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Health and safety during work in the laboratory – Chemical Engineering
(Safety when working with chemicals)

I. General rules

The following work environment tasks apply to the responsible supervisor:

- **Ensure that employees are given relevant instructions about working methods, equipment and chemical health risks to help prevent illness and accidents in the relevant laboratory activities**

- **Ensure that risk assessments are implemented for laboratory activities where the risk of illness and accidents exists.**

All substances at the laboratory must be handled as if they were toxic, unless it is certain that they are harmless!

If you have even the slightest uncertainty regarding a chemical's properties and the correct means of handling and storage, the Material Safety Data Sheet (MSDS) must be consulted! The simplest way to find these is by performing a search on the internet; e.g., "MSDS" + "*name of the chemical*", or consulting LTU's chemical register KemRisk, www.antivenena.com/kemrisk3/index.php.

Poisoning caused by solid or liquid substances can be avoided by observing the utmost orderliness and cleanliness during all laboratory work. When working with gaseous, toxic or hazardous compounds, it is possible to protect oneself by working in a fume cupboard or closed reaction chamber.

Eye protection

Protective eyewear must always be work in the laboratory. Your own glasses or protective glasses will suffice. Those who use contact lenses must have full eye protection (motorcycle goggles style) or remove their lenses and use their own glasses.

Protective clothing

Protective clothing (lab coat or apron) is also mandatory. Protective clothing may not be used outside of the laboratory, e.g., in the kitchen.

Protective gloves

It is sometime necessary to wear protective gloves, but they must be removed when they are not needed. Any spillages on the gloves are easily spread to e.g., door

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handles, bottles and cans if the gloves are worn constantly. You should also check that the material that the gloves consist of provides protection for the work at hand. Not all protective gloves will protect you against everything!

Ear protection
When working in noisy environments, ear protection must be used. The use of ultrasound also requires protective equipment in order to avoid damage to hearing.

Protective mask/gas mask
Use a protective mask or gas mask when working in dusty environments. Note that dust can be hazardous to health and in some cases toxic. When working with powder or in situations where dangerous gases may be present or form, the MSDS must be study before work is commenced and measures taken; e.g., ensure that breathing equipment is available.

Prohibitions in the laboratory
It is prohibited to eat and drink in the laboratory. There is always a risk of chemicals coming into contact with the hands in connection with laboratory work. This means that the risk of intoxication increases when ingesting food, fruit, sweets, taking snus (a Swedish snuff product) etc. For this reason it is also important to wash your hands carefully before leaving the laboratory.

Orderliness in the laboratory
Keep the laboratory workbench and other places of work (scales, fume hood etc.) clean, tidy and free from surplus glass objects, apparatuses and chemicals. It is also important to keep the floor clear of objects that cause people to stumble or tread on and break. Outdoor clothes must be left on the hooks intended for this purpose outside the laboratory.

Electricity
Unearthed electrical equipment can cause conductors (pieces of metal, water, solutions, etc.) to become live (conductive). For this reason, you should always use protectively earthed equipment. Be sure to check that cables and contacts are whole, clean and dry.

Burners
Ensure that no combustible material is in close proximity when burners are used. Don't forget to check above the burner!

Chemicals
Laboratory flaks of concentrated acids must not be removed from their normal place of storage.
Avoid placing chemicals in direct sunlight. **Make it a habit to always read the material safety data sheet (MSDS) for the chemicals being handled.**

Waste/spills
Throw away waste into the right container: Paper in the waste paper bin, sharp and cutting waste in cardboard boxes marked glass waste (check that the boxes contain the

plastic bag intended for this purpose). Ensure no broken glass pokes up over the corner of the box. If the box is full, close it and put out a new box!
Chemicals and solvents must be collected in special containers for this purpose. *Be sure to take care of any spilled chemicals immediately* (including water).

If in doubt: Contact the personnel responsible!

