# Yuan Ze University Department of Chemical Engineering and Materials Science Laboratory Safety Manual

## **General Provisions**

# I. Basis:

In Article 25 of Labor Safety and Health Law of the University, it provides that "The employers shall prepare any appropriate safety and health work rules, together with labor representatives, in compliance with this Law and other related stipulations, and then make a proclamation and effectively implement it after approved by governmental examination agency". Accordingly, the safety manual for the department has therefore been formulated pursuant to the following guidelines:

(I) The safety and health work content stipulated in Article 35, 36 and 37 of Labor

Safety and Health Bylaw of the university.

(II) YZU Environmental Safety and Health Manual.

# II. Purpose

(I) To ensure personnel's safety and health.

(II) To ensure that department's faculty, staff and students are fully aware of the laws relating to safety and health and comply absolutely with the Labor Safety and Health Law of the university.

III. Contents

Chapter I: Powers and Responsibilities of Different Levels of Safety and Health Management Chapter II: Equipment Maintenance and Examination Chapter III: Work Safety and Health Standard Chapter IV: Education and Training Chapter V: First Aid & Emergency Rescue Chapter VI: Preparation, Maintenance and Operation of Emergency Equipment Chapter VII: Incident Reporting and Response Chapter VIII: Other Relevant Measures

Chapter I Powers and Responsibilities of Different Levels of Safety and Health Management Powers and responsibilities of the chairperson of the department of chemical engineering and materials science and the safety and health section

- (1) To cooperate with the school's environmental safety and health center in developing the relevant safety and health measures and the enforcement of the same.
- (II) To oversee the environmental safety and health management of the departmental laboratories.
- (III) To conduct a regular or unannounced field inspection.

- (IV) To plan and implement a 3 or more hours education and training in safety and health each year.
- (V) In case of an incident or occupational hazard occurring, assist to handle and investigate the incident process, and notify the environmental safety and health center (ext 2278) at once.
- (VI) To implement hazard communication education and training sessions yearly.

Powers and responsibilities of laboratory's superintendents

- (I) To cooperate with the school's environmental safety and health center and the department's safety and health section in implementing the relevant safety and health based measures.
- (II) To detect and mitigate possible hazard associated with the environment and operations conducted in the laboratory.
- (III) Personnel education, training and overseeing:
  - 1. To draft laboratory safety and health work rules, and fully implement them through educating, overseeing and rectifying personnel.
  - 2. Only qualified operators are allowed to operate dangerous machinery and equipment.
- (IV) Instruments and equipment:
  - 1. Implementing of automatic inspection—complete the required form, make a record and keep it on file.
    - (1) Routine inspection: Undertake a routinely daily, monthly and yearly inspection and maintenance for instruments and equipment.
    - (2) Major inspection: Undertake a major inspection task for the instrument at its initial employment, or re-employment after it has been taken apart and adapted or repaired.
    - (3) Task focus: Accurately undertake key inspection points for the instruments and equipment every day or every time before operation.
  - 2. Dangerous machinery or equipment: Machinery or equipment identified as hazardous by the central government supervising agency can be employed only after it has passed a satisfactory checking by an examination agency or a deputy inspection organization designated by the central government supervising agency. In case it has been employed over the allowable period stipulated, its re-inspection is necessary to ensure the safety of its re-employment.
  - 3. Installation and renewal of the necessary safety and health equipment, measures, and protective equipment and first-aid medicine.
  - 4. When operating the X-ray instrument, it is imperative to wear the radiation dosage badge.

(V)Physical hazard, health hazard and toxic chemical substance—familiar with the legal categories stated in the promulgated law, and manage and handle them pursuant to the said law.

 Physical hazards promulgated under the Hazard Communication Regulations are classified into 7 categories, including explosives, combustibles, oxidizing substances, inflammables, flammable gas, explosive articles and miscellaneous dangerous goods designated by the central government supervising agency.

- 2. Health hazards promulgated under the Hazard Communication Regulations such carcinogens, toxic substances, acute toxic substances, sensitizers, irritants and corrosives, and are classified into the following 5 categories:
  - (1)Organic solvent: 56 kinds of organic solvents controlled under the organic solvent based intoxication prevention generations
  - (2)Specific chemical substance: 63 kinds of specific chemical substances controlled under the specific chemical substance based hazard prevention criteria.
  - (3) Miscellaneous chemical substance: 254 kinds of legal chemical substances
  - (4)Radioactive substance:
  - (5)Miscellaneous dangerous goods designated by the central government supervising agency
- 3. The Toxic Chemical Management Regulations provides that toxic chemical substances are those which are intentionally produced or accidentally generated from the production process, and have been presently promulgated by the central government supervising agency to reach a total of 114 kinds. Its toxicity is classified into the following 4 categories:
  - (1)Category 1: Recalcitrant substance
  - (2)Category 2: Chronic toxic substance
  - (3)Category 3: Acute toxic substance
  - (4)Category 4: Suspected toxic chemicals
- 4. Management of physical hazard, health hazard and toxic chemical substance
  - (1)To develop a hazard communication program under the Hazard Communication Regulations
    - a. Purpose

To become familiar with any hazards existing in the workplace, and to notice the safety and health related matters.

b. Scope

Inclusive of legally promulgated physical hazard, health hazard and toxic chemical substance

- c. Implementation
  - (a) Establishment of hazardous substance inventory
  - (b) Establishment of material safety data sheets
  - (c) Affixing a label to the container
- (2)According to the Rules of Toxic Chemical Management for Academic Institutions:
  - (a) To affix labels to the containers for toxic chemical substances, and prepare material safety data sheets for these substances.
  - (b) To record and report the process of using toxic chemical substances—keeping records of the process of using toxic chemical substances for the school to report to the local supervising agency on its previous year's records of usage prior to May 1<sup>st</sup> of every year; the said records shall be kept at least three years for further enquiry.
- (VI) Waste management

- 1. Resource recycling: To retrieve five categories of solid wastes including batteries, papers, PE bottles, steel and aluminum can, and aluminum foil waste in response to the school's recycling policy.
- 2. waste liquid recycling: To retrieve thirteen categories of liquid wastes including grease, halogens, organic materials, heavy metal, chromium liquid waste, cyanogens liquid waste, mercury liquid waste, HF liquid waste, acid waste, specific liquid waste, inorganic solid and biomedical waste in response to the school's liquid waste recycling policy; a record and tally of the wastecollected will be made once every three months before they are delivered to the school's recycling storage site by workers from the environmental safety and health center, and forwarded to the external recycling company for further treatment.
- (VII) To implement the measurement of the working environment and the record thereof.
- (VIII) To formulate the laboratory's emergency response guideline.
- (IX) To set up environmental safety archives for future reference—which contain the environmental safety and health related official documents and other law related announcements received by each laboratory. Each laboratory shall set up different portfolios by document categorization and also submission of related data or information in writing.
- Once an accident or occupational hazard happens, a rapid response is Necessary; in addition to making immediate notification to the department's chairperson (the department's spokesman towards the incident outside), submit a report through YZU Occupational Hazard Form within three working days after the said incident.

Powers and responsibilities of faculty and staff

(I) Abide by any working guidelines for safety and health and other safety and health related regulations.

(II) Abide by the standard operation procedure and implement a regular inspection for the equipment and facility

(III) Undergo general and specific physical examination and health examination, and follow the recommended matters from the results of the said examination.

- (IV) Receive a safety and health based training
- (V) Once an incident happens, assist to handle the related matters in the scene and implement the investigation of occupational hazard.
- (VI) Assist the newcomers to be aware of the operation procedure and method, and how to use the safety and health related equipment and facilities.
- (VII) Be sure to check completely the working environment and equipment before operation; if finding any unusual conditions, immediately undertake an adjustment of the equipment and report it to the related unit's supervisor.
- (VII) Implement a regular inspection and maintenance and renewal of the personal protective equipment, emergency rescue equipment and facilities, and keep the workplace clean and hygienic.

(VIII) Be sure to follow the basic principles at work such as, self-protection, a mutual help and site monitoring in order to achieve a zero incident rate.

