# Chapter 3 General Safety Tips

## Section 1 Introduction

**"People make mistakes. We need to assume they will make mistakes and respond accordingly."**

### 1 Beginner's Guide

New and transfer students should follow the teachings of faculty members and senior students and become accustomed to life at the University as quickly as possible.

(1) Familiarize yourself with the performance of equipment, tools, and instruments, and learn how to operate them and use them with care.

(2) Ask a faculty member or senior staff member if anything is suspicious or unclear, even if it is a small matter. Be careful not to make hasty judgments or assumptions on your own, as this can result in injury.

(3) As you become accustomed to the work, you will tend to relax. Be mindful not to become distracted or negligent when conducting experiments.

### 2 Clothing and footwear

The priority in appropriate clothing for work is to make it easy to work and to protect oneself from disasters. There have been many cases of severe injury due to forgetting this point; therefore, the following precautions should be considered.

(1) When conducting experiments using chemicals, wear long-sleeved jackets and other clothing that does not expose the extremities. Wear a white lab coat and properly use protective equipment such as safety glasses.

(2) Shirt hems that may get caught in rotating machinery should be tucked into pants.

(3) In general, non-slip footwear should be used, and never wear shoes with untied laces or step on the heels of the shoes, as there is a risk of tripping.

### 3 Posture

(1) It is important to work in a stable posture suited to the task, with a relaxed and straight back.

(2) Face the desk straight, sit deeply in the chair, and try to work in a natural posture.

(3) Continuing in the same posture for extended periods causes "static fatigue" due to the continuous tension and contraction of certain muscle groups. It is necessary to eliminate this "static fatigue" through light exercise, etc.

### 4 Organization, neatness, cleaning, and sanitation

The fundamentals of safety are organization, neatness, cleaning, and sanitation. In many cases, poor organization and tidiness are the causes of disasters.

(1) Desk organization

(a) The desktop should be kept clean at all times for it to be used spaciously, and office supplies should be organized.

(b) When leaving your seat, be sure to retract your chair under the desk/table.

(2) Object placement

(a) All items should be placed in a designated area and always in place.

(b) Items should be aligned at one end or one side, particularly against an aisle, with the aisle face aligned.

(c) Do not place objects that obstruct lighting on the window side.

(d) Tall shelves, bookcases, glass shelves, etc. should always be placed near the wall to prevent them from tipping over, and earthquake-proof measures should be implemented.

(e) Documents and items should not protrude from shelves and desks.

(3) Organization of aisles

(a) Do not place any objects in the aisles.

(b) Do not place any objects near aisle entrances, emergency exits, stairways, etc., indoor fire hydrants, or fire extinguishers.

(c) Do not place fragile, flammable, or dangerous objects near aisles.

(4) Cleaning

(a) Make an effort to be organized, neat, and clean every day.

(b) Sink areas should be cleaned regularly, paying particular attention to sanitation.

## Section 2 Examples of minor accidents and lessons learned

Often minor accidents occur in the laboratory. Fire, water, electricity, heavy objects, and chemicals are the main causes of accidents. Some examples are given below.

### 1 Examples of accidents resulting in death or injury

In October 1991, during an experiment using Chemical Vapor Deposition (CVD) equipment at a university in Osaka, an explosion occurred in a cylinder supplying monosilane. The check valve on the nitrous oxide purge line did not operate properly owing to a deterioration of the O-ring, causing nitrous oxide to flow back into the monosilane cylinder through the purge line, forming an explosive gas mixture that exploded from an ignition source. This incident triggered a revision of the High-Pressure Gas Control Act.

## 2 Examples of nearly fire incident

(1) A gas stove was being used in the laboratory and a beaker was being filled with alcohol and machine parts were being cleaned near the stove. The beaker was inadvertently dropped on the floor, and although the spilled alcohol ignited the stove and caught fire, the fire did not cause severe damage because there were no combustible materials nearby.

(2) In an experiment to concentrate a sample solution using a rotary evaporator, a plastic basin was used as a water tank, and the water was heated using a throw-in heater. After the experiment was over, the sample solution was heated using a throw-in heater. Several hours later, the water in the basin evaporated, the basin became empty, and the plastic basin burned owing to the heating of the heater. This triggered the smoke detector in the room and set off the fire alarm; the staff rushed to the room and extinguished the fire using a fire extinguisher, and the fire was extinguished, and only the wash basin and the rubber pipe for cooling water were destroyed by fire.

(3) When making sample pieces from magnesium-lithium ingots, the ingots were hand-sawed and sanded. After the work, the chips and fine powder from the filing were placed in an iron can and left without closing the lid of the can. The humidity in the air oxidized the fine powder, and the heat stored from the oxidation caused the powder to spontaneously combust, scorching part of the floor surface.

(4) When using a dryer or experimental apparatus, the state of progress was not checked. In addition, the sample in the apparatus overheated and became a blur because the operator left the apparatus.

