量。
消防人員之特殊防護裝備：消防人員必須配戴A級氣密式化學防護衣、空氣呼吸器。

六、 洩漏處理方法

個人應注意事項：1.在污染區尚未完全清理乾淨前，限制人員接近該區。 2.確定清理工作是由受過訓練的人員負責。 3.穿戴適當的個人防護裝備。
環境注意事項：1.隔離有危害的區域。 2.確定清理工作是由穿戴自攜式呼吸防護具與特殊防護防護衣物的受過訓練的人員負責。 3.報告政府職業安全衛生與環保相關單位。 4.考慮下風處須撤離。 5.若洩漏大容器方圓1500公尺內所有方向人員均應考慮撤離漏洩。
清理方法：1.在安全許可的情形下，設法阻止或減少溢漏。 2.利用水霧或噴水來降低或驅走蒸氣。 3.不要直接噴水於洩漏物或洩漏處。 4.圍堤洩漏的以免其流入下水道、水溝或密閉的空間內。 5.勿讓水流入容器內。 6.受污染之物料和外洩物具有同樣的危害性。 7.連絡消防、緊急處理單位及供應商以尋求協助。 8.儘可能將氣化氫溶液回收。

七、 安全處置與儲存方法

處置： 1.以專用推車或手推車搬運鋼瓶，避免以油污的手處理鋼瓶。 2.鋼瓶須標示，勿從蓋頂吊舉，保持直立且固定。 3.避免鋼瓶掉落或碰撞，不用時關閉所有閥，用時才開閥蓋。 4.使用時將閥完全打開使用時每天至少開閥一次，以免卡住。 5.在通風好的指定區內採最小量操作。 6.作業時避免釋出氣體或霧滴於作業場所空氣中。 7.備有隨時可用於滅火及處理洩漏的緊急應變裝置。 8.液化氣體鋼瓶應貯存於陰涼、乾燥、通風良好及陽光無法直射的地方。 9.貯存須遠離熱源及不相容物，如氧化性物質、還原性物質、強鹼。 10.貯存區的建材、照明設備與通風系統應抗腐蝕。 11.鋼瓶應直立於地面上，固定於防火地板且避免容器受損。 12.隨時保持鋼瓶閥蓋上。 13.空桶亦應加標示，並與實瓶分開存放。 14.保持鋼瓶和調整器遠離碳氫化合物，如油脂或潤滑油。
儲存： 1.貯存不要超過六個月。 2.考慮裝設洩漏偵測和警報系統。 3.限量儲存，並且限制人員進入儲存區。 4.儲存區應遠離作業場所。定期作洩漏或損毀等瑕疵檢查。 5.遵循貯存與處理壓縮氣體的相關法規。

SDS

Take hydrogen fluoride (HF) as an example

8. Exposure precautions /personal protection

- Control parameters (such as eight-hour time-weighted average/short-term exposure limit/ceiling values, biological indicators).
- Appropriate engineering control methods.
- Personal protective equipment (respiratory protection, hand protection, eye protection, skin and body protection).

安全資料表

序　號：67　　第3頁 / 5 頁

八、暴露預防措施

工程控制：1.一般操作須使用局部排氣通風系統。 2.在高濃度區域使用向下通風的整體換氣。 3.單獨使用抗腐蝕性的通風系統。 4.排出的廢氣須先處理，才可釋放到屋外。 5.供給充分新鮮的空氣以補充排氣系統抽出的空氣。

控制參數

八小時日時量平均容許濃度 TWA	短時間時量平均容許濃度 STEL	最高容許濃度 CEILING	生物指標 BEIs
—	—	5 ppm	—

個人防護設備：

呼　吸　防　護：1.50 ppm 以下：含防 HCL 濾罐的動力型空氣淨化式或全面型化學濾罐式呼吸防護具、含 HCL 濾罐的防毒面罩、全面型自攜式或供氣式呼吸防護具 2.未知濃度：正壓自攜式呼吸防護具、正壓全面型供氣式呼吸防護具輔以正壓自攜式呼吸防護具。 3.逃生：含防酸氣濾罐之氣體面罩、逃生型自攜式呼吸防護具

手　部　防　護：1.防滲手套，材質建議以丁基橡膠、Telfon、Barricade、Responder 為佳。

眼　睛　防　護：1.不漏氣的化學安全護目鏡、護面罩。

皮膚及身體防護：1.上述橡膠材質連身式防護衣、工作靴。

衛生措施：1.工作後儘速脫掉污染之衣物，洗淨後才可再穿戴或丟棄，且須告知洗衣人員污染之危害性。 2.工作場所嚴禁抽煙或飲食。3.處理此物後，須徹底洗手。4.維持作業場所清潔。

九、物理及化學性質

外觀：無色、發煙氣體，吸濕性	氣味：刺激味
嗅覺閾值：1-5ppm（偵測）、10ppm（刺激）	熔點：-114℃
pH 值：-	沸點/沸點範圍：-85 ℃
易燃性（固體，氣體）：-	閃火點：不燃
分解溫度：—	測試方法（開杯或閉杯）：
自燃溫度：-	爆炸界限：-
蒸氣壓：42.7 atm@21.1℃	蒸氣密度：1.267（空氣=1）
密度：-	溶解度：50.6g/100ml（水）
辛醇/水分配係數（log Kow）：—	揮發速率：/

十、安定性及反應性

安定性：正常狀況下安定

特殊狀況下可能之危害反應：1.醇、乙二醇、胺、酮、不飽和脂肪族：反應，產生熱。 2.乙醛、環氧物：觸發劇烈聚合，產生熱及壓力。 3.金屬、還原劑：反應產生易燃氫氣。 4.氧化劑：反應產生熱、有毒或腐蝕性的氣和氧化氣氣體。 5.磷化物：反應釋出有毒且易燃的磷氣。 6.氰化物、硫化物：反應釋出有毒氣體。 7.炸藥：反應造成爆炸。 8.乙炔化物、硼化物、碳化物、矽化物：反應產生易燃氣。

應避免之狀況：—

SDS

Take hydrogen fluoride (HF) as an example

9. Physical and chemical properties

- Appearance (physical state, color, etc.), smell, olfactory threshold, pH value, melting point/freezing point, boiling point/boiling point range, flash point, explosion limit, vapor pressure, vapor density, density, solubility, partition coefficient, auto-ignition temperature, decomposition temperature.

安 全 資 料 表

序　號：67　　第3頁 / 5 頁

八、 暴露預防措施

工程控制：1.一般操作須使用局部排氣通風系統。 2.在高濃度區域使用向下通風的整體換氣。 3.單獨使用抗腐蝕性的通風系統。 4.排出的廢氣須先處理，才可釋放到屋外。 5.供給充分新鮮的空氣以補充排氣系統抽出的空氣。

控 制 參 數			
八小時日時量平均 容許濃度 TWA	短時間時量平均 容許濃度 STEL	最高容許 濃度 CEILING	生物指標 BEIs
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個人防護設備：

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手　部　防　護：1.防滲手套，材質建議以丁基橡膠、Telfon、Barricade、Responder 為佳。

眼　睛　防　護：1.不漏氣的化學安全護目鏡、護面罩。

皮膚及身體防護：1.上述橡膠材質連身式防護衣、工作靴。

衛生措施：1.工作後儘速脫掉污染之衣物，洗淨後才可再穿戴或丟棄，且須告知洗衣人員污染之危害性。 2.工作場所嚴禁抽煙或飲食。3.處理此物後，須徹底洗手。4.維持作業場所清潔。

九、 物理及化學性質

外觀：無色、發煙氣體，吸濕性	氣味：刺激味
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易燃性（固體，氣體）：-	閃火點：不燃
分解溫度：—	測試方法（開杯或閉杯）：
自燃溫度：-	爆炸界限：-
蒸氣壓：42.7 atm@21.1℃	蒸氣密度：1.267（空氣=1）
密度：-	溶解度：50.6g/100ml（水）
辛醇/水分配係數（log Kow）：—	揮發速率：/

十、 安定性及反應性

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應避免之狀況：—

SDS

Take hydrogen fluoride (HF) as an example

10. Stability and reactivity

- Chemical stability, possible hazardous reactions under special conditions, conditions to be avoided (such as static electricity, shock or vibration), substances to be avoided, hazardous decomposition products.

安 全 資 料 表

序　號：67　　第3頁 / 5 頁

八、 暴露預防措施

工程控制：1.一般操作須使用局部排氣通風系統。 2.在高濃度區域使用向下通風的整體換氣。 3.單獨使用抗腐蝕性的通風系統。 4.排出的廢氣須先處理，才可釋放到屋外。 5.供給充分新鮮的空氣以補充排氣系統抽出的空氣。

控 制 參 數

八小時日時量平均容許濃度 TWA	短時間時量平均容許濃度 STEL	最高容許濃度 CEILING	生物指標 BEIs
—	—	5 ppm	—

個人防護設備：

呼　吸　防　護：1.50 ppm 以下：含防 HCL 濾罐的動力型空氣淨化式或全面型化學濾罐式呼吸防護具、含 HCL 濾罐的防毒面罩、全面型自攜式或供氣式呼吸防護具 2.未知濃度：正壓自攜式呼吸防護具、正壓全面型供氣式呼吸防護具輔以正壓自攜式呼吸防護具。 3.逃生：含防酸氣濾罐之氣體面罩、逃生型自攜式呼吸防護具

手　部　防　護：1.防滲手套，材質建議以丁基橡膠、Telfon、Barricade、Responder 為佳。

眼　睛　防　護：1.不漏氣的化學安全護目鏡、護面罩。

皮膚及身體防護：1.上述橡膠材質連身式防護衣、工作靴。

衛生措施：1.工作後儘速脫掉污染之衣物，洗淨後才可再穿戴或丟棄，且須告知洗衣人員污染之危害性。 2.工作場所嚴禁抽煙或飲食。3.處理此物後，須徹底洗手。4.維持作業場所清潔。

九、 物理及化學性質

外觀：無色、發煙氣體，吸溼性	氣味：刺激味
嗅覺閾值：1-5ppm（偵測）、10ppm（刺激）	熔點：-114℃
pH 值：-	沸點/沸點範圍：-85 ℃
易燃性（固體，氣體）：-	閃火點：不燃
分解溫度：—	測試方法（開杯或閉杯）：
自燃溫度：-	爆炸界限：-
蒸氣壓：42.7 atm@21.1℃	蒸氣密度：1.267（空氣=1）
密度：-	溶解度：50.6g/100ml（水）
辛醇/水分配係數（log Kow）：—	揮發速率：/

十、 安定性及反應性

安定性：正常狀況下安定

特殊狀況下可能之危害反應：1.醇、乙二醇、胺、酮、不飽和脂肪族：反應，產生熱。 2.乙醛、環氧物：觸發劇烈聚合，產生熱及壓力。 3.金屬、還原劑：反應產生易燃氫氣。 4.氧化劑：反應產生熱、有毒或腐蝕性的氣和氧化氣氣體。 5.磷化物：反應釋出有毒且易燃的磷氣。 6.氰化物、硫化物：反應釋出有毒氣體。 7.炸藥：反應造成爆炸。 8.乙炔化物、硼化物、碳化物、矽化物：反應產生易燃氣。