Chapter II Equipment Maintenance and Inspection

- I. Dangerous machinery or equipment: Machinery or equipment identified as hazardous by the central government supervising agency can be employed only after it has passed a satisfactory checking by an examination agency or a deputy inspection organization designated by the central government supervising agency. In case it has been employed over the allowable period stipulated, its re-checking is necessary to ensure the safety of its re-employment.
- II. Implementing in house inspection
  - (I) Routine inspection: Undertake a routine of daily, monthly and yearly inspection and maintenance for instruments and equipment.
  - (II) Major inspection: Undertake a major inspection task for the instrument at its initial employment, or re-employment after it has been taken apart and adapted or repaired.
  - (III) Task focus: Accurately undertake key inspection points for the instruments and equipment every day or every time before operation.
  - (IV) Recording: Complete the required form for an inspection record, and deliver one copy to the department office; each laboratory may keep the photocopy on their individual environmental safety and health based archives. Entries on the record contain:
    - 1. inspection date, items, methods and results;
    - 2. improvement measure proposed depending on the inspection results; and
    - 3. signatures by the inspector and the unit's supervisor.
  - (V) Safety and health inspection entries for the CEMS department's laboratories are listed below:
    - 1. Waste (waste glass and waste liquid) marking
    - 2. Position and marking of fire extinguisher and first-aid kit
    - 3. Keep entry and exit doors and passage clear
    - 4. Inspection sheet for organic solvent and specific chemical substance
    - 5. The running of air-exhaust
    - 6. Chemicals marking and placement
    - 7. Markings for self-formulated chemicals and sampling solutions obtained from the pharmaceutical factory
    - 8. Drawer classification and marking
    - 9. Steel cylinder marking and secured
    - 10. Power cord secured
    - 11. Signs for designated workplace of toxic chemicals
    - 12. Substance safety data sheet
    - 13. Hazard and toxic chemicals inventory
    - 14. Records for using toxic chemicals
    - 15. Inspection sheet for exhaust fume hood and partial exhausting equipment
    - 16. Inspection sheet for steel cylinders and air compressors

- 17. Inspection sheet for safety protective equipment
- 18. Laboratory layout map
- 19. Emergency contact telephone directory
- 20. Emergency power-off device
- 21. Marking of power switchboard
- 22. Safety manual

(VI) Laboratory layout map

Oven	First-aid kit
Exhaust fume hood	Exit & entry door and passage
Chemical cabinets	Chemical refrigerators
Safety protective equipment	Gas steel cylinders
Substance safety data sheets	Precision instrument
Waste liquid and waste glass area	Laboratory desks
Switchboard case	Pressure vessels
Fire extinguishers	Emergency power-off button
Emergency call numbers	Toxic chemicals area

Chapter III Workplace Safety and Health Standards

- I. Each laboratory is required to draft a laboratory safety and health guideline:
  - (I) that specifies all the matters relevant to laboratory to regulate the conduct of

faculty and study members while they conduct an experiments in the laboratory. Post a copy of the guideline in the laboratory and file a copy with the department office. The contents expected are contain laboratory safety reminders, filling out the forms,

attentions for the use of instruments and equipment and other related matters that shall be abided by. If necessary, a subsequent review and amendment will be carried out (as appendix 1);

- (II) teaching laboratory safety reminders for laboratories of general chemistry, organic chemistry, instrumental analysis, physical chemistry and chemical engineering are as specified in appendix 2 to 5
- II. Each laboratory is required to draft a standardized operating procedure:
  - (I) Purpose: To regulate the laboratory's instruments, equipment and its operating process to be run in a proper way to avoid any errors and ensure the user's safety.
  - (II) Outline: Each laboratory, through its individual evaluation and analysis in workplace safety, has priority to develop an effective standardized operating procedure for which is a higher rate of injury, a higher injury severity and potential hazard where an accident has once happened, one each for the department office and the laboratory's posting up. The contents to be expected to draft include:
    - 1. Names of instruments and equipment.
    - 2. The proper operating procedures

- 3. Regulations safety attentions for potential hazard and possible harm
- (III) Regulations for using organic solvent and specific chemical substance:
  - 1. Only the amount of organic solvent needed exactly for the use of the day is allowed in the working area, and the remainder on the stipulated location.
  - 2. Keep a tight lid on the container of organic solvent whether it is in use or not.
  - 3. Prevent yourself from inhaling the vapor of organic solvent and direct skin contact.
- (IV) Attentions for high pressure gas vessel:
  - 1. Keep inflammables or volatile liquids at least 2 meters away from gas steel cylinders, and keep the cylinders values clean without any oil or grease stains.
  - 2. Check regularly whether soft tube or steel tube joint is properly tightened and whether there is aging crack on its surface.
  - 3. Prevent the exterior of the high pressure gas cylinder from damage or becoming Deformed, and affix a hazardous marking label to the cylinder, indicating the name and color of the substance contained inside the cylinder, and its hazardous characteristics.
  - 4. Describe precisely the conditions of the use of pressure gauge and hydrometer, and monitor regularly the change of pressure and flow.
  - 5. When opening the valve, it is imperative to open it slowly.
  - 6. Gas steel cylinder shall be firmly secured by a chain. Turn off the switch of pressing air after operation to completed. Gas cylinders shall be covered when not in use.

Appendix I: General Laboratory Safety Guide

# General Safety

- 1. It is imperative to wear safety goggles, and attired with the lab coat when conducting experiments, and never to conduct any hazardous chemical experiments alone at nighttime.
- 2. It is mandated to post the <u>department-specified standard charts</u> on the outer laboratory doors, such as the markings of the emergency contact phone directory, laboratory layout map, no entry permitted for non-laboratory personnel and the like.
- 3. When operating hazardous chemical experiments, it is imperative to inform one's lab partners, asking them to be aware of laboratory safety at all times.
- 4. It is <u>imperative</u> to be familiar with the emergency body, and eye rinsing devices, and the using time and operating methods for the equipment contained in the chemical disaster first-aid equipment cabinet, and be familiar with how to operate them.
- 5. The laboratory shall be fitted with the following safety equipment: fire extinguisher, first-aid kit, personal protective equipment, emergency lighting, and emergency power-off device.
- 6. The laboratory's partial ventilation device (the universal air ventilation hood, air ventilation cabin) shall be inspected on a regular basis, and properly documented in order to maintain their proper functions

- 7. Before entering the laboratory, first be familiar with the layout map to discern the interior layout.
- 8. The laboratory is to appoint one safety manager, who is charged with overseeing laboratory safety measures, and supporting the <u>department's</u> safety and health implementation.
- 9. In accidence incident response, an accidental incident report is to be filled out within the ensuing three days; in the event of an occupational hazard case, a false incident report is to be filled out when no one is injuries, or an occupational hazard report is to be filled out when there are personnel injured; the advisor is to file a written report with the safety committee within the ensuing week.
- 10. It is strictly prohibited to engage in cooking of foods (neither by an electric cooker nor by a gas stove) in the laboratory or at the postgraduate student lounge.
- 11. It is strictly forbidden for any student to remain in the laboratory alone, or sleep overnight in the laboratory.

Chemicals and Waste Output

- 12. It is strictly forbidden to place flammable solvents and gases, such as ether, n-Hexane, hydrogen gas and such near the heat source or by <u>a power source</u>, such as an oven, heating plate, heating pack, to avoid creating hazard.
- 13. The residual chemical after an experiment <u>shall be</u> disposed of by following the correct method; it is <u>strictly prohibited</u> to pour the residual chemical directly into the washbasin or the garbage bin.
- 14. A MSDS chart is to be produced for all hazardous materials, toxic compounds and controlled substances, and a hazardous marking label is to be affixed to the container of <u>such chemicals</u>, which is to be stored by category.
- 15. The use of toxic compounds is to follow "Toxic compound requisition process", and after the procurement, an operating record is to be kept when using such toxic compound; the operating site shall be ominously marked as a "Toxic chemical operating site.
- 16. All waste liquids generated from the experiments are to be sorted (into 13 categories) as specified, and be emptied into the marked <u>20-liter PE waste liquid barrels</u>.
- 17. The scrapped glass flasks generated at the laboratory are to be sorted (by colored glass, colorless glass, plastic bottles) as per the regulated methods, and palced in the marked bins.
- 18. All self-formulated chemicals are to be precisely marked (with the contents, formulator and the formulating date).