Cleanup
When the lab work is finished the entire laboratory site must be cleaned and all used equipment thoroughly cleansed. Bear in mind when cleaning equipment that not all chemicals are soluble in water; it may be necessary before using water and washing-up liquid to use organic solvent (acetone is usually effective). If you are unsure what to use, please ask the laboratory supervisor. Always finish by using clean water, and perform a final rinse with deionized water (light green taps).

Common sense?!
Use your own judgement. No rules and regulations can protect you from accidents if you fail to use common sense! Never stress - stress is the best friend of accidents. Moreover, if you stress, the results are often worse than when adopting a calm approach.

Never work alone in the lab. If an accident should happen, who will help you?

Think through the risks that a laboratory session (experiment) may give rise to and be sure to plan any safety measures (protective equipment, reversal agents, etc.) in advance.

II. In the laboratory

General safety measures
All laboratories are equipped with the safety equipment necessary for the activities carried out there. Learn as soon as possible how the safety equipment functions; once an accident has happened there is no time to read instructions!

Fume hoods/cupboards
Ventilation in fume hoods (fume cupboards) and at other extraction points is generally regulated (adjusted). Find out how this regulation functions. Always check when working in a fume hood that the ventilation is working. The fume hood aperture should never be opened more than necessary.

III. Toxic substances

Always read the material safety data sheet (MSDS). Examples of especially toxic substances include:

Solid. *Cyanides, (e.g. KCN), Asbestos compounds, Pb and other particularly hazardous metals.*
Liquid. *Benzene, formalin, methanol, hydrofluoric acid and concentrated, strong*

acids.
Gaseous. *Carbon monoxide (CO), hydrogen halides (HF, HCl, HBr), nitrous gases (NO_x), halogens, sulphur dioxide (SO_2).*

Particularly hazardous metals and their salts as well as cyanides must not be poured into the sinks. They are to be collected in the indicated container/vessel. Do not use glass beakers for this; you must collect the waste in the plastic containers intended for this purpose. This makes matters easier when sending the waste for destruction. You will then need to store the plastic containers without a cork in a fume cupboard so that the water can evaporate.

All work with toxic gases, or where toxic gases may be formed, shall be carried out in fume hoods/cupboards.
This also applies to work with malodorous compounds, even if they are not toxic. H_2S gives off a strong smell already at very low concentrations (below the "hazard limit"), whereas CO, HCN and nitric oxides are odourless even at dangerous concentrations.

IV. Corrosive substances

Strong acidic and alkaline solutions are very corrosive and should be handled with great care. It is particularly injurious to get lye (caustic soda) in the eyes.
Moreover, a number of weak organic acids such as formic acid and acetic acid may, in concentrated form, give rise to corrosive damage. Hydrofluoric is especially unpleasant (see below).

Precautionary measures!
a) Use Peleus ball or other pumping device!

b) Rubber gloves should be used where corrosive substances may come into contact with the hands.

c) Take off bracelet, watch, rings or such like.

d) Never add water to concentrated acids, e.g., pure sulphuric acid. Overheating in this case gives rise to splattering. You should add the acid carefully to the water, in small portions whilst constantly stirring. Other concentrated acids should also be diluted in this way.

e) Any work where corrosive or toxic gases may be formed must be carried out in a fume hood (cupboard).

V. Flammable and/or explosive substances

Handling
Open handling of flammable liquids must be done in a fume hood (cupboard), with the exception of the small quantities used in cleansing. If open handling is to be performed outside of a fume cupboard, a risk assessment must always be performed first in consultation with the lab supervisor. This risk assessment must take into account the risks involved in handling and in particular the risk of an explosive atmosphere forming. There are special instructions for the safe handling of gas in the laboratory.