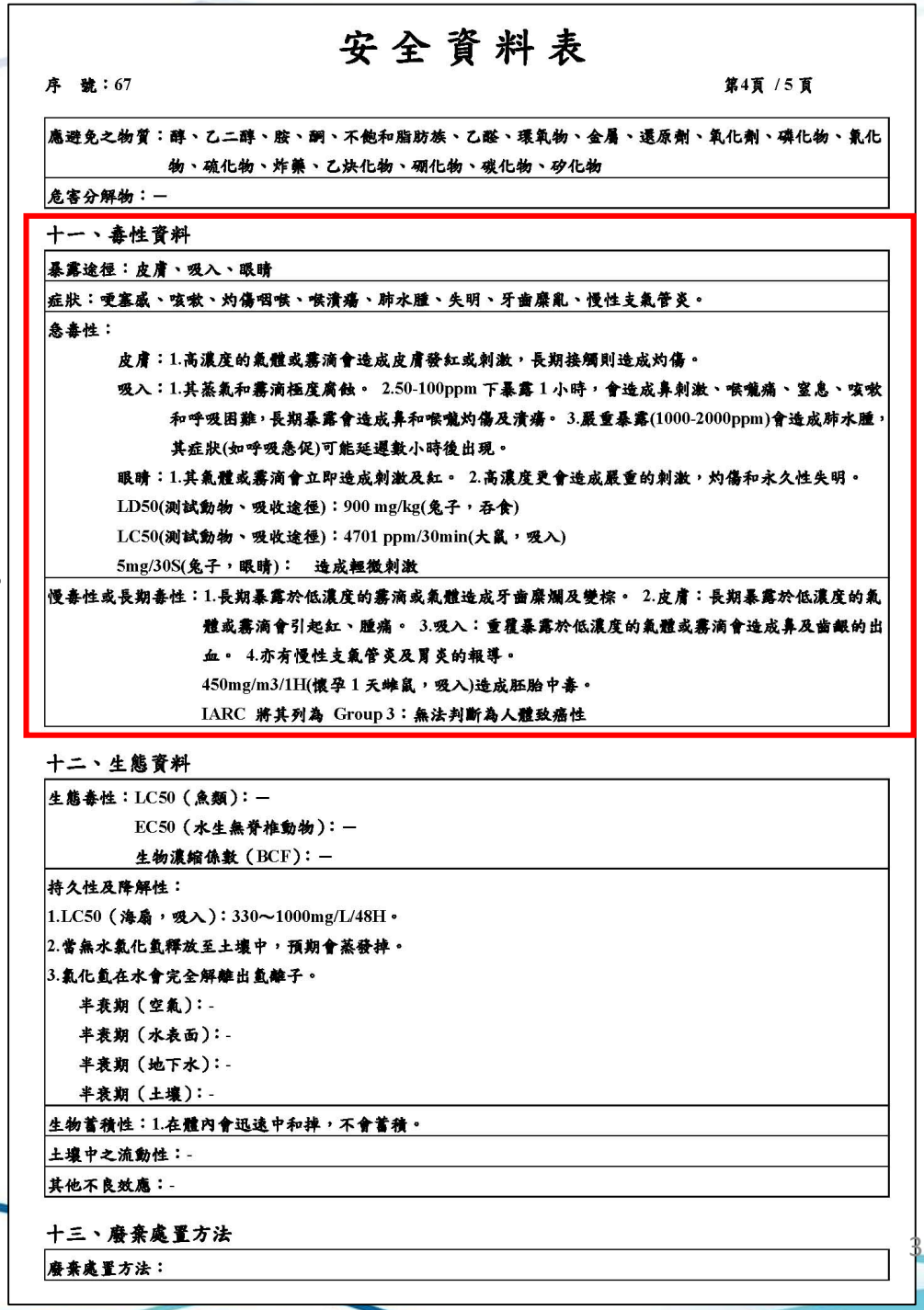
應避免之狀況：—

SDS

Take hydrogen fluoride (HF) as an example

11. Toxicity data

- Information on possible routes of exposure (inhalation, ingestion, skin and eye contact).
- Symptoms related to physical, chemical and toxicological properties.
- Delayed and immediate effects and chronic effects caused by long-term and short-term exposure.
- Toxicity measures (e.g. acute toxicity estimates)



安全資料表

序　號：67　　第4頁 / 5頁

應避免之物質：醇、乙二醇、胺、酮、不飽和脂肪族、乙醛、環氧物、金屬、還原劑、氧化劑、磷化物、氰化物、硫化物、炸藥、乙炔化物、硼化物、碳化物、矽化物

危害分解物：－

十一、毒性資料

暴露途徑：皮膚、吸入、眼睛

症狀：哽塞感、咳嗽、灼傷咽喉、喉潰瘍、肺水腫、失明、牙齒腐亂、慢性支氣管炎。

急毒性：

皮膚：1.高濃度的氣體或霧滴會造成皮膚發紅或刺激，長期接觸則造成灼傷。

吸入：1.其蒸氣和霧滴極度腐蝕。 2.50-100ppm 下暴露 1 小時，會造成鼻刺激、喉嚨痛、窒息、咳嗽和呼吸困難，長期暴露會造成鼻和喉嚨灼傷及潰瘍。 3.嚴重暴露(1000-2000ppm)會造成肺水腫，其症狀(如呼吸急促)可能延遲數小時後出現。

眼睛：1.其氣體或霧滴會立即造成刺激及紅。 2.高濃度更會造成嚴重的刺激，灼傷和永久性失明。

LD50(測試動物、吸收途徑)：900 mg/kg(兔子，吞食)

LC50(測試動物、吸收途徑)：4701 ppm/30min(大鼠，吸入)

5mg/30S(兔子，眼睛)： 造成輕微刺激

慢毒性或長期毒性：1.長期暴露於低濃度的霧滴或氣體造成牙齒腐爛及變棕。 2.皮膚：長期暴露於低濃度的氣體或霧滴會引起紅、腫痛。 3.吸入：重覆暴露於低濃度的氣體或霧滴會造成鼻及齒齦的出血。 4.亦有慢性支氣管炎及胃炎的報導。

450mg/m3/1H(懷孕 1 天雌鼠，吸入)造成胚胎中毒。

IARC 將其列為 Group 3：無法判斷為人體致癌性

十二、生態資料

生態毒性：LC50（魚類）：－

EC50（水生無脊椎動物）：－

生物濃縮係數（BCF）：－

持久性及降解性：

1.LC50（海扇，吸入）：330～1000mg/L/48H。

2.當無水氟化氫釋放至土壤中，預期會蒸發掉。

3.氟化氫在水會完全解離出氫離子。

半衰期（空氣）：-

半衰期（水表面）：-

半衰期（地下水）：-

半衰期（土壤）：-

生物蓄積性：1.在體內會迅速中和掉，不會蓄積。

土壤中之流動性：-

其他不良效應：-

十三、廢棄處置方法

廢棄處置方法：

SDS

Take hydrogen fluoride (HF) as an example

12. Ecological information

- Ecotoxicity (in water and soil, if any).
- Persistence and degradability.
- Bioaccumulation.
- Mobility in the soil.
- Other adverse effects.

安全資料表

序　號：67　　第4頁 / 5頁

應避免之物質：醇、乙二醇、胺、酮、不飽和脂肪族、乙醛、環氧物、金屬、還原劑、氧化劑、磷化物、氰化物、硫化物、炸藥、乙炔化物、硼化物、碳化物、矽化物
危害分解物：—

十一、毒性資料

暴露途徑：皮膚、吸入、眼睛
症狀：哽塞感、咳嗽、灼傷咽喉、喉潰瘍、肺水腫、失明、牙齒腐亂、慢性支氣管炎。
急毒性： 皮膚：1.高濃度的氣體或霧滴會造成皮膚發紅或刺激，長期接觸則造成灼傷。 吸入：1.其蒸氣和霧滴極度腐蝕。 2.50-100ppm 下暴露 1 小時，會造成鼻刺激、喉嚨痛、窒息、咳嗽和呼吸困難，長期暴露會造成鼻和喉嚨灼傷及潰瘍。 3.嚴重暴露(1000-2000ppm)會造成肺水腫，其症狀(如呼吸急促)可能延遲數小時後出現。 眼睛：1.其氣體或霧滴會立即造成刺激及紅。 2.高濃度更會造成嚴重的刺激，灼傷和永久性失明。 LD50(測試動物、吸收途徑)：900 mg/kg(兔子，吞食) LC50(測試動物、吸收途徑)：4701 ppm/30min(大鼠，吸入) 5mg/30S(兔子，眼睛)：　造成輕微刺激
慢毒性或長期毒性：1.長期暴露於低濃度的霧滴或氣體造成牙齒腐爛及變棕。 2.皮膚：長期暴露於低濃度的氣體或霧滴會引起紅、腫痛。 3.吸入：重覆暴露於低濃度的氣體或霧滴會造成鼻及齒齦的出血。 4.亦有慢性支氣管炎及胃炎的報導。 450mg/m3/1H(懷孕 1 天雌鼠，吸入)造成胚胎中毒。 IARC 將其列為 Group 3：無法判斷為人體致癌性

十二、生態資料

生態毒性：LC50（魚類）：— EC50（水生無脊椎動物）：— 生物濃縮係數（BCF）：—
持久性及降解性： 1.LC50（海扇，吸入）：330～1000mg/L/48H。 2.當無水氟化氫釋放至土壤中，預期會蒸發掉。 3.氟化氫在水會完全解離出氫離子。 半衰期（空氣）：- 半衰期（水表面）：- 半衰期（地下水）：- 半衰期（土壤）：-
生物蓄積性：1.在體內會迅速中和掉，不會蓄積。
土壤中之流動性：-
其他不良效應：-

十三、廢棄處置方法

廢棄處置方法：

SDS

Take hydrogen fluoride (HF) as an example

13. Disposal methods

- Description of the remaining waste and information on its safe disposal and disposal methods, including the disposal of any contaminated packaging.

安全資料表

序　號：67　　第4頁 / 5 頁

應避免之物質：醇、乙二醇、胺、酮、不飽和脂肪族、乙醛、環氧物、金屬、還原劑、氧化劑、磷化物、氰化物、硫化物、炸藥、乙炔化物、硼化物、碳化物、矽化物
危害分解物：—

十一、毒性資料

暴露途徑：皮膚、吸入、眼睛
症狀：哽塞感、咳嗽、灼傷咽喉、喉潰瘍、肺水腫、失明、牙齒腐亂、慢性支氣管炎。
急毒性： 皮膚：1.高濃度的氣體或霧滴會造成皮膚發紅或刺激，長期接觸則造成灼傷。 吸入：1.其蒸氣和霧滴極度腐蝕。 2.50-100ppm 下暴露 1 小時，會造成鼻刺激、喉嚨痛、窒息、咳嗽和呼吸困難，長期暴露會造成鼻和喉嚨灼傷及潰瘍。 3.嚴重暴露(1000-2000ppm)會造成肺水腫，其症狀(如呼吸急促)可能延遲數小時後出現。 眼睛：1.其氣體或霧滴會立即造成刺激及紅。 2.高濃度更會造成嚴重的刺激，灼傷和永久性失明。 LD50(測試動物、吸收途徑)：900 mg/kg(兔子，吞食) LC50(測試動物、吸收途徑)：4701 ppm/30min(大鼠，吸入) 5mg/30S(兔子，眼睛)： 造成輕微刺激
慢毒性或長期毒性：1.長期暴露於低濃度的霧滴或氣體造成牙齒腐爛及變棕。 2.皮膚：長期暴露於低濃度的氣體或霧滴會引起紅、腫痛。 3.吸入：重覆暴露於低濃度的氣體或霧滴會造成鼻及齒齦的出血。 4.亦有慢性支氣管炎及胃炎的報導。 450mg/m3/1H(懷孕 1 天雌鼠，吸入)造成胚胎中毒。 IARC 將其列為 Group 3：無法判斷為人體致癌性