#### **Electrical Safety**

- 19. It is strictly forbidden to operate any heating appliances, such as an electric heater and the like, in the laboratory or at the postgraduate student lounge.
- 20. In the event of an electrical short-circuit in the laboratory, or at the postgraduate student lounge, please ensure to file a report with the instructor or the department office assistant. All instruments are to be marked with the power consumption rating and permissible power consumption rating.

- 21. It is strictly forbidden to use non-fused extension cords in the laboratory or at the postgraduate student lounge.
- 22. All power plugs not in use shall be removed when leaving the laboratory.

Steel Cylinders

- 23. Handling of the gas cylinder shall adhere to the specified anchoring and marking methods. When operating hazardous gases, such as carbon oxide, hydrogen and so forth, make certain to keep the windows and doors open to maintain proper air circulation.
- 24. All gas cylinders are to routinely undergo the leakage test once every month, and the inspection records properly retained

Appendix II: General Chemistry and Analysis Laboratory Safety Guide

- 1. It is imperative to wear the safety goggles (not allowing to wear contact lenses), and attired with the (cotton-made) lab coat.
- 2. Do not attempt to touch any chemical substance with bare hands, or smell any chemical compound with the nose.
- 3. Students are expected to attend class on time, and not allowed to leave the laboratory during the class.
- 4. No noise, playing, chatting and eating when students enter the laboratory; it is prohibited to invite any one who is not the classmate in the same class to the laboratory.
- 5. Only conduct experiments that are assigned or recognized by the instructor; it is strictly forbidden to conduct unauthorized experiments, or engage in work that is unrelated to the experiment.
- 6. Before conducting any experiment, it is imperative to read carefully the content of the experiment. To avoid hazards of conducting an experiment, please pay special attention to any precautions mentioned in the teaching materials. Students are expected to submit an experimental report written clearly and honestly by their own gains and reflections on the experiment, and any submission copied from others' findings is prohibited. Reflections and doubtful points relevant to the experiment may be written down in the end of the report.
- 7. During each lab session, retrieve and place only instruments needed for the experiment, rather than retrieving everything. As all communal chemicals or instruments are assigned with a fixed place of storage, do not remove or place an instrument elsewhere. It is forbidden to carry any instrument or chemical out of the laboratory. Violating this, a stiff punishment will be inflicted on the violator.
- 8. It is imperative to conduct an experiment carefully by following the experiment reminders and laboratory safety rules.
- 9. The students on duty for cleaning up are required to complete all mandated work.

Appendix III: Organic Laboratory Safety Guide

- Before conducting any experiment, it is imperative to understand the content, procedure and probable hazard of a particular experiment. At the laboratory classes, it is best to avoid wearing loose clothing, a necktie or any dangling necklaces, and students that wear long hair are kindly asked to tie their hair to their back. Students are also required to attire in the working uniform, complete with protective gears including the lab gloves, safety goggles and the like.
- 2. Timely maintain the cleanliness of the laboratory, and do not leave any object unrelated to the experiment on the laboratory lenchtop.
- 3. The laboratory is fitted with good ventilation equipment to prevent accident from occurring with the accumulation of toxic or flammable gases.
- 4. Do not attempt to touch any chemical substance with bare hands, or smell any chemical compound with the nose.
- 5. Only conduct experiments that are assigned or recognized by the instructor; it is strictly forbidden to conduct unauthorized experiments, or engage in work that is unrelated to the experiment.
- 6. At each lab experiment session, retrieve and place only instruments needed for the experiment, rather than retrieving everything. As all communal chemicals or instruments are assigned with a fixed place of storage, do not remove or place an instrument elsewhere. It is forbidden to carry any instrument or chemical out of the laboratory.
- 7. All laboratory personnel shall be fully aware of the location and the operating methods of the first-aid kit, emergency rinsing devices and fire extinguishers.
- 8. Never leave the work post unattended while an experiment is in progress, and an individual may only exit momentarily after informing lab partners of all proper cautions when deemed necessary.
- 9. During the progression of an experiment, it is strictly forbidden to engage in smoking or food intake, particularly at experiment sites that are prone to combustion or explosion hazards.
- 10. All operations shall abide by the standard operating procedures and as per the laboratory superintendent's instructions. Do not attempt to use any chemical without a label or not properly labeled.
- 11. Routinely conduct laboratory chemical inventorying, cleaning and scrapping, and regularly update the laboratory chemical checklist.
- 12. Follow the specified procedures when formulating and mixing the chemical fluids, particularly cautioning for safety when mixing chemical substances with strong acid, strong alkali or toxicity. When diluting a concentrated acid, it is prudent to add the acid slowly into the distilled water, and when the skin is accidentally spluttered by the acidic or alkali solution, rinse the skin with ample amount of water, and seek medical attention at once in severe cases.

- 13. It is prudent to handle irritating, toxic, evaporative chemicals in the fume hood, and refrain from conducting hazardous experiments alone.
- 14. Do not mix strong oxidants (such as hydrochloric acid, nitric acid, chlorate, peroxide and the like) with anti-reductant (such as sulfate, sulfuric compounds, glycerin oil and the like).
- 15. In the event of an electric wire fire, turn off the power source at once, and put out the fire with dry powder fire extinguisher.
- 16. Pour the waste liquid only into the laboratory waste liquid recycling barrel; do not recklessly abandon the waste liquid or empty it into the sink.
- 17. Once completing a laboratory session and before leaving the lab, make sure to turn off the water and power, and clean up the benchtop and washbasin.
- 18. When storing chemical compounds, heed to the principle of separating the dry and liquid chemicals, together with proper safeguard sought to prevent toppling by earthquake and similar circumstances. Legally designated hazardous materials are to be enlisted under monitoring, and padlocked where deemed necessary.

Appendix IV: Physical Chemistry Laboratory Safety Guide

- 1. It is imperative to comply with the following provisions; those going against the regulations will be required to quit the laboratory immediately, and inhibit them from conducting any experiment in the laboratory.
- 2. Take care to protect your eyes any time. Always wear safety goggles whenever you are working in the laboratory, and students who wear loose clothing, a necktie or long hair are kindly asked to tie them well to avoid touching any chemicals at their ends.
- 3. It is imperative to wear the lab coat to protect your body and clothing. It is prohibited to wear shorts (or a skirt), slippers, sandals, or open-toe shoes when entering the laboratory.
- 4. It is imperative to be familiar with the positions and operating methods of laboratory's safety equipment (such as fire extinguisher, eye rinsing devices, fire-extinguishing blanket, first-aid kit, water-drenching device and exit of the laboratory and so forth).
- 5. In the laboratory, students are prohibited to have such behaviors as smoking, eating, playing, making a noise, frolicking, lingering alone, violence, and malicious damage to experimental equipment.
- 6. During the experiment, any guests are required to wait outside the laboratory, not allowed to get in or be taken in directly.
- 7. To prevent any hazards from conducting an experiment, check if the chemical used is toxic or explosive by MSDS before the experiment.
- 8. Keep openmouthed glass jar storing organic solvent away from sources of ignition and heat. Do not take the mouth of glass jar towards anyone when it is heating, and do not put solid materials into heated liquid to avoid causing a Boiling Liquid Expanding Vapor Explosion.

- 9. All chemical containers are to be precisely marked. Do not pour any chemical liquid back into the container when it has been take out.
- 10. Take high-temperature materials with cotton gloves, and dispose of corrosive liquids by wearing rubber- or PE-made gloves.
- 11. Do not pour any chemical substance directly into the washbasin; waste liquid (including acetone for rinsing purpose) is required to pour into the designated waste liquid recycling barrel.
- 12. In the case of strong acid or strong alkali (except of sulfuric acid and other corrosive chemicals) coming into contact with the skin or sputtering into the eye, rinse first with plenty of water for at least 30 minutes, together with an immediate call to the class assistant for further assistance by other classmates; in case of skin or eye contact with sulfuric acid or lime, wipe it off before rinsing.
- 13. Be very careful while conducting any experiment, and comply adequately with the Physical Chemistry Laboratory Safety Rules.