These examples show that accidents are not caused by a single cause but are the result of a cascade of unfortunate incidents caused by several inadvertent events. Additionally, if a lucky break occurs along the way, a major accident may be prevented. Therefore, safety measures should be performed in duplicate or triplicate.

Fire is the most dreaded accident for researchers. A fire may take the lives and time of not only you, but also those around you. Furthermore, it not only ruins the experimental equipment but also causes the loss of various data that have been accumulated up to that point. It takes a significant amount of time to obtain data. Money can buy experimental equipment, but it cannot buy human life or time. Preventive measures are simple: do not use flammable liquids or gases in a place where there is fire, do not place flammable materials, and do not leave the vicinity of experimental equipment.

## 3 Water accidents

(1) An oil diffusion pump used to exhaust the vacuum system was water-cooled; thus, tap water was run from the faucet through a vinyl hose. However, the vinyl hose had become old and had a small hole in it. Vinyl tape was wrapped around it to temporarily plug the hole. Although the researcher considered replacing it with a new one later, since there was no water leakage, it was left unchanged and the

researcher went home. That night, the pressure of the water supply increased, and water leaked from the emergency hole, flooding not only the laboratory but also the laboratory on the floor below.

(2) A researcher opened a water tap to conduct an experiment, but the water was cut off due to construction that day, so the researcher went home without closing the tap. When the water was restored, the cooling hose connected to the experimental apparatus was disconnected due to the water pressure during the restoration, and the room was flooded.

These accident examples teach us that makeshift procedures should not be used. It should be noted that makeshift measures become permanent, and ultimately result in accidents. It should also be noted that the connection points of hoses used for faucets and laboratory equipment are the places where the most trouble can occur. Many electronic devices and instruments become unusable when exposed to water, and accidents can also occur as a result of a remote cause of water exposure. In addition, reports and books are ruined when wet, which can hinder research.

## 4 Faulty electrical wiring

When wiring electrical equipment for experiments, makeshift wiring can result in accidents. For example, if two cords are not sufficiently long and are connected by simply twisting them together, after a long time, they may fail to make contact or generate heat, causing an accident. Frequently, when experimental equipment is repaired or modified, the wiring is implemented temporarily and left as it is, but after an extended period, it can cause accidents. Temporary easily turns into permanent.

## 5 Chemicals accidents

While a researcher prepared an aqueous solution of caustic soda on a laboratory table, the caustic soda solution suddenly boiled and splashed into the researcher's eye. The researcher immediately rinsed his eyes with plenty of water and rushed to an ophthalmologist, but he almost lost his eyesight. This accident occurred to a physics student who did not know how to handle chemicals. This shows that even physics students should have a rudimentary knowledge on handling chemicals and wear safety glasses. Conversely, students of chemistry and biology should also have a rudimentary knowledge on handling machinery and equipment.

## 6 Heavy objects

When lifting heavy objects, do not lift from the side or at an angle. Instead, face forward, hang your hands as deeply as possible, bend your knees, keep your hips low, and lift slowly to keep your spine vertical. Be careful not to lift too abruptly, as this may cause back pain.

When carrying objects by hand, do not carry items that obstruct your view. When carrying long or bulky items, make sure that there are no hazardous areas or obstacles on the course to prevent collisions.

# Section 3 Measures to prevent major accidents

Most laboratory accidents can be prevented if common-sense precautions are taken. However, in the unlikely event of an accident, measures must be taken to prevent severe consequences. For example:

(1) Do not experiment alone at night. It is dangerous because no one is available to administer first aid or report an emergency if you are injured, lose consciousness, or otherwise become immobile.
If students wish to conduct experiments at night or on holidays, they must fill out an "In-Person Use" form and obtain approval from their supervisor. In addition, when conducting all-night unattended operations, etc., students must fill out the "All-night Unattended Use" form and obtain instructions and approval from their supervisor. This procedure is shown in Appendix 1.

(2) In summer, do not conduct experiments in short sleeves or other clothing that exposes skin. Contact with electricity to the naked body can cause limbs to move unintentionally, causing secondary accidents by touching nearby machines, instruments, or chemicals.

Major accidents rarely occur suddenly, and in most cases, some signs are evident (e.g., malfunction of machinery or equipment, physical condition, mood, etc.). If appropriate measures are taken at the first sign of irregularity, accidents can be prevented. Of course, major accidents must be reported as described in this guide, but the experimenter should also inform the person in charge of the laboratory of even minor problems in the laboratory. The person in charge must then take appropriate measures and nip major accidents in the bud before they occur. The importance of early detection and treatment does not only apply to the body.

Researchers are professionals and students learn from them. Although experiments and research are always risky, professionals know the boundary between safety and danger and work within the limits of safety. However, working outside safe limits, or working beyond the realm of safety realm is amateurish and is unbecoming of a real researcher or engineer.