十二、生態資料

生態毒性：LC50（魚類）：— EC50（水生無脊椎動物）：— 生物濃縮係數（BCF）：—
持久性及降解性： 1.LC50（海扇，吸入）：330～1000mg/L/48H。 2.當無水氟化氫釋放至土壤中，預期會蒸發掉。 3.氟化氫在水會完全解離出氫離子。 半衰期（空氣）：- 半衰期（水表面）：- 半衰期（地下水）：- 半衰期（土壤）：-
生物蓄積性：1.在體內會迅速中和掉，不會蓄積。
土壤中之流動性：-
其他不良效應：-

十三、廢棄處置方法

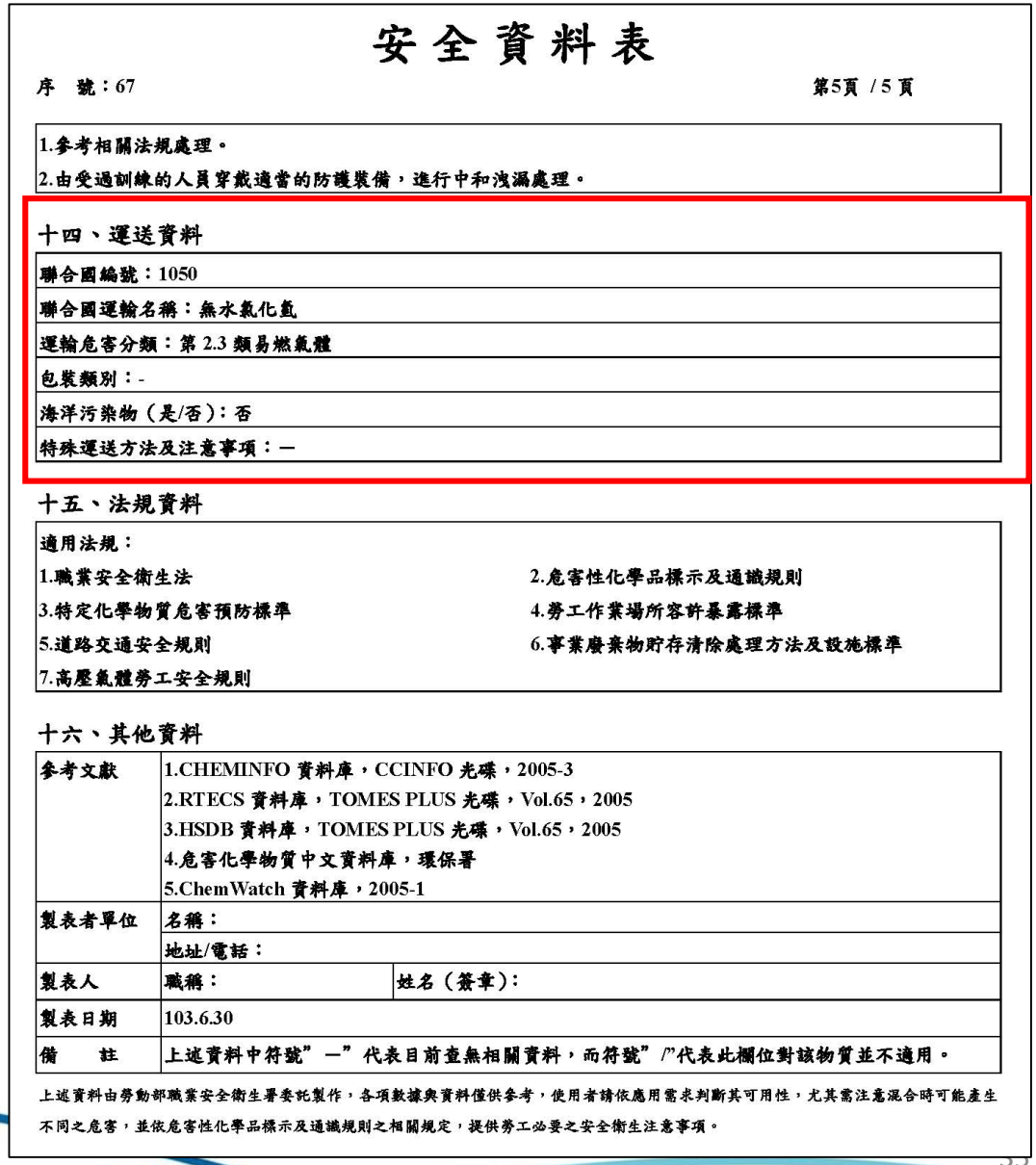
廢棄處置方法：

SDS

Take hydrogen fluoride (HF) as an example

14. Shipping Information

- UN number, UN shipping name, transportation hazard classification, packaging type, marine pollutants (yes/no), special transportation methods and precautions.



安全資料表

序　號：67　　第5頁 / 5 頁

1.參考相關法規處理。 2.由受過訓練的人員穿戴適當的防護裝備，進行中和洩漏處理。

十四、運送資料

聯合國編號：1050
聯合國運輸名稱：無水氟化氫
運輸危害分類：第 2.3 類易燃氣體
包裝類別：-
海洋污染物（是/否）：否
特殊運送方法及注意事項：—

十五、法規資料

適用法規：	
1.職業安全衛生法	2.危害性化學品標示及通識規則
3.特定化學物質危害預防標準	4.勞工作業場所容許暴露標準
5.道路交通安全規則	6.事業廢棄物貯存清除處理方法及設施標準
7.高壓氣體勞工安全規則	

十六、其他資料

參考文獻	1.CHEMINFO 資料庫，CCINFO 光碟，2005-3 2.RTECS 資料庫，TOMES PLUS 光碟，Vol.65，2005 3.HSDB 資料庫，TOMES PLUS 光碟，Vol.65，2005 4.危害化學物質中文資料庫，環保署 5.ChemWatch 資料庫，2005-1	
製表者單位	名稱：	
	地址/電話：	
製表人	職稱：	姓名（簽章）：
製表日期	103.6.30	
備　　註	上述資料中符號”—”代表目前查無相關資料，而符號”/”代表此欄位對該物質並不適用。	

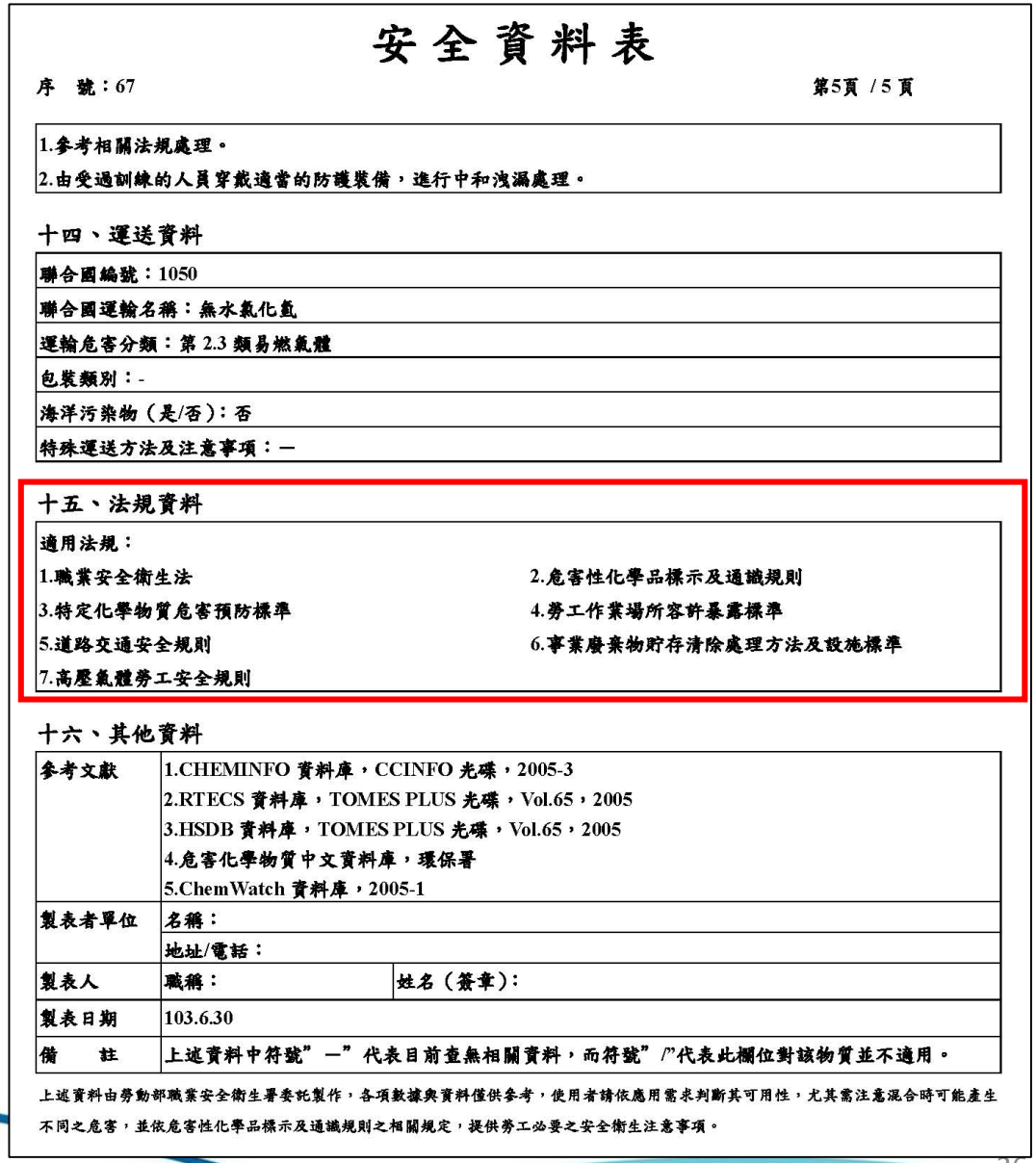
上述資料由勞動部職業安全衛生署委託製作，各項數據與資料僅供參考，使用者請依應用需求判斷其可用性，尤其需注意混合時可能產生不同之危害，並依危害性化學品標示及通識規則之相關規定，提供勞工必要之安全衛生注意事項。

SDS

Take hydrogen fluoride (HF) as an example

15. Regulatory information

- Specific regulations on product safety, health and environment.