Appendix V: Instrument Analysis Laboratory Safety Guide

- 1. No smoking, eating or storing food and beverages in the laboratory; it is imperative to wear the safety goggles, and attired with the lab coat and slippers while conducting an experiment.
- 2. When operating hazardous experiments, it is imperative to inform your lab partners; meanwhile, take heed of the individual's self-protection and make your familiar with the operating method of suction ball in safety.
- 3. Prior familiarity with precautions for the hazards of the chemicals and the instrument operation in the experiment procedure; for example, make yourself familiar with MSDS before using the chemicals; check if the gloves are in good condition before taking corrosive chemicals out for further use; using toxic chemical compounds is required to first fill out the operating record sheet, and padlock them when not in use and the like.
- 4. Think ahead any response measures for emergency, such as while an emergency happens, which switch should be turned off first; where to find shelter; the location of an emergency exit and the like.
- 5. It is imperative to adequately mark gas cylinders according to hazard related rules, and secure them with chains, without random removal. Before using the gas cylinder, conducting the leakage test (soap bubbles) is required; monitor the flow speed and the pressure at all times during the use of it; ensure its pressure has been relieved after using it.
- 6. Properly adjust the scales on the laboratory table before using them, and to maintain a higher degree of sensitivity, always clean the scales well after using them. Once completing a laboratory session, do not recklessly abandon medicaments or chemical utensils on the laboratory table, make sure to clean up the tabletop well before leaving the lab.
- 7. The waste is divided into three categories, garbage, glass waste and liquid waste. Separate garbage and glass waste into different bins. The liquid waste is divided into three kinds, including organic

MeOH, organic THF and organic halogen CHC1<sub>3.</sub> Do not pour strong acids or alkalis into washbasin.

- 8. Handle volatile substances in the fume hood; when using them, pull down the safety glass, and do not lean into the fume hood.
- 9. It is imperative to understand the probable accident happening of a particular experiment, and not to repeat the same accident again.

Appendix VI: Chemical Engineering Laboratory Safety Guide

- 1. Before conducting any experiment, it is imperative to understand the content, procedure and probable hazard of a particular experiment. Students are required to attire in the working uniform, complete with protective equipment including the lab gloves, safety goggles and the like.
- 2. Timely maintain the cleanliness of the laboratory, and do not leave any object unrelated to the experiment on the laboratory tabletop.
- 3. The laboratory shall be fitted with good ventilation equipment to prevent accident from occurring with the accumulation of toxic or flammable gases.
- 4. All laboratory personnel shall be fully aware of the location and the operating methods of the first-aid kit, emergency rinsing devices and fire extinguishers.
- 5. Never leave the work post unattended while an experiment is in progress, and an individual may only exit momentarily after informing lab partners of all proper cautions when deemed necessary.
- 6. During the progression of an experiment, it is strictly forbidden to engage in smoking or food intake, particularly at experiment sites that are prone to combustion or explosion hazards.
- 7. All operations shall abide by the standard operating procedures and as per the laboratory superintendent's instructions.
- 8. Do not attempt to use any chemical without a label or not properly labeled. Follow the specified procedures when formulating and mixing the chemical fluids, particularly cautioning for safety when mixing chemical substances with strong acid, strong alkali or toxic compounds.
- 9. It is prudent to handle irritating, toxic, volatile chemicals in the fume hood, and refrain from conducting hazardous experiments alone.
- 10. Do not mix strong oxidants (such as hydrochloric acid, nitric acid, chlorate, peroxide and the like) with anti-reductant (such as sulfur, sulfide, glycerine and the like). When diluting a concentrated acid, it is prudent to add the acid slowly into the distilled water.
- 11. When the skin is accidentally spluttered by the acidic or alkali solution, rinse the skin with ample amount of water, and seek medical attention at once in severe cases.
- 12. Before or after using the instrument, it is imperative to implement an inspection and properly keep records in the record log look.
- 13. In the event of an electric wire fire, turn off the power source at once, and put out the fire with dry powder fire extinguisher.

- 14. Pour liquid waste only into the laboratory waste liquid recycling barrel; do not recklessly abandon the liquid waste or empty it into the sink. Keep a record of the liquid waste poured into the recycling barrel by date of pour, and contents, expected amount and name of liquid waste.
- 15. Once completing a laboratory session and before leaving the lab, make sure to turn off the water, power and gas.
- 16. When storing chemical compounds, heed to the principle of separating the dry and liquid chemicals, together with proper safeguard sought to prevent toppling by earthquake and similar circumstances. It is better to store large bottles of chemicals or strong acids/alkalis on the lowest shelves of any chemical storage area.
- 17. Store volatile chemicals and those requiring refrigeration in the air-exhausting chemical cabinet or refrigerator.
- 18. Routinely implement inventory management and checkup of chemicals, write-off of disused chemical stocks, and renewal of chemical inventory data.

#### Chapter IV Education and Training

- I. General Personnel: Laboratory Based Newcomers or Exchanged Workers
  - (I) Are required to receive a 3-hour education and training program for safety and health as described below:
    - 1. Introduction to Labor Safety and Health Regulations
    - 2. Labor safety and health concepts and site safety and health related rules
    - 3. Emergency response and shelter matters
    - 4. General knowledge of fire fighting and first aid
    - 5. Other related matters
- II. Specialized Personnel: Specific Workplace Based Workers
  - (I) Those who have to operate hazardous machinery and equipment, or handle hazards are required to add a 3-hour hazard communication training.
  - (II) Specialized operation superintendents: All superintending personnel specialized in the operation of organic solvent and specific chemical substance are required to receive a 18-hour safety and health training.
  - (III) Specialized personnel who administer tasks relevant to ionizing radiation are required to receive a 40-hour job-related training program and also obtain a certificate of qualification in the related field; an additional 3-hour on-the-job training for radiation protection once every year is required; if operating the equipment capable of producing the energy of ionizing radiation over 100Kev, or handling the concentration of radioactive material beyond the range accredited by the working individual's license, he or she should receive a professional training program in administering ionizing radiation, and also obtain a certificate of qualification in the related field.

(IV) First aid personnel are required to receive a 18-hour occupational hazard related training program for first aid personnel, and also obtain a certificate of qualification in the related field.

#### Chapter V First aid & emergency rescue

- I. General emergency rescue principles
  - 1. Before administering emergency rescue, make sure that there is no further harm to the injured or yourself.
  - 2. Swiftly move the patient from a high-risk area to a safe area.
  - 3. Onsite emergency rescuers are to administer treatment to the injured at once, with priority given to those in a dire need, and when deemed necessary, do not hesitate to send the injured patient to a physician or a hospital for medical attention.
  - 4. Be familiar with the cardiovascular resuscitation techniques in order to maintain an injured patient's respiration and blood circulation.
  - 5. Do not administer food or beverage to individuals who are unconscious, or in a coma, or have lost consciousness, or to those likely to receive anesthesia.
  - 6. Avoid onlookers from gathering around when administering emergency first-aid procedure so not to hinder the emergency rescue work.
  - 7. Lift the head of injured patients who appear to have a flushed complexion, and lower the head of the injured patients who appear to be pale or in a state of shock.
  - 8. Make sure to prevent the injured patient form suffering further injury, and prevent the occurrence of shock.
  - 9. Telephone-inform the security protection section (ext 2236) and the environmental protection center (ext 2278) with the state of injury and medium of injury, and seek for assistance (by leaving contact telephone number).
  - 10. Be comprehensive of your own mission in the rescue organization in an emergency response.
  - 11. Uphold the first priority of rescuing human lives in emergency rescue missions.
  - 12. Accept the supervisor's orders to conduct personnel evacuation and emergency first-aid rescue.
  - 13. When a worksite is at risk of imminent hazard likely to occur, the employer or the worksite superintendent shall immediate order the workers to suspend the work, and have the workers evacuate to a safe worksite.
  - 14. Emergency transport of injured patients,
    - (1) Before moving, check the state of injury in the patient's head, neck, chest, abdomen, and four limps, stabilize where injured, and making sure to securely strap the transport equipment.
    - (2) Keep the injured patient in a comfortable position.