安全資料表

序　號：67　　第5頁 / 5 頁

1.參考相關法規處理。 2.由受過訓練的人員穿戴適當的防護裝備，進行中和洩漏處理。

十四、運送資料

聯合國編號：1050
聯合國運輸名稱：無水氟化氫
運輸危害分類：第 2.3 類易燃氣體
包裝類別：-
海洋污染物（是/否）：否
特殊運送方法及注意事項：—

十五、法規資料

適用法規：	
1.職業安全衛生法	2.危害性化學品標示及通識規則
3.特定化學物質危害預防標準	4.勞工作業場所容許暴露標準
5.道路交通安全規則	6.事業廢棄物貯存清除處理方法及設施標準
7.高壓氣體勞工安全規則	

十六、其他資料

參考文獻	1.CHEMINFO 資料庫，CCINFO 光碟，2005-3 2.RTECS 資料庫，TOMES PLUS 光碟，Vol.65，2005 3.HSDB 資料庫，TOMES PLUS 光碟，Vol.65，2005 4.危害化學物質中文資料庫，環保署 5.ChemWatch 資料庫，2005-1	
製表者單位	名稱：	
	地址/電話：	
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上述資料由勞動部職業安全衛生署委託製作，各項數據與資料僅供參考，使用者請依應用需求判斷其可用性，尤其需注意混合時可能產生不同之危害，並依危害性化學品標示及通識規則之相關規定，提供勞工必要之安全衛生注意事項。

IV. PERSONAL PROTECTIVE EQUIPMENT

Hazard assessment and control

Types of personal protective equipment

Head protection

Face and eye protection

Hearing protection

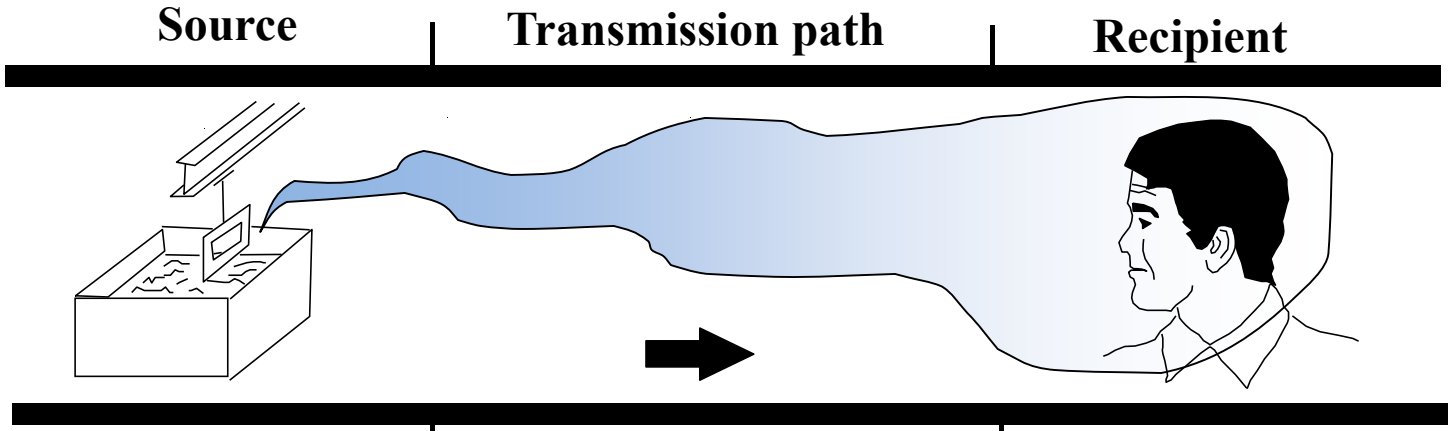
Hand protection

Protective clothing

Foot protection

Hazard assessment and control

- Hazard prevention methods



Source	Transmission path	Recipient
1. Alternative	1. Cleaning	1. Education and Training
2. Process changes	2. Overall ventilation	2. Shift work
3. Surround	3. Increase the distance	3. Surround
4. Isolation	4. Monitoring	4. Personal Monitoring System
5. Humidification	5. Maintenance Management	5. Personal protective equipment
6. Local exhaust		6. Maintenance management
7. Maintenance management		

Prior choice high → low

Time spent short → long

Improve cost less → more

Hazard assessment and control (cont.)

- When to use personal protective equipment
  - Temporary work, short work time or short work period (such as annual repair)
  - When carrying out the maintenance, maintenance and repair of the workplace hazard prevention device (such as the school air extraction cabinet failure)
  - When the workplace or the process itself cannot take appropriate engineering control measures (such as paint baking)
  - Even if engineering control measures have been adopted, the possible hazard risk cannot be reduced to an acceptable range
  - Escaping or saving lives in an emergency

Types of personal protective equipment

Head protection
helmet

Eye and face
goggles, face shield

Respiratory protection
dusk masks, gas masks

Hearing protection
earplugs, earmuffs

Hand protection
protective gloves

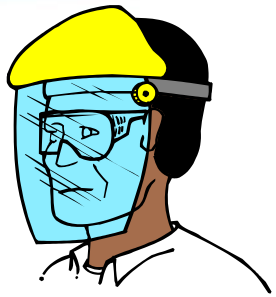
Full protective clothing

Foot protection
safety shoes

Head protection

- Purpose: A helmet used to protect the upper part of the head against impacts to prevent injuries from falling objects, bumps, and electric shocks.
- Precautions when choosing
  - Date of manufacture, and the cap should be free of bubbles, cracks, pinholes and protrusions.
  - According to the nature of the work, and suitable for the wearer's own characteristics.
  - Correctly wear and adjust the wearing gear to the most suitable size when using it and check it accurately.
- Maintenance
  - Clean the cap shell, harness and belt with water at any time, and keep it in a dark place without ultraviolet radiation.

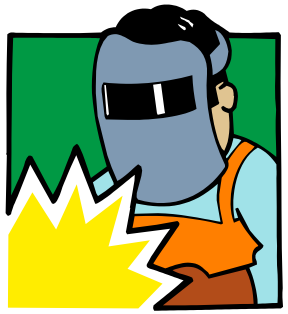
Face and eye protection



- Purpose: To prevent damage from mechanical energy (such as splashed particles, splashed liquid substances) and radiant energy (ultraviolet, visible, and infrared in electromagnetic waves).

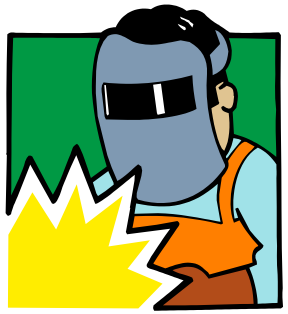
- Type
  - Protect your eyes from flying objects: reinforced glass lens, hard plastic lens, safety mask.
  - Radiation protection function: radiation protection glasses (shading glasses), protective masks for welding.

Face and eye protection (cont.)



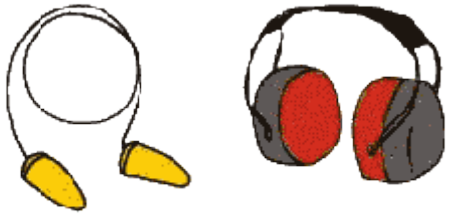
- Precautions when choosing
  - Strengthened glass lens and hard plastic lens of the side guards: when there is acid mist (such as electroplating operation), powder (such as cement bagging operation) and other fine particles scattered during operation.
  - Safety mask: larger particles will be produced during operation (such as acid droplets from dehydration, broken particles during grinding).

Face and eye protection (cont.)



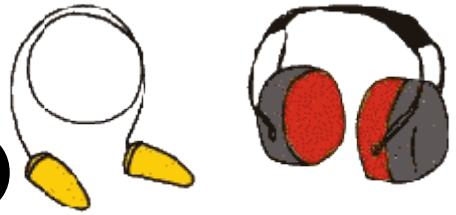
- Precautions when choosing
  - Shading glasses: To protect from exposure to ultraviolet light (such as from ultraviolet disinfection operations in a hospital) or infrared light (such as from observing the temperature of a hot melting furnace) during operation.
  - Welding protective mask: Use when there is radiation (UV rays and sparks or metal slag generated during electric welding).

Hearing protection



- Purpose: to reduce the entry of sound into the ear canal and prevent conductive hearing loss and sensorineural hearing loss. Its performance depends on the sound attenuation value.
- Type:
  - Earplugs: used in the external auditory canal or at the entrance of the external auditory canal to prevent sound (sound) from entering the inner ear from external auditory canal via air transmission.

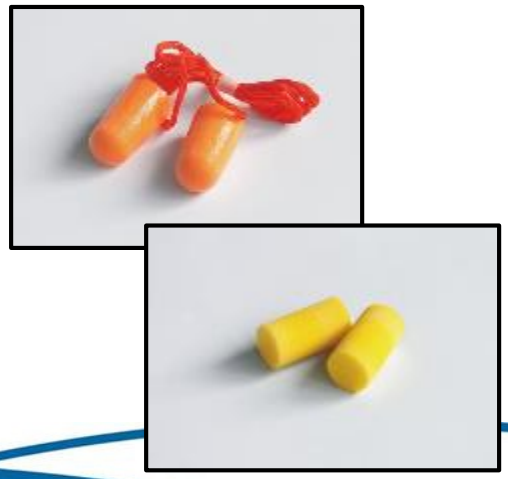
Hearing protection (cont.)



– Earmuffs:

- Passive soundproofing type: The earmuff has a sound insulation function and a hard cover that covers the outer ears, or has a soft pad that fits the ears. The soft pads are usually lined with sound-absorbing materials to absorb sound.
- Active soundproof type: Rely on electronic filtering or anti-sonic method to block noise.

Hearing protection



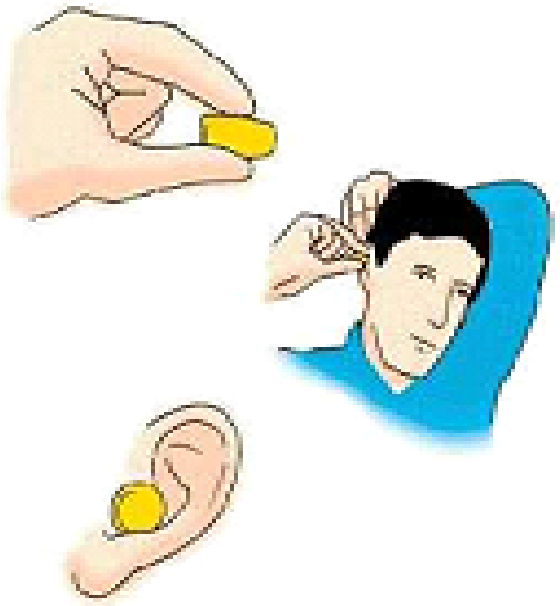
- Earmuffs
  - Reusable.
  - Large size, not easy to lose.
  - Maintenance and cleaning are easy, and infection is not easy to occur.
  - Applicable to patients with ear diseases.
  - Easy to check if workers are wearing.
- Earplugs
  - Cheap and can be replaced at any time.
  - Small size, light weight and easy to carry.
  - Does not affect head movement.
  - Can be used with other protective gear.
  - Suitable for use in high temperature, high humidity and dusty environments.

Hearing protection-how to wear earplugs

- Because the external auditory meatus is bent towards the front of the eyes, it is necessary to wear earplugs and straighten the auditory meatus to achieve the desired effect.

Hearing protection-how to wear earplugs (cont.)

- The method is as follows:



Step 1. If it is compressible, knead the earplugs into a long and thin strip; if it is incompressible, skip this step

Step 2. With the other hand around the head, straighten the ears outward and back

Step 3. Insert the earplug into the ear canal and press it from outside to inside for a few seconds

Foam-type earplugs are not recommended for repeated use

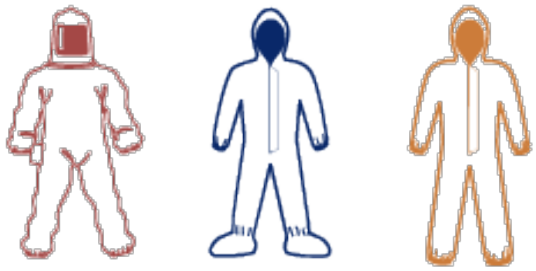
Hand protection

- Purpose: To prevent burns, cuts and punctures, chemical corrosion, chemical absorption through skin contact, electric shock, abnormal temperature.
- Classified by material and purpose:
  - General cotton gloves
  - Anti-acid and alkali gloves
  - Solvent resistant gloves
  - Anti-cutting gloves
  - Heat-resistant gloves
  - Low temperature gloves (liquid nitrogen)

Hand protection (cont.)

- Precautions when choosing
  - Choose appropriate protective gloves according to the use requirements.
  - Before use, check whether the appearance of the gloves is normal and there are no defects that hinder use.
  - Gloves should avoid common phenomena such as cracks, peeling, melting, spots, shrinkage, hardening, etc.
  - Choose an appropriate size, and finger movement should be obstructed.
  - Pay attention to hand flexibility and comfort.
  - Types of tasks that gloves are not allowed : work on drilling machines, angle cutters and other rotating cutting tools. If the worker's fingers are likely to be touched, gloves must not be used.

Protective clothing



- Purpose: To prevent burns, cuts and punctures, chemical corrosion, chemical absorption through the skin, ionizing radiation or electric shock.
- Full body protective clothing is generally called chemical protective clothing, which is made of a special protective film (base layer) or fabric (barrier layer) coated with an elastic polymer.

--Common protective clothing has four levels : A, B, C, and D:

(1) Level A and Level B protective clothing has excellent resistance to most chemical solvents and gases, so they are mostly used as protective clothing for rescue in chemical disasters.

(2) Level C protective clothing is lighter and impervious to water. It is generally used as a standard protective accessory for

Protective clothing (cont.)

Class A
Fully covered type
(airtight)+
Air cylinder

Class B
Fully covered
(Not airtight)

Class C
Semi-covered
type/
Overhead type

Class D
Simple type

Fatal hazard

Treatable hazards

Biological hazard

Biological/radioactive

Foot protector–safety shoes

- Purpose: Prevent burns, crush injuries, puncture injuries, chemical corrosion, chemical absorption through the skin, and prevent electric shock.
- Common safety shoes:
  - Electricity-proof safety shoes: mainly used in places with electricity and that are prone to fire and explosion hazards.
  - General safety shoes: equipped with steel toe guards to protect the feet. The steel toe guards can withstand the impact of 200 pounds from a height of one foot. It can also be selected if it is anti-acid, anti-alkali or anti-spark made of different suitable materials.
  - Non-slip safety shoes: used in slippery and humid areas, such as wineries, freezing plants, etc. to prevent slipping.

Foot protector−safety shoes (cont.)

- Precautions when choosing
  - Choose suitable protective equipment according to manufacturing materials, protective functions and workplaces.

- Matters needing attention in use and maintenance
  - Should be properly worn and maintained like normal shoes.
  - Pay attention to the following matters when using anti-static safety shoes:
    - The leakage resistance in the floor and shoes cannot exceed 10^{10} ohms.
    - Do not add insoles or wear thick socks by yourself, except for anti-static socks.
    - Measure whether the resistance is between 10^5 and 10^8 ohms when repairing shoe soles or on a regular basis
    - Do not touch objects with current.

V. RESPIRATORY PROTECTION

Respiratory physiology

Respiratory hazards

Principles of respiratory protection

Respirators

Respiratory physiology

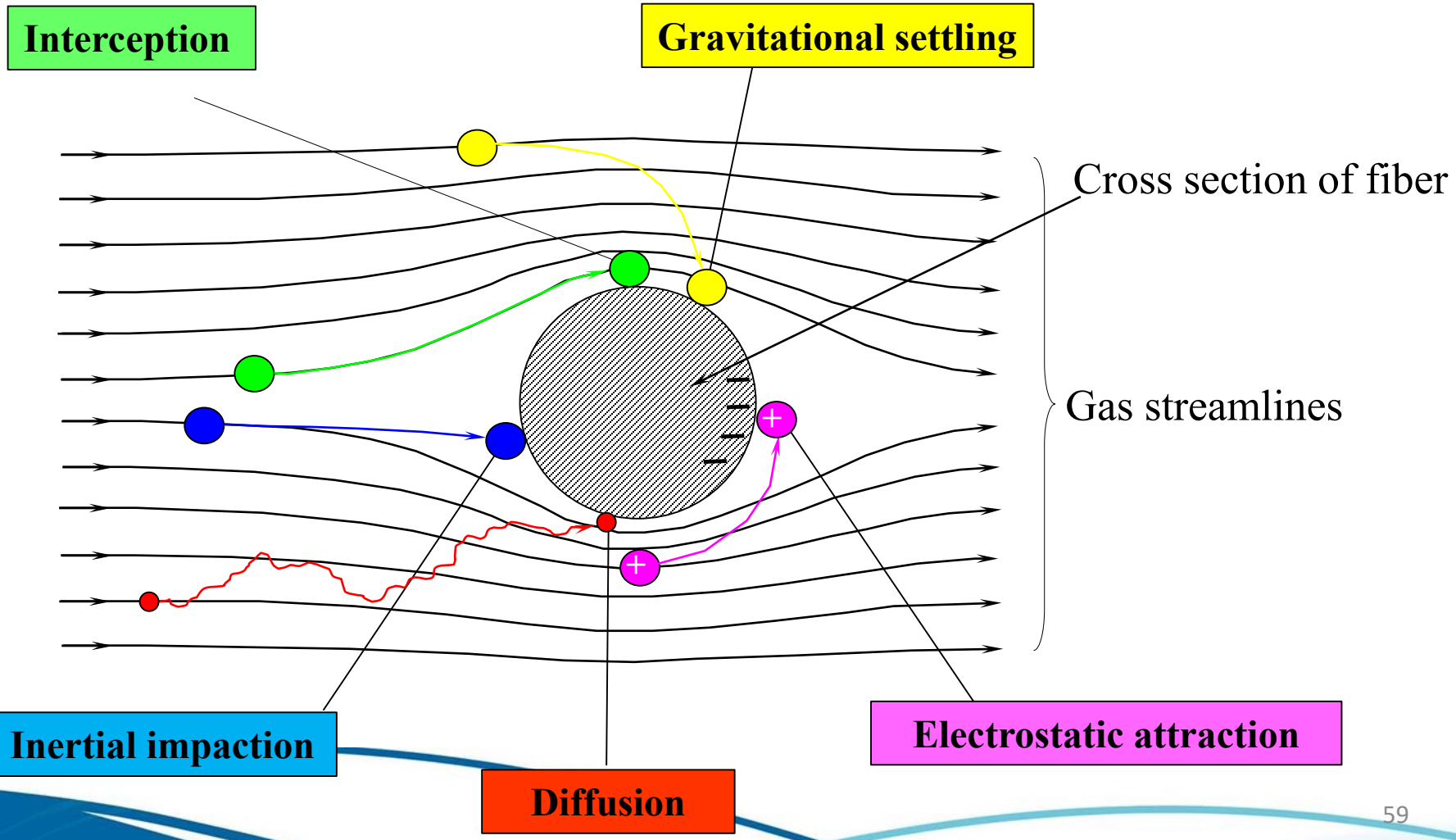
- The human respiratory system is composed of the nasal cavity, throat, trachea, bronchus, lungs, diaphragm and respiratory muscles.

- The purpose of human respiration is to provide oxygen necessary for the metabolism of body tissues, and at the same time to excrete carbon dioxide produced by body tissue metabolism out of the body through the alveoli to assist the body in maintaining and controlling the acid-base balance.

Respiratory physiology (cont.)

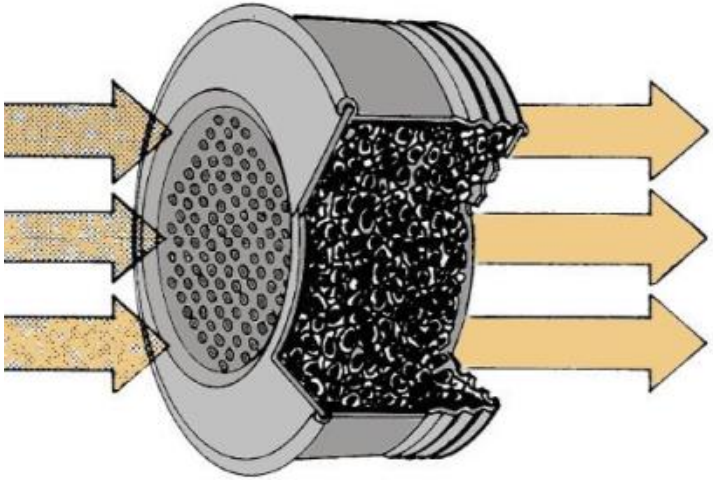
- The respiratory system is divided into two parts according to the different physiological functions:
  - Conductive airway: including nasal cavity, oral cavity, pharynx, larynx, trachea and bronchi; the function of this component is to transmit gas to the respiratory unit.
  - Respiratory unit: including bronchioles, interalveolar channels and alveoli (terminal air sacs); it is the area for gas exchange.

Principles of respiratory protection

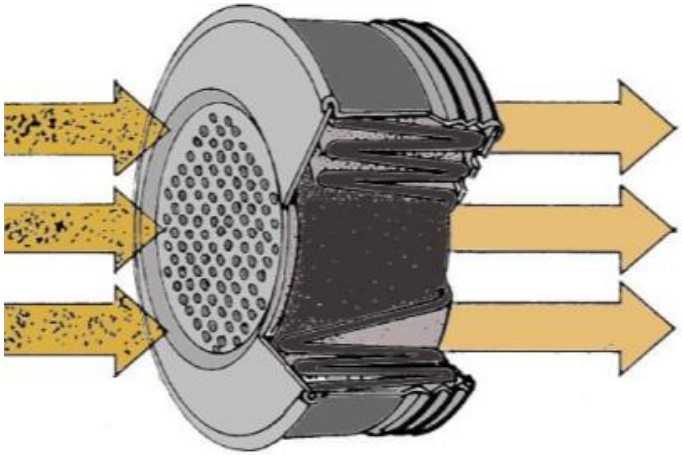


Principles of respiratory protection (cont.)

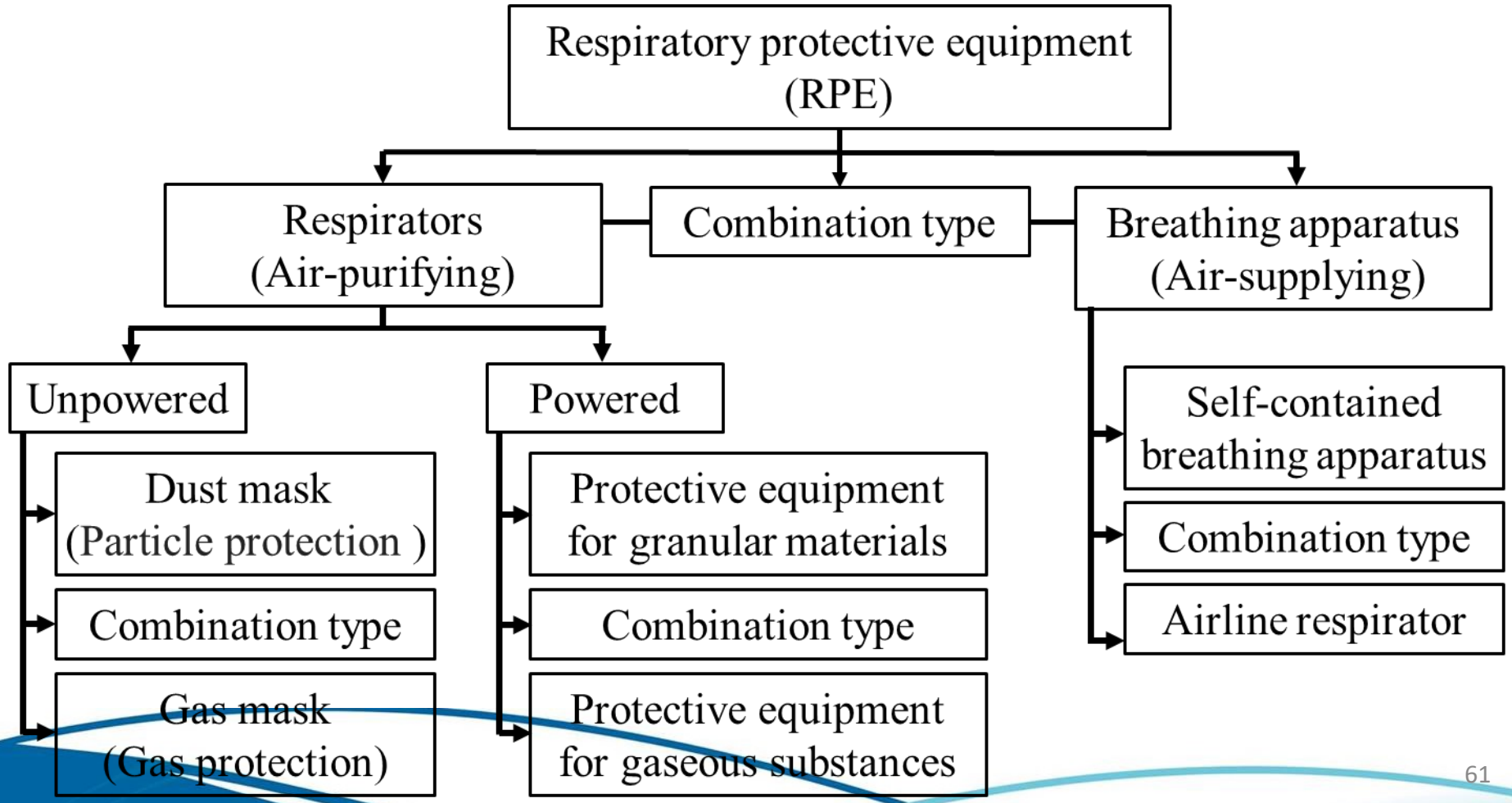
- **Gaseous pollutants**
  - Use solid adsorbents (such as activated carbon or silicone).