- (3) When in need of moving the injured patients to a safe place, drag the patient in the length-wide direction of the body.
- II. Unique injury emergency rescue principle
  - 1. Burn emergency rescue principle
    - (1) Rinse: Rinse with water for at least fifteen minutes. If injuries should occur to the eye, open the eyelid and rinse slowly with water, keeping the water flow at a 10 15cm height.
    - (2) Removal: if the injured skin is stuck with clothing, rinse with water and try to cut open the clothing to avoid the skin from being damaged or the injured surface from spreading.
    - (3) Soak: Soaked the injured spot in water, and do not squeeze the blisters to avoid infection.
    - (4) Cover: Gently cover the injured spot with clean, wet bandage to avoid infection.
    - (5) Send for medical attention: send for medical attention as soon as possible.
  - 2. External injury hemorrhaging emergency rescue principle:
    - (1) Keep the bleeding spot above the position of the heart, and remove the blood clog at where injured to avoid bleeding, and disinfect the injured spot to avoid infection.
    - (2) Any blood stopping method calls for releasing 15 minutes at the interval of every 10 to 15 minutes to avoid the tissue from damaging.
    - (3) Direct blood stopping treatment for general hemorrhaging: cover the wound with clean gauze dressing or towel, and press down with your hand for at least five minutes.
    - (4) Indirect blood stopping method for arterial hemorrhaging: Press the blood stopping point near the heart at where the bleeding occurs with your fingertips to reduce the blood flow, and it is best to incorporate the idrect pressure blood stopping method at the same time. (The blood stopping point at the thigh: the center point of the groin; the blood stopping point of the head: the artery vein along the side of the neck; the blood stopping point in the upper arm: the artery on the inside of the upper arm).
    - (5) When an injured patient is bleeding profusely and the homeostasis cannot be stopped using the direct or indirect blood stopping method, it is prudent to stop the blood flow by using the tourniquet, with the tourniquet strapped at the wound closer to the position of the heart, and also marked down the wrapping time.
    - (6) In the case of a nosebleed, keep the injured patient in a semi-sitting position with the head slightly inclined forward, with pressure applied to the two sides of the nose to stop the bleeding; release in 10 minutes, and exert the pressure once more if the bleeding does not stop.
    - (7) In the case of severed limps, clean the severed limps at once and segregate with a plastic bag in cold storage with ice cubes, and send the severed limps along with the patient for reconstructive procedures.
  - 3. Bond fracture emergency rescue principle:
    - (1) Avoid shifting the fractured bond and nearby joints.

- (2) Stabilize an injured limp with crimping board, and transport with a gurney.
- (3) Lift the anchored injured limp to avoid swelling and discomfort.
- (4) Send for medical first-aid attention.
- 4. Electrocution injury emergency rescue principle:
  - Turn off the power source first and make sure you are not at risk of being electrocuted. Use a dry wooden stick or rope to separate the electric conductive object from the injured patient.
  - (2) Administer emergency rescue procedure to the injured patient using the general emergency rescue principle.
- 5. Inhalation of poison's emergency rescue principle:
  - (1) The rescuer should be attired in suitable respiratory protective gears before entering the disaster site, and is to open the ventilation first.
  - (2) Do not willfully turn on any power source or light source if the toxic gas is flammable.
  - (3) Move the injured patient to a place with fresh air ventilation, loosen the clothing to allow a smooth passage of the respiratory track.
  - (4) Oxygen should be administered to victims who fall unconscious or having difficulty breathing.
  - (5) Those who stop breathing should be administered with cardiovascular pulmonary resuscitation in order to maintain the respiratory system functioning.
  - (6) Those who stop breathing should be administered with pulmonary massage to keep the circulatory system functioning.
  - (7) Send for medical first-aid attention: caution to keep warm to avoid hypothermia to the body.
- 6. Erroneous swallowing emergency rescue principle:
  - (1) First try to induce vomiting if non-corrosive toxins were injected.
  - (2) Do not try to induce vomiting of corrosive toxins were injected; administer a small amount of water to the patient if the patient is able to swallow.
  - (3) It is prohibited to induce vomiting if an individual is in a coma and experiencing spasm; administer the general first-aid procedure depending on the patient's cardiovascular conditions.
  - (4) Retain the toxin and send for medical analysis along with the patient.
- III. Laboratory accidental incident response
  - 1. In the case of a fire caused by a toppled alcohol lamp, cover the fire with a wet rag at once for the fire to extinguish naturally.
  - 2. In the case of a severe combustion following an organic solvent caught fire, cover the fire with <u>Hexafluorine</u> solid absorber to put out the fire naturally.
  - 3. If acidic alkali or corrosive chemical should sputter into the eye, rinse first with water for at least ten minutes or use the eye rinse at the emergency first-aid cabinet; of those with severe

conditions, after the first-aid rescue, send for medical attention at the medical office or a hospital.

- 4. In the case of strong acid or strong alkali coming into contact with the skin, rinse first with water, or rinse with Diphoterine at the first-aid equipment cabinet; of those with severe conditions, after the first-aid rescue, send for medical attention at the medical office or a hospital.
- 5. If the skin should be cut by a small knife or glass, it is best to remove the glass chaff, rinse the wound with water, apply iodine or potassium iodine, and wrap with adhesive bandage; of those with severe conditions, send for medical attention at the medical office or a hospital.
- 6. If the skin should be burned by fire it is prudent to rinse the wound with amble amount of water until it no longer feels burning hot, or apply initial treatment using burnt treatment medication; of those with severe conditions, send for medical attention at the medical office or a hospital.
- 7. If someone should become poisoned and fainted suddenly at the laboratories, remove the patient to an outdoor location with good ventilation in a sideway inclined position or sitting down in a stool with the head inclined forward, administered the patient with an oxygen respirator and send for medical attention.
- 8. If erroneously injecting or making contact with poisonous chemicals, first decipher the detoxification method and detoxify it on your own; if unable to respond on your own, seek medical attention with a physician.
- 9. Response method when a mercury thermometer ruptures: first gather mercury in large clusters into a flask or dish, and spray the remainder with mercury treatment agent before collecting the solids into the disposal box. The mercury disposer is stored at the organic laboratories, which can be loaned out at any time when needed.
- 10. Students who encounter accidents on campus may dial the telephone to seek help; a list of the laboratories' emergency contact telephone directory outside the school is as follows which is also posted on all laboratory doors to facilitate easy lookup.
- At the school/department  $\rightarrow$  2551, 2552, 2565, 2566
- Bodily injuries → School medical office at 2236 (during office hours), military training office at 455-3698 (during non-office hours)
- General incidents  $\rightarrow$  School police squad at ext 2270, 2271, 2279
- Fire incidents  $\rightarrow$  school environmental safety protection at ext. 2278, 2263, 2264
- Fire  $\rightarrow$  119; Neili fire brigade at 452-0958, 452-1694, 462-2036
- Severe burnt injuries → Chang Gang Burn Center at (03)328-1200, ext. 2160; emergency room at ext. 3199
- General physical injuries → Provincial Taoyan Hospital emergency room at (03)369-9721
- Poisoning incidents → Veterans General Hospital Pharmacology Consulting Center at (02)875-7525
- Toxin Disaster Response Center  $\rightarrow$  0800-057-119, 0952-330-005~8,

• Hazardous material inquiry  $\rightarrow$  035-917-777, 035-916140

## Chapter VI Preparation, Maintenance and Use of Protective Equipment

- 1. Each laboratory's superintendent shall adequately provide related personnel with the individual's protective equipment and safety and health facilities, and routinely implement the maintenance, repair and renewal of the equipment and facilities mentioned above.
- 2. The individual protective equipment shall be properly applied when necessary, and shall be maintained the cleanliness and the well function by regular self-examination.
- 3. In the event of protective equipment being unsuitable to use any more, overdue or deficient in safety, it is imperative to apply for renewal or repair of the equipment, and let it fall into disuse.
- 4. Protective equipment users shall receive the related training program to understand how to use and maintain the equipment.
- 5. Those exposed to the average sound pressure level exceeding 85 dBA or the noise exposure reaching 50% or higher in the workplace for 8 working hours each day are required to wear earplugs or earflaps for protection against noise damage.
- 6. When engaging in carrying, handling or using irritant or corrosive toxic substance, be sure to wear protective equipment such as protective gloves, protective clothing, safety shoes, protective goggles, protective oral-nasal mask and safety mask.
- 7. Those exposed to ionizing radiation, biopathogen, pernicious gases, vapor or dust, or other hazardous substances in the workplace are required to wear safety mask, dust mask, gas mask, protective goggles and protective clothing and so forth.
- 8. Those workers who may be injured due to skin contact with chemical substances in use, or suffer poisoning phenomenon by infection or skin penetration and absorption of any form of hazardous substance capable of producing intoxication at work are required to adequately wear the protective equipment such as non-penetrating protective clothing, protective gloves, protective boots and protective shoes.
- 9. It is imperative to implement a routine inspection of all the instruments and appliances stored in public emergency equipment cabinet as specified in table 1 in order to always maintain an adequate quantity and functional normality of the said instruments and appliances
- 10. It is imperative to implement a routine inspection of the emergency equipment for body rinsing and eye bathing in order to always maintain an adequate quantity and functional normality of the said equipment.
- 11. Those workers who engage in a task related to electric equipment are required to properly wear safety helmets for head protection, insulating protective equipment and any other required protective accessories.