- **Particulate pollutants**
  - Fill the fiber filters in the canister using multiple folding methods.

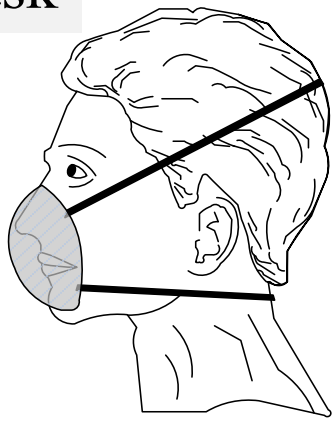


Respirator classification

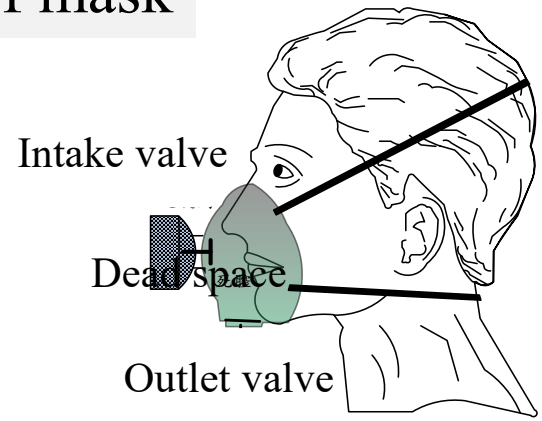


Respiratory protective equipment -classified by coverage

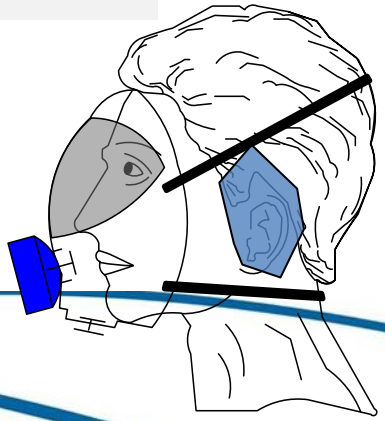
Quarter mask



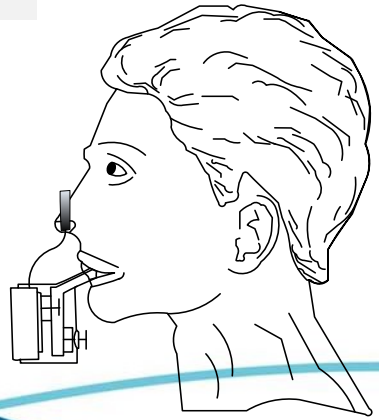
Half mask



Full-face mask



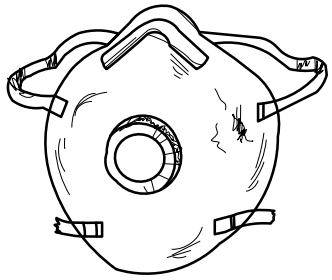
Mouth-bit



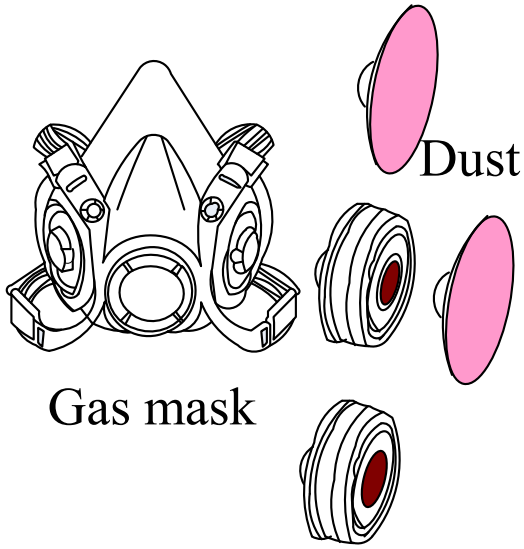
Respiratory protective equipment -classified by function

Air-purifying respirators

Air-supplying respirators



Dust mask



Dust filter

Gas mask

Anti-virus canister

Powered air-purifying respirators

Supplied-air respirators

Self-contained breathing apparatus

Classification table of environmental hazard grade and its protective gear selection (A)

Protection level	Level A
Equipment requirements	1. Airtight jumpsuit. 2. Chemical protection shoes. 3. Chemical protection gloves. 4. Self-contained breathing apparatus or supplied-air respirator combined with self-contained breathing apparatus for escape use. 5. Two-way talk radio. 6. Other necessary protective gear.
Degree of protection	Provide the highest level of respiratory, eye and skin protection.

Classification table of environmental hazard grade and its protective gear selection (A) (cont.)

Protection level	Level A
Application occasion	1. Environments where high concentrations of highly toxic chemicals are known to exist or may be produced. 2. An environment with substances that are harmful to the skin. 3. Confined spaces or poorly ventilated environments.
Conditions	Chemical protective clothing must be impermeable to harmful substances in the working environment.
Remarks	This level of protective equipment is required when the concentration of harmful substances reaches IDLH or situations of hypoxia and fire escape arise.

Immediately Dangerous to Life or Health, IDLH

Environmental hazard level and its protective equipment selection classification table (B)

Protection level	Level B
Equipment requirements	1. Non-airtight one-piece protective clothing. 2. Chemical protection shoes. 3. Chemical protection gloves. 4. Self-contained breathing apparatus or supplied-air respirator combined self-contained breathing apparatus for escape use. 5. Two-way talk radio. 6. Other necessary protective gear.
Degree of protection	Provides the highest level of protection for the respiratory system and eyes; less conservative protection may be adequate for skin protection.

Environmental hazard level and its protective equipment selection classification table (B) (cont.)

Protection level	Level B
Application occasion	1. Harmful substances are highly toxic by inhalation but have no obvious harm to the skin. 2. Unknown gas or vapor exists and will not cause serious harm to skin contact. 3. The environment where the oxygen concentration is less than 19.5%.
Conditions	Not suitable for environments where the presence of gas or vapor will cause harm to the skin or will be absorbed by contact.
Remarks	This level of protective equipment is suitable when the concentration of harmful substances does not reach IDLH but is harmful to the respiratory system with no obvious harm to the skin.

Environmental hazard level and its protective equipment selection classification table (C)

Protection level	Level C
Equipment requirements	1. Chemical protection shoes. 2. Chemical protection gloves. 3. Full-face air-purifying respirator with filtration devices. 4. Two-way talk radio. 5. Other necessary protective gear.
Degree of protection	The degree of skin protection is the same as that of Level B, but the required respiratory protection is less.

Environmental hazard level and its protective equipment selection classification table (C) (cont.)

Protection level	Level C
Application occasion	1.The types of air pollutants are known and can be removed with air-purifying respirators with filtration devices. 2. Other environments suitable for air-purifying respirators.
Conditions	The air pollutant concentration does not reach IDLH and the oxygen concentration is at least 19.5% or more.
Remarks	

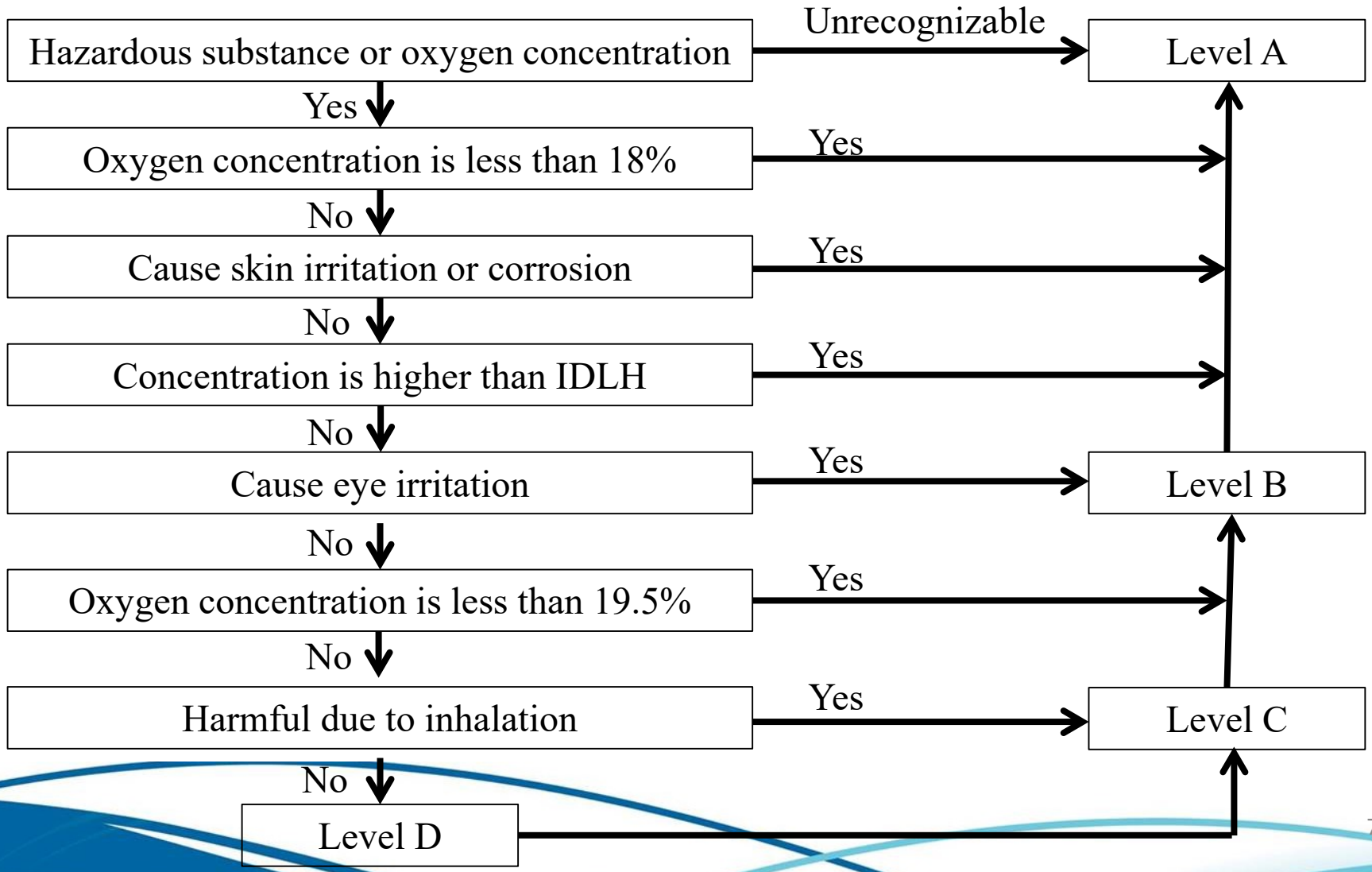
Environmental hazard level and its protective equipment selection classification table (D)

Protection level	Level D
Equipment requirements	1. General work clothes. 2. Safety glasses. 3. Safety shoes. 4. Other necessary protective gear.
Degree of protection	Only minor skin protection is required, and no respiratory protection is required.
Application occasion	1. The working environment has been determined to be harmless.

Environmental hazard level and its protective equipment selection classification table (D) (cont.)

Protection level	Level D
Application occasion	2. The environment is not prone to generation of harmful gases or vapors: no chemical splashes are possible.
Conditions	The oxygen concentration in the working environment is at least 19.5% or more.
Remarks	

Environmental hazard classification



VI. FIRE EXPLOSION

Fire and explosion

Classification of hazardous materials

The dangers and hazards of fire and explosion

Fire and explosion

- Fire
  - In fire protection, a fire is defined with the following three phenomena:

  (1) Source(s) to cause the fire.

  (2) Loss of control or arson to cause the fire to expand and become a disaster.

  (3) Need to use fire extinguishing equipment to control loss.
- Explosion
  - The rapid generation of pressure and release to the surrounding environment of lower pressure. The rapid expansion of gas and subsequent squeeze of air or friction of the container wall makes noise and usually causes damage.

Three essential elements of fire

- Fuel: Flammable substances such as wood, coal, gasoline, gas or dust reaching the lower explosive limit (LEL)
- Oxygen: Air is the main source of oxygen. Oxygen in oxidizing substances may also become a source of oxygen during high temperature combustion.
- Heat: Fuel must have a certain amount of heat to burn. The sources of heat may be open flames, electrical sparks, impact, friction, overheated objects, high-temperature surfaces, spontaneous combustion.

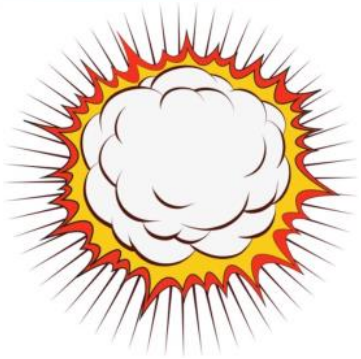
Type of fire

- Fires can be classified according to whether it is appropriate to use water to rescue the burning material:
  - Class A: Extinguish with water or aqueous foam with extinguishing agents.
    - Fires of solid combustibles such as cottons/fibers, plastics/rubbers burning.
  - Class B: Dry powder, chemical foam or mechanical foam fire extinguisher
    - Refers to fires with oil, flammable liquid, flammable gas burning

Type of fire

- Fires can be classified according to whether it is appropriate to use water to rescue the burning material:
  - Class C: Carbon dioxide fire extinguisher (precision machine).
    - Refers to electrical fires with voltage wiring, electrical machines, and transformers
  - Class D: Use special dry powder fire extinguisher
    - Refers to fires with flammable metals, water-proof substances, and special gas (silane)

Type of explosion



- Distinguished by the physical state of the substance at the time of the explosion
  - Gas, liquid and solid explosion
- Distinguished by the characteristics of the explosion
  - Physical explosion
    - The high-pressure container leaked and exploded.
    - Water vapor explosion.
  - Chemical explosion
    - Gas explosion, flammable vapor explosion, droplet explosion, dust explosion, chemical uncontrolled explosion, high explosive, etc.
  - Physicochemical explosion
    - Boiling liquid expanding vapor explosion, BLEVE

Classification of hazardous materials

- Explosive substance: flammable and oxygen-supplying
- Flammable substances: including water-proof substances, spontaneous combustion substances, flammable solids
  - Water-proof substance: It can emit flammable gas and heat when wet, causing combustion or explosion.
  - Spontaneous combustion substances: Spontaneously ignite due to chemical changes or environmental temperature and humidity.
  - Flammable solids: Catch fire when exposed to fire, heat, impact, friction or contact with oxidants.

Classification of hazardous materials (cont.)

- Flammable liquid: Can evaporate and ignite at room temperature (flash point).
- Oxidizing substances: it is ignited by chemical reduction.
- Flammable gas: Combustible under normal conditions (at atmospheric pressure, 15°C).

The dangers and hazards of fire and explosion

- Danger
  - The larger the value, the more dangerous the parameters: combustion range (explosion range), vapor pressure, combustion speed, combustion heat, flame propagation speed
  - The smaller the value, the more dangerous the parameters: lower combustion limit (lower explosion limit) value, flash point, auto-ignition temperature, boiling point, minimum ignition energy

The dangers and hazards of fire and explosion

- Direct factors of fire hazard threatening life
  - Oxygen depletion: hypoxia (oxygen concentration <18%), suffocation (6-8%)
  - Toxic gas: such as CO, CO_2
  - Smoke: pneumonia, inhalation choking, poor visibility
  - Flame and high fever: skin burns/burns, dehydration, shock
  - High pressure: detonation, bursting fragments

VII. EMERGENCY RESPONSE SYSTEM

Emergency response

Hazard identification

Emergency plan

Emergency response stage and organizational structure

Emergency response operation process

Emergency response

- In terms of the timeliness of disaster relief, the initial stage of a disaster is the most conducive time for disaster elimination. The most basic resilience must always be maintained to effectively and quickly reduce the losses caused by the disaster.
- It depends on the routine adequate preparation to establish most basic emergency response ability, of which an appropriate emergency response plan is a must.

Emergency response (cont.)

- The first step in formulating an effective emergency response plan is "hazard identification". The information obtained from the hazard identification can be used as a reference for preventing hazards in advance and priority-setting in planning response.

Hazard identification

- Hazard identification consists of three elements:
  - Dangerous situation: Refers to any situation that is sufficient to cause personal injury, property damage, or environmental damage
  - Damage characteristics: refers to the degree of damage to life, property, and the environment when a dangerous situation occurs
  - Risk level: refers to the possibility or probability that a dangerous situation will occur and cause damage

Emergency plan

1. The purpose and preface
2. Hazard identification or risk assessment
3. Emergency Response Organization Structure
4. Contact system for emergency notification procedures
5. Statistics of various response facilities and configurations
6. Evacuation plan
7. Emergency response procedures
8. Emergency response measures for accidents in various laboratories
9. Training plan
10. Update of simulation exercises and plans

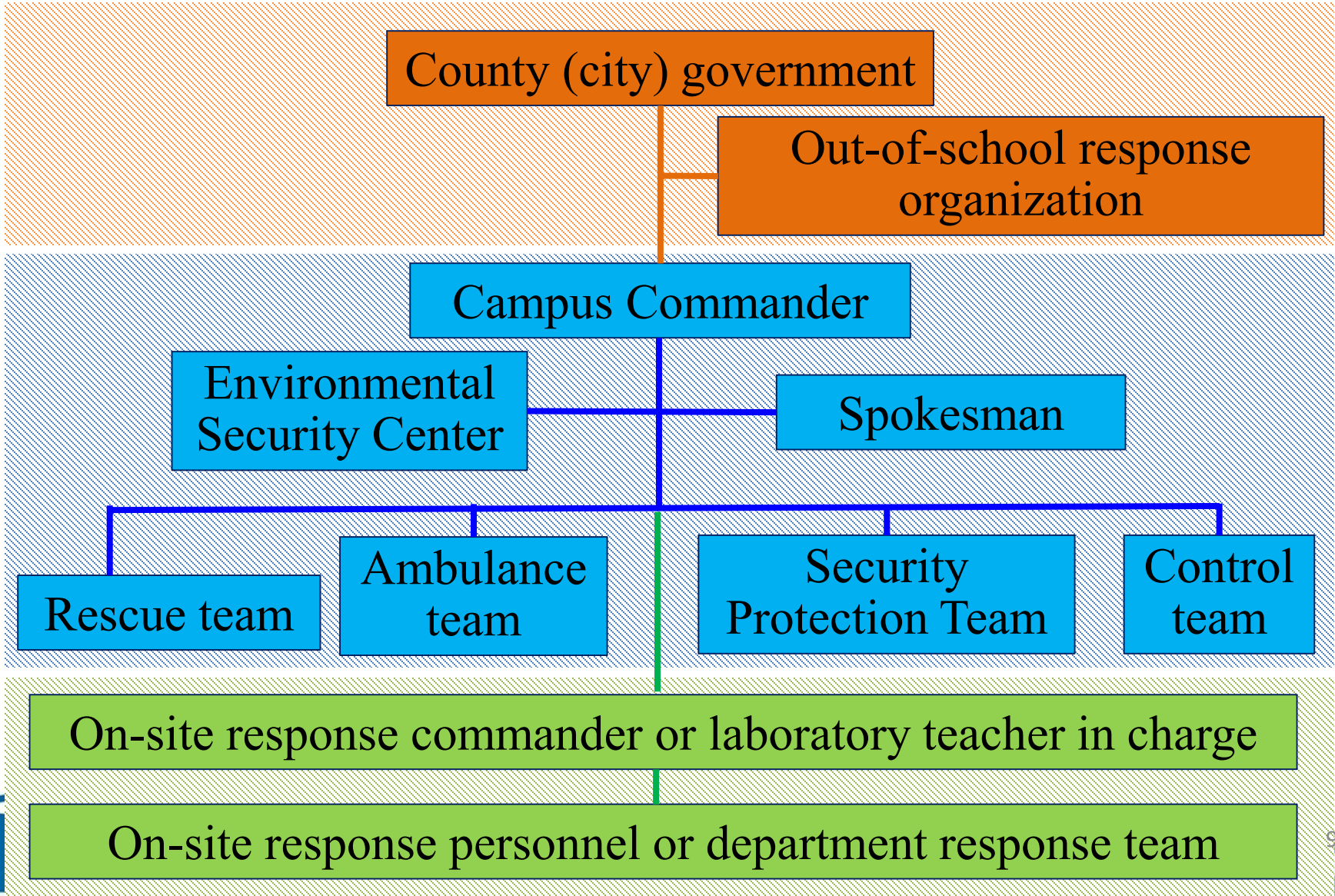
Emergency response stage and organizational structure

- Emergency response in the school laboratory can be divided into three stages according to the scale of the disaster:
  - The first stage: The laboratory or department can handle small leaks or small fires by itself, without the need to evacuate.
  - The second stage: To handle a relatively large amount of leakage or fire or when the disaster spreads to other areas, the support of other personnel in the school is required, and evacuation may be required.
  - The third stage: Major disasters that require the support of off-campus units (such as the fire brigade). These are serious emergencies that affect the safety of life and property and evacuation of residents outside the school is needed.