12. Any protective equipment shall be approved by national testing agency, which is designed by the operational function of less interference to avoiding users' discomfort at work.

Equipment Name	Characteristics	Quantity		
Level-C protective clothing	Yellow, a suit	2		
Filtering half masks	Gray mask	2		
Chemical protective gloves	Green gloves	2		
Universal treatment agent for chemical leakage	About 800g each,	1		
(Diphoterine)	powdery			
Universal aerosol burn sprayer	White, bottled, 250ml	2		
Washing solutions for hydrofluoric acid and acid	Bottled, 500ml	1,2		
skin, and eyes (Hexafluorine)				
Burn and scald spraying can	Bottled, 59ml	3		
Chemical absorbent cotton	Sheet-type, wiper-like	1 box		
Chemical absorption pillow	Yellow, pillow-like	1 box		
Chemical liquid sorbent sock	Yellow, strip-type	2		
Portable oxygen resuscitator, type 2-025	About 2.7Kg	1		
Pocket smoke-escaping mask	450°C resistance	4		
Escape mask	More than 20 minutes	2		
	in usability			
Folding stretcher	About 6Kg	1		
Fire extinguishing blanket	1800*1800mm	1		
Chemical decontamination lotion	1 kg each for	6		
	ABCDEF			
Waste disposal bag	PE-made, acid and	2		
	alkali resistance			
Dynamic entry tools		1		

 Table 1
 Yuan Ze University Emergency Response to Chemical Disaster and First Aid Cabinet

#### Chapter VII Incident Notification and Response

- I. Incident Notification
  - 1. In the event of an occupational hazard occurring, notify the related units through the school's emergency notification system.
  - 2. Notification contents include reporter's name and telephone, hazard occurrence time, location, number of injured person, incident-causing medium, emergency response situation, emergency support needed.

Yuan Ze University Experiment Site Occupational Hazard Reporting and Contact Diagram



Emergency response handling procedure

- 1. Fire (including chemical substance fire)
  - (1) In the case of small fire when discovered, try at best to turn off the power source and fire source, safety permitting, put out the fire with the fire extinguishing equipment at once, and look for nearby working personnel to help out the fire, administer first-aid to injured patients, and notify the department superintendent at once.
  - (2) If a fire should be burning beyond control, leave the site immediately, segregate the incident site, and notify the nearby working personnel to help evacuate the crowd; besides onsite emergency rescue and response crews, all other personnel shall be cordoned off from coming near the scene.
  - (3) Ascertain the type and characteristics of the chemical substance that caused the fire and notify the fire authorities to conduct fire rescue.
- 2. Explosion
  - (1) The person discovers the first shall expeditiously turn out all switches beyond the site and insulate the explosion source; when concerned of probable electrocution, turn off the power source away from the incident site first, or notify the construction unit to respond to the situation.
  - (2) Verify the type of explosive materials and render whether there is potential hazard of a secondary explosion. Before eliminating the hazard, do not willfully enter the site, but to notify the fire authorities at once.
  - (3) Segregate the incident site, evacuate the nearby crowds, assist rescuing the injured patients, and also notify the department superintendent where the incident occurred at once.
- 3. Chemical substance leakage
  - (1) At the onset of a small leakage, turn off the leakage source promptly, and absorb the leaked material using the absorbent cotton. In the event of a large leakage, try to contain the leakage from spreading by using flow stopping ropes or strips. Notify the department superintendent where the incident occurred at once.
  - (2) The department is to respond to the incident at once if the leakage and decontamination is containable. If uncontainable, seek outside support immediately to avoid the disaster from spreading.
  - (3) Segregate the incident site, and evacuate the crowds. Except the emergency rescue and response personnel, all other personnel shall be cordoned off from coming near the scene.
  - (4) The leaked chemical substance and decontaminant shall be collected in contamination removal bag for uniformed disposal.

Fire response handling procedure (Phase I)





Fire response handling procedure (phase II)





Chemical leakage response processing procedure (phase II)





- (3) Occupational hazard investigation
  - 1. Regardless of the occurrence of a disability injury, false alarm incident or property loss, the department supervisor shall voluntarily conduct an investigation to analyze the cause of incident, and fill out the Yuan Ze University occupational hazard report form in three days by presenting a detailed incident report.
  - 2. Regardless of the size of a fire, or whether there are losses or otherwise, the department where the incident occurred shall promptly present a fire report within the ensuring three days.

3. Following the occurrence of a fatal incident or when the number of disaster-hit should exceeding three persons, a report shall be promptly filed with the Council of Labor Affairs' northern inspection office within twenty-four hours.

#### Chapter VIII Other relevant measures

- 8.1 Introduction of commonly used toxic and hazardous chemical compounds and gasses A majority of chemical compounds invariably contain toxicity. Many chemicals used in biology, even when used in a minute volume, would still need to caution particularly of their toxicity. Exercise special caution when handling and using a variety of toxic substances and chemical compounds by avoiding making direct contact of any chemical compounds, and avoiding inhaling any vapor of chemical testers. Special caution is to be made when making contact of high-temperature liquids and high-concentration testers or toxic materials, particularly during the cleaning process, and remember to use only clean glass flasks. A separate description to the hazard characteristics of some of the commonly used chemical compounds and substances is provided below.
- 8.1.1 The handling principle for commonly used chemical compounds
  - Toxins

Containers loaded with toxic chemicals shall be affixed with the hazardous toxin label. The user shall use the chemical correctly by filling out the usage record, and refrain from willfully leaving or disposing the container to avoid inflicting harm to others.

• Hydrogen Peroxide

It needs to be stored in plastic bottles with a volume not exceeding 1000ml, and the cap shall not be overly tightened.

- Chlorinated hydrocarbons (CHCs) It is strictly forbidden to smoke when handling phosgene that are likely to create acute toxins (such as carbon tetrachloride or trichloroethylene).
- Mercury

Sputtering mercury in a conceal space would create hazardous mercury vapors. For safety reason, please respond by following the guideline listed below,

- (1) Good ventilation.
- (2) A fume hood is to be used when processing a large volume of mercury (such as the filling pressure gauge).
- (3) The container for loading mercury shall be placed on a smooth and seamless plate to prevent mercury from spluttering onto the floor; it is imperative to avoid the skin from contacting mercury.

- (4) In the event where mercury liquid should fall onto the ground surface, remove it with the mercury leak neutralization agent.
- Flammable liquids
  - (1) In laboratories, it is best to store as little amount of flammable liquids as possible. Meaning that the amount in storage shall not exceed the volume needed normally. Any flammable liquid not in use shall be stored in a safe location.
  - (2) It is forbidden to store a large amount of flammable liquid in the laboratories, but shall be stored in a storage room with fire equipment.
  - (3) When pouring flammable liquid from the storage flask to a beaker, place the beaker on a metal tray first to avoid sputtering the flammable liquid onto the ground surface.
  - (4) It is best to pour flammable liquid inside the fume hood.
  - (5) It is best to absorb sputtered flammable liquid with absorbent cotton, and place the used absorbent cotton in a sealed recycle bag for safety reason.
- Solvents

Used solvents that cannot be dissolved in water are forbidden to be emptied into the water basin, but shall be stored in special containers, together with a label identifying the name of the used solvent, pending discarding disposal, and may not be mixed with other solvents to avoid creating hazard. It is forbidden to place used solvent in plastic bottles, or put solvent containing chloride in metal cylinders.

• Combustible solvents

It is forbidden to place flasks or container with combustible solvents on the chemical rack. Do not exceed the volume required when handling this type of solvent. Before handling the solvent, distinguish the flame. Caution: sulfur dioxide could be ignited under hot steam, so can ether be ignited when coming into contact with hot metal floor.

• Liquid nitrogen

It is forbidden to cool mechanical components exposed in air with liquid nitrogen. Because as oxygen in the atmosphere tends to condense and deposit onto such mechanical components, any oxidant contained on a piece of mechanical component could lead to hazardous explosion. For safety reason, it is best to forego using liquid nitrogen for cooling occasions that can be substituted with dry ice.

• Electropolishing solution

As there have been severely fatal explosive incidents with electropolishing solution that contains hydrochloric acid, it thus calls for taking up special caution when handing the solvent.

Special caution shall be made that the density of porchloric acid shall not exceed 1.48 (or 60%) when storing porchloric acid solution.

- (2) Electropolishing solution shall be stored in a flask, complete with a label affixed describing the chemical contents, and formulation date.
- (3) Caution to prevent overheating when handling electropolishing solution to avoid creating hazard.
- (4) Wear the mask and protect the eye when formulating the electropolishing solution, and caution also to add the porchloric acid slowly into the solution for safety reason.
- (5) The electropolishing process shall be conducted in the air-extracting cabinet.
- (6) The carbon dioxide fire extinguishers shall be prepared for handy use in a bid to maintain the safety.

Caution: the above cautionary measures also apply to other electropolishing solutions and chemical polishing solutions.

• Hydrogen gas

When handing hydrogen gas with a concentration exceeding 4% (the bulk percentage after mixing with air), special attention shall be made to caution for safety to prevent explosion. Hydrogen gas in a lab setting shall only be discharged into the atmospheric air via fireproof air-extracting system.

• Hydrofluoric acid

Hydrofluoric acid is of a colorless, fuming liquid, and contains high corrosiveness. When used carelessly, it can result in severe or fatal injuries to the skin, eyes, respiratory organs and respiratory track. Special caution shall be made even handling a very minute amount of hydro fluoric acid in a laboratory setting. When handing hydrofluoric acid, it is imperative to wear the mask and gloves (in PVC or plastic), and in the fume hood for safety reason. Regardless of the amount of a sputter, it needs to be rinse out with ample water to fully cleanse the water basin. When handling hydrofloric acid, it is strictly forbidden to engage in smoking, eating to avoid inflicting harm to the face, digestive track and respiratory organs. When handling hydrofluoric acid in a laboratory setting, it is imperative to ready the following safety measures,

- 1. A good source of water supply.
- 2. The supply of hydrofluoric acid rising agent.
- 3. The supply of glucose acid calcium ointment.
  - (1) Skin or eyes:

When coming in contact with any acid, it is imperative to rinse the skin with ample water to dilute the concentration and to avoid inflicting harm. Use hydrofluoric acid rising agent (Hexafluorine) to rinse the inflicted spot and apply an adequate amount of glucose acid calcium ointment over the burn area, complete with gently messaging the inflicted are with clean fingertips. For partial skin burn, following the foresaid method for effective treatment; however, of those in severe conditions, seek medical attention at once. If the acid should accidentally splutter into the eye, rinse with ample amount of water for 15 minutes or longer and seek medical attention at once.

#### (2) Respiratory organ:

As hydrofluoric acid vapors severely irritate the eye, nose, mouth and lungs, thus the fewer vapors the safer it is. Hydrofluoric acid at a concentration of 50 ~ 250ppm becomes very dangerous, and can even become explosive. The emergency first-aid for respiratory organ contamination is as follows: Remove the injured patient from the hazardous area, remove the contaminated clothing, and administer CPR (but not mouth-to-mouth) when deemed necessary. If needed, administer a pulmonary resuscitation procedure, and call for an ambulance to send for medical attention.

• Chloride compounds

It is prudent to utilize the fume hood cabinet when handling chloride compound chemicals for safety reason. Below highlights the special caution to be taken,

- (1) Do not empty chloride compound into the water basin, and never put acid in contact or near chloride compounds.
- (2) Never inhale chloride compound vapor, and never let it come into contact with the skin, as such type of hazard can never be overlooked.
- (3) After handling chloride compounds, rinse spots of the air-extracting cabinet being contaminated with alkali solution, then rinse with ample of water.

#### • Asbestos and ceramic whisker

Whisker in an asbestos shape and size, such as high purity of silicon carbon (SiC), tends to result in abnormal growth in rodent lungs when used excessively for over a year's time. Consequently it is prudent to follow the disposal methods listed below when handling any compounds that contain whisker, such as the old insulation materials, asbestos sheets, medium to low temperature oven utensils,

Be sure to wear the gloves (of smooth surface, washable), mask, and prepare clean water and wet sponge (avoid using wool cloth or textile product), and under the condition of no wind and air-conditioning, try not to come into contact with the skin when opening the package, or removing insulating asbestos material. Under normal temperatures, whisker tends to form a clustering configuration, and there is no harm when gently retrieving the amount of 10 to 50gm each time. When in need of handling more than one gram each time, ensure that it is handled in a ventilated cabin with high-efficiency surface flow. After handling, wash the hands immediately, clean the gloves and mask, and use the standby web sponge to wipe clean the tabletop and any residual spots, such as the cuffs and weighing scale and so forth. Special caution shall be followed thoroughly in every step of the operation and the cleanup afterward.

Special caution: In the instance where a large amount of whisker should spread accidentally, segregate the contaminated area, and seek professionals to clean up the contamination. Asbestos and whisker though do not cause harm strongly when inhaled, but could remain in the lungs for an extended period of time. Asbestos or whisker products (excluding cured

products) to be discarded can only be discarded after being mixed with epoxy and becoming solidified.

• Ultra-micro particles

Ultra-micro ceramic particles, for being lightweight and in minute powder form (smaller than 0.2mm), can linger in air for hours or even days. When inhaled into the lungs over an extended period of time, it could trigger respiratory allergy or respiratory difficulties. When inhaling silicic acid substance (such as calcium silicate) in the powder form, steadily over an extended period of 10 to 20 years, there is a risk that it could turn into silicosis that could be life threatening.

When retrieving a large amount of ceramic powder, it is imperative to wear the mask, and retrieve it in a small amount using a small shovel. Do not attempt to retrieve the powder by using a pouring method. After each handing, wipe all places with a wet sponge. Before discarding any excessive powder particles, mix it with a solidifying agent (such as epoxy) evenly before discarding such ceramic powder.

• Polytetrafluoroethylene (Teflon)

When heated to over 200°C, the compounds polytetrafluoroethylene dissolves could cause severe injuries or even fatality to humans. To avoid the harm caused by Teflon, it is imperative to following the cautionary measures listed below,

- (1) When heating Teflon for whatever reason, make sure there is a working ventilation system.
- (2) After cutting or buffing Teflon, make sure to remove all Teflon dust and chaffs from your clothing, and wash your hands thoroughly.
- Ionizing radiation

As any instrument that operates a voltage exceeding 5000 volts could become a hazardous source of radiation, such as an X-ray analyzer, and a host of electronic telescopes, hence it is imperative to operate such instruments with care and caution.

• Non-ionizing radiation

Non-ionizing radiation refers to laser, ultraviolet ray, infrared ray, ultrasound, microwave and such. When handling instruments that contain non-ionizing radiation (such as for soldering), special caution shall be taken to caution the safety of the eye and skin, and also to caution for fire.

# • Steel cylinders

Caution shall be taken when transporting or handling steel cylinders filled with compressed air.

(1) For safety reason, make sure to maintain sufficient distance when filling steel cylinders with combustible gas or flammable gas.

- (2) Always use the handcart when moving steel cylinders.
- (3) Secure steel cylinders against the wall using steel chains.
- (4) Install a flow meter when operating steel cylinder in order to safely control the volume of flow.
- (5) Make sure to turn off the flow meter when finish using a steel cylinder to prevent the gas from leaking out.
- (6) Never lay acetylene ( $C_2H_2$ ) cylinders horizontally to prevent the acetylene from leaking out.
- 8.1.2 The harm of organic solvents' toxicity to the human body
  - 1. The toxicity of organic solvents

Any individual exposed to organic solvent vapors over an extended period of time could suffer chronic poisoning phenomenon, while there is still risk to developing acute poisoning lethal risk when exposed to a high concentration of organic solvent vapors over a short period of time. In industrial health, the hazard of organic solvent to the human body is inextricably correlated to the volatile nature of solvent. Under ambience temperatures, low volatile solvent in air tends not to cause harm. Other variables of harm to the human body include the fatty dissolution of solvent, response tendency, state of impurity, method and means by which it is absorbed by the human body, and metabolic ratios of the human body, state of accumulation, individual perception and sensitivity, timing of exposure and so forth.