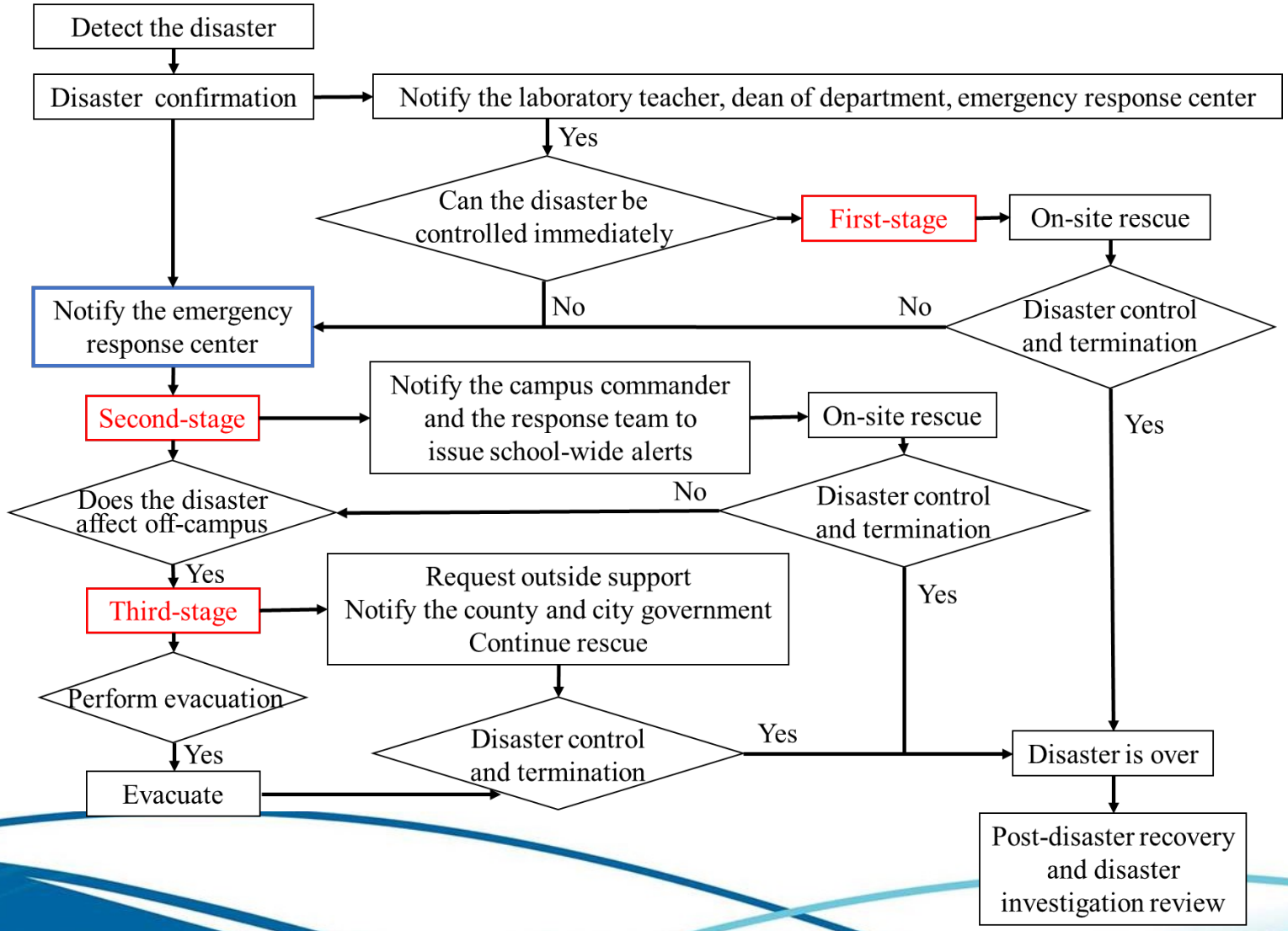
Emergency response stage and organizational structure (cont.)

- For different types of disasters in the same response level, the corresponding response organizations and structures are similar.

Three-stage response organization structure



Emergency response operation process



VIII. FIRST AID

First aid precautions

Basic First Aid

Accident management

First aid precautions

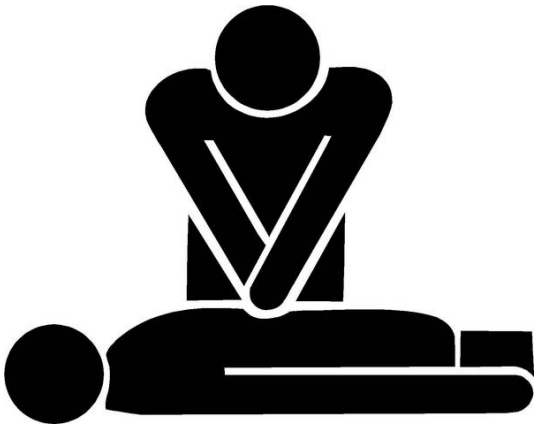
- Emergency personnel should first confirm the situation on the spot and pay attention to their own safety.
- If the hazard situation is critical, emergency personnel should assist the injured to evacuate the scene immediately.
- Observe and confirm the injury. If the injury exceeds the on-site handling capacity, immediately send to a doctor or dial 119 for medical support and implement emergency notification procedures.

First aid precautions (cont.)

- If the injury is minor, perform first aid procedures.
- Even if the injury is minor, the condition of the injured should be closely observed during and after the first aid. If there is any unrecognizable condition (such as sudden dizziness, or even shock), you should immediately send to a doctor or seek medical support.
- If you are sent to the doctor due to contact with, ingest, or inhale chemical substances, you must inform the medical staff of the toxic chemical substances

Basic first aid– basic life support

- Basic Life Support, BLS: Continuous life
  - Cardio-Pulmonary Resuscitation, CPR
    - Call: check consciousness (call out, tap the shoulder, watch the breath)
    - Call: 119
    - C：immediately compress the chest
    - A：open the airway
    - B：blow to maintain breathing
  - First aid mantra
    - Untrained rescuer: call call CCC。
    - Healthcare professionals: call call CAB。



Basic first aid−Heimlich maneuver

- Heimlich maneuver: Relieve airway obstruction
  - Standing position/abdominal compression

  (1) The rescuer stood behind the patient in a stride.

  (2) Touch the belly button with your left hand, make a fist with your right hand, and face inward.

  (3) Place your right hand above your belly button and hold your left hand in an embracing position with your right hand.

  (4) Rescuers squeeze inward, backward, upward.

Basic first aid−defibrillation shock

- Defibrillation Shock: Stop lethal heart rate
  - Automatic External Defibrillator, AED
  - Perform BLS for two minutes first, if not effective, then perform defibrillation shock

    (1) On: Turn on the switch

    (2) Stick: Stick the patch and plug according to the voice and patch icon

    (3) Electric: If you need an electric shock, press the electric shock button after the machine is automatically charged

      - Do not touch the patient during electric shock
  - In the process of CPR+AED, we still have to abide by "the principle of not interrupting CPR"

Accidental treatment-first aid for exposure to chemicals

- On-site treatment:
  - Immediately rinse the affected area with water for 15 to 20 minutes
    - Eye contact: Open the eyelids and rinse the eyeball and eyelids with water from the corner of the eye to the outside, but the water pressure should not be too high to avoid hurting the eyeball. In addition, slowly and continuously roll your eyes so that the chemicals can be washed out.
    - Skin contact: Take off the contaminated clothing immediately and rinse the contaminated part with clean water

Accidental treatment-first aid for exposure to chemicals (cont.)

- Precautions:
  - Refer to the first aid information of the Safety Data Sheet
    - Whether it is necessary to apply special medicine (eg., HF-calcium gluconate ointment) on the affected area and how to apply it.
  - If the wounded needs to be hospitalized, bring the chemicals and related information to the medical staff

Accidental treatment-first aid for poisoning by inhalation or ingestion

- On-site treatment:
  - Determine the patient's state of consciousness and vital signs
  - When ingesting poisons, do not induce vomiting at will; do not neutralize acid and alkali
    - Do not induce vomiting on corrosives (sulfuric acid, hydrochloric acid) and petroleum (such as steam/motor oil)
  - When inhaling poisoning, place the patient in a ventilated place

Accidental treatment-first aid for poisoning by inhalation or ingestion (cont.)

- Precautions:
  - Call for help and follow the guidance of medical personnel.
  - Try to remove patients from toxic substances.
  - Confirm poison information (such as name of poison, dose, time of occurrence, route of exposure, patient response, etc.) and tell medical staff

Accidental treatment-first aid for burns

- On-site treatment:
  - Rinse: Rinse with clean water for at least 30 minutes.
  - Take off: Use scissors to remove clothes.
  - Soak: Soak the wounds before the patient being hospitalized.
  - Cover: Cover with clean cloth or gauze.
  - Send: Immediately send to the emergency room for emergency treatment.

Accidental treatment-first aid for burns (cont.)

- Precautions:
  - If it is a chemical burn, check whether there is an emergency instruction on the chemical container, and immediately send the patient to a doctor for treatment.
  - If the agent is lime or magnesium, it will generate heat when washed with water. Make sure to remove the powders before washing.

Accident treatment
-first aid for electric shock

- On-site treatment:
  1. Cut off the power supply or use an insulator to push the objects carrying electricity away from the injured.
  2. If the injured is still breathing, lay him/her down in a recovery position.
  3. Cardiopulmonary resuscitation should be performed immediately when the patient's breathing or heartbeat stops.
  4. Once the injured recovers his heartbeat and breathing, untie the injured clothes and remove all straps, rub the skin of the whole body with a dry towel or brush to restore the function of the capillary.
  5. Seek medical care as soon as possible.

Accident treatment
-first aid for electric shock (cont.)

- Precautions:
  - If it is high-voltage electricity, the insulator should not be used to touch the injured, and the power should be cut off immediately.
  - Before the power is cut off, do not touch the injured with bare hands.
  - If the injury suffers from burns, apply the treatment method for treating burns.

Accident treatment-first aid for frostbite

- On-site treatment:
  1. Move the injured to a warm place.
  2. Immediately remove all restraints from the wound and the distal limbs.
  3. The injured should immediately and continuously bath in warm water to warm up the frostbite until the affected area recovers its blood.
  4. Elevate the affected area to reduce swelling and pain.
  5. Wrap the affected area with a soft dressing, taking care to avoid infection and avoid blisters bursting.
  6. Seek medical care as needed

Accident treatment
-first aid for frostbite (cont.)

- Precautions:
  - If the skin is stuck to the appliance at extremely low temperature, do not pull it away forcibly. Use warm water to rinse the appliance to defrost.
  - Do not expose to the cold again and avoid rubbing or moving the frostbite with hard objects.

Accidental treatment-first aid for cutting and puncture injuries

- On-site treatment:
  - Wash the wound with normal saline or cold water, and then disinfect with betadine
    - Keep dry and breathable when foreign bodies cannot be removed from the wound, seek medical attention immediately.

Accidental treatment-first aid for cutting and puncture injuries (cont.)

- Hemostasis method:
  - Direct compression: Use fingers/hands or cover with clean clothes to directly compress the bleeding wound.
  - Elevate the affected limb: Use fingers, palms and dressings to directly press on the wound, and elevate the injured limb (above 25 cm above the heart).
  - Hemostasis point: At the pulsation point near the heart of the affected limb, press with the thumb or the base of the palm to reduce the amount of bleeding.
  - Tourniquet (used when life-threatening).

Accidental treatment-first aid for exposure of infectious substances

- Exposure to infectious substances:
  - Cuts and punctures with needles or knifes with infectious agents.
  - Infectious fluids in contact with mucous membranes or damaged skin or in contact with healthy skin for an extended period of time.
  - Bacteria, virus, laboratory animal bites, scratches.
- Before the experiment, it is necessary to evaluate the potential risk according to the biological material and the experiment procedure and establish preventive measures and first aid treatment procedures.

Accidental treatment-first aid for exposure of infectious substances (cont.)

- On-site treatment:
  - Squeeze blood from the wound from the proximal end to the distal end from heart.
  - Clean the wound or contacted surface area.
  - Notify the laboratory manager for follow-up treatment according to the emergency procedures.

Data sources

- Complied, edited, and reviewed by Professor Chen-Peng Chen of China Medical University Department of Occupational Safety and Health
- Edited by Chang Jung Christian University team - Yow-Jer Juang

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Data sources (cont.)

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