- 2. The medium by which the toxicity becomes harmful to the human body
  - (1) The harm triggered by skin contact:

Organic solvent vapors could cause tearing in the human eyes as it irritates the mucus of the eye; its coming into contact with the skin could dissolve the skin's fatty oil to penetrate into the tissue to disrupt physiological functions and dehydration, causing the skin to dry and become infected of contaminant and bacteria. Dissolution of the epidermal cuticle can result in epidermal keratinocyte, irritate the outer skin to result in red swelling and blistering. Solvent that penetrates into the human body can sabotage the blood cells, bone marrows and the like.

(2) The harm triggered through the respiratory organs

As organic solvent in the steam form is inhaled through the respiratory organs into the human body, an individual tends to experience a paralysis effect. A majority of the inhaled steam traverses through the organs to reach the lungs, and is spread through the blood stream or lymphatic fluid to reach other organs to result in varied levels of poisoning. With the surface of the human body's lung bubbles tenfold that of other body surfaces, and with a rapid diffusion through blood circulation, it often creates severe harm to the respiratory track, nervous system, lungs, kidneys, blood and blood synthesizing systems, while poisoning triggered by organic solvents through the respiratory system remains much emphasized.

(3) The harm triggered through the digestive organs

The main causes leading to organic solvent poisoning through the digestive organs have been food intake at contaminated solvent steam sites, smoking or accidental contact of the mouth through contaminated fingers, and the hard triggered takes hold in the mouth cavity, as it enters into the gullet and the stomach and intestines to result in nausea and vomiting phenomena, and continues to pose harm to other organs as the toxin reaches the digestive system.

3. The physiological effects of the toxicity harmful to the human body

The general symptoms of organic solvent poisoning include headache, slack, poor appetite, giddiness, and the like. High concentration acute poisoning can result in suppressing the central nervous system, depriving an individual of consciousness to result in a paralysis phenomenon, which would initially manifest in delirium, lethargy, headache, eye dizziness, slack, poor appetite, loss of consciousness; low concentration of steam-included chronic poisoning can affect the blood platelets and erythrocyte to cause blood system, nostril, gum and hypodermal hemorrhaging to result in the phenomenon of anemia in the human body.

# 8.1.3 Laboratories and Telephone Listing of the Department of Chemical Engineering and Materials Science

Office of Military Training 4553698 ext 8585 Health and Hygiene Section 2236/2233 Guardroom 2270/2271 Health and Hygiene Section 2278/2264 Department office line (03)4638800 ext 2561

		1					
	Laboratory Name	Telephone	Contact Person	Superintendent/Faculty			
1	2003 Chemical Engineering Unit Operations	2003	Xu JiaHui 2576	Chen YongXin 2570			
	Laboratory						
2	2107 Materials Processing Laboratory	1070	Xu JiaHui 2576	Chen YongXin 2570			
3	2201 Instrumental Analysis Laboratory	2010	Deng YaWen 2566	Hong YiMing 2569			
4	2202 Physical Chemistry Laboratory	2020	Li Zhong 2552	Lan QiWei 3550			
5	2205 Organic Chemistry Laboratory	2060	Lin YiYa 2565	Huang Ju 3551			
6	2206 General Chemical Laboratory	2060	Li ZhongLing 2552	He ZhengEn 3552			
	2207 Conference Room, 2208 Conference Room		Hong HuiQing 2575	Wu HeSheng 2564			
	2209 Departmental Chairperson Office	2564	Wu HeSheng 2564	Wu HeSheng 2564			
	2210 Department Office	2551	Chen MeiYan 2551	Wu HeSheng 2564			
	2211 Shed and Computer Control Room	2576	Li ZhongLing 2576	Wu HeSheng 2564			
7	Precision Instrument Room 2212	2212	Xu JiaHui 2576	Wu HeSheng 2564			
8	Precision Instrument Room 2213	2213	Xu JiaHui 2576	Wu HeSheng 2564			
9	Precision Instrument Room 2214	2214	Xu JiaHui 2576	Wu HeSheng 2564			
10	Precision Instrument Room 2215	2215	Xu JiaHui 2576	Wu HeSheng 2564			
11	2204 Photoelectricity Materials Laboratory	2040	Lin DaoKai 2561~2040	Liao ChaoGuang 2573			
12	2204-1 Molecule Materials Laboratory	2041	Xu HuiRu 0928559895	Liao JianXun 2567			
13	2301 Aerosol Science Laboratory	3010	Chen YuKai 0919603154	Zhang YouZhen 2571			
14	2303 Biochemical Catalyst Laboratory	3030	Luo JiWei 0928586106	Wu HeSheng 2564			
15	2304 Electrochemical Laboratory	3040	Huang ShengJie 0921430529	Yin GengMing 2556			
16	2306 Catalysts Reaction Laboratory	3060	Chen LiJun 0933309356	Lin ShengDian 2554			
17	2318 Separation Technology Laboratory	3180	Gao XiangQian 0936818777	Zhuang RuiXin 2555			
18	2320 Environmental Nano-Catalyst Laboratory	3200	Liu ZhiPing 0919348818	Lin KunSong 2574			
19	2320-1 Ultra-fine Functional Materials Laboratory	3200	Chen WeiYu 0937060011	Xie JianDe 2577			
20	2401 Surface Mounting Laboratory	4010	Gao CongKai 0910949691	Hong XinGuo 2559			
21	2403 Plasma Surface Engineering Laboratory	4031	Wu XinYi 2561031	Huang Jun 3551			
22	2404 Advanced Semiconductor Packaging Material	4040	Wu WeiXiang 2561~4040	He ZhengEn 3552			
	Laboratory						
23	2404-1 Biorefinery and Bioprocess Laboratory	4041	Wang HuaiLi 2561041	Lan QiWei 3550			
24	2406 Membrane Biotechnology Laboratory	4060	Huang YuZhen 0911103378	Sun YiMing 2558			
25	2419 Macromolecule Electrolyte Laboratory	4190	Li JiaJun 0919092271	Yu ZiLong 2553			
26	2419 Macromolecule Fuel Cell Membranes	4190	Qiu JiWei 0936201213	Lin XiuLi 2568			
	Laboratory						
27	2421 Macromolecule Photoelectric Laboratory	4210	Shi JunZhi 0927115137	Huang ZhenQiu 2560			

## 8-1.5 Laboratory Safety and Health Checkup of the Department of Chemical Engineering and Materials Science

Laboratory Checkup Sheet of Yuan Ze University Department of Chemical Engineering and Materials Science

	Inspector:								(Photographing) Checking date:								
Check Items	Liao ChaoGuang	Liao JianXun	Zhang YouZhen	Wu HeSheng	Yin GengMing	Lin ShengDian	Zhuang RuiXin	Lin KunSong	Hong XinGuo	Hong YiMing	Huang Ju Laboratory	He ZhengEn	Lan QiWei Laboratory	Sun YiMing	Yu ZiLong Lin XiuLi	Fuel Cells	Huang ZhenQiu
	2204	2204-1	2301	2303	2304	2306	2318	2320	Laboratory 2401	2403	2403-1	Laboratory 2404	2404-1	2406	2419	2419-1	Laboratory 2421
Waste glass and waste liquid																	
classification and marking																	
Position of fire extinguisher and																	
first-aid kit																	
Keep entry and exit doors flow																	
Power switchboard marking																	
Whether air-extracter works normal																	
Chemicals marking and placement																	
Self-formulated chemicals and drawer marking																	
Steel cylinder marking, anchoring and	1																
placement																	
Neat, power cord fixation																	
Organic and specific chemical																	
substance checkup sheet																	
Material safety data sheet																	
Chemical hazardous substance																	
inventory																	
Toxic substance utilization record																	
sheet																	
Air-extracting cabinet checking sheet																	
Steel cylinder and air-compressor																	
checking sheet																	
Protective equipment checking sheet																	
Laboratory layout map																	
Emergency contact telephone listing																	
Emergency power off device																	
Toxic substance operating site map																	
Occupational hazard reporting and																	
contact diagram																	
Laboratory safety manual																	
Accompanying inspector																	