Storage of flammable goods
Flammable goods must be stored in a chemical storeroom or chemical cupboard in the laboratory. A maximum of 50 litres of flammable liquid may be kept in a buffer storage in the laboratory (according to the university's fire safety documentation). Flammable goods may not be stored together with toxic substances. Toxic substances which are also flammable must be stored as flammable goods or kept separate. Their placement is noted in the chemical register. The maximum permitted quantity of flammable liquid used in the laboratory at any one time is 10 litres.

Organic solvents may not be poured into the sinks with the exception of those that are fully miscible in water and also non-toxic **(**methanol, ethanol and acetone**).** Other solvents shall be placed in containers (vessels) intended for the purpose.

Oxidants such as HNO_3, $KClO_3$, $HClO_4$ and NH_4NO_3 may give rise to fire or even powerful explosions if they come into contact with organic materials such as coal, paper and cork!

VI. Action in event of fire

In the event of a fire, the following procedure shall be applied:

WARN those in the area that a fire or other emergency incident has occurred.
SAVE anyone in immediate danger and evacuate the premises.
ALERT the emergency services, ambulance and police via SOS via the telephone number 112.
EXTINGUISH if you feel you can manage this without taking unnecessary risks.
CLOSE the fire in.

Small fires
Very small fires can often be put out by starving them of air. If for example a small amount of solvent in a flask or cup has caught fire, this can be smothered through covering the aperture, thereby cutting the supply of air. A small fire on a workbench surface can be put out using sand. For safety's sake, however, even in this case it may be appropriate to use a fire extinguisher.
Fire on clothing can either be extinguished under the emergency shower or by starving it of air. In the latter case the person is laid down and a fire blanket, coat or similar is

moved from the head downwards over the body in order to protect the head from burns in the best possible way.

Large fires
Should a major fire occur in a laboratory this must, first of all, be drawn to the attention of other laboratory workers and the premises evacuated. Shut off the main gas tap. Turn off the ventilation and shut the door to the laboratory in order to reduce the inflow of air. Raise the alarm and evacuate adjoining laboratories if there is a risk of explosion.

VII. Hazardous operations

Hot/cold work
When working with hot processes, e.g., in the cooking chamber, a silver apron and gloves most be worn before placing samples in warm ovens or incubators or removing them. Care must also be taken when working with e.g., Bunsen burners, hot plates and heated baths. Use the correct equipment for hot work. Pyrex glass, for example, tolerates temperatures of up to 1,000 °C, whereas normal glass breaks at just 200 °C. You should also take care and use appropriate protective equipment for work involving low temperatures, e.g., the handling of liquid nitrogen.

Mechanical hazards
When using equipment with moving parts, the risk of mechanical damage (e.g., crushing) should be observed. The user must always check where the emergency stop function is located before commencing work. Power to the equipment must be cut before mechanical faults are rectified or components exchanged. Work involving over or under-pressure can entail the risk of explosion or implosion. In such cases, protective eyewear must be worn, in addition to other protective equipment. Even the use of a centrifuge can be considered to constitute a mechanical risk. A counterweight must be used to balance the centrifuge when samples are
centrifugalised. When using older centrifuges which do not have a locking mechanism, the door must not be opened until the centrifuge has stopped completely.

Radiation hazards
Radiation hazards are not only present when working with radioactive material; they can also be present when working with non-ionising radiation, e.g., ultra violet (UV) and infra-red (IR) radiation and microwaves. UV radiation is for example used for sterilisation and in certain types of analytical equipment. The risks consist primarily of eye inflammation or visual impairment, burns, and in certain cases skin cancer. Laser radiation differs from other radiation in that the effect does not decrease as the distance increases. Use protective eyewear and possibly full protective clothing and gloves where there is a risk of radiation.

Biological hazards
Working with microorganisms – e.g., viruses, funguses and bacteria – can constitute a biological hazard. These can cause infections, allergies or intoxication. When such hazards are present, gloves and face masks should be used, in addition to normal protective clothing.

Glass tubes through rubber stoppers
Take great care when passing glass tubes through rubber stoppers and corks, when inserting rubber tubing into a glass tube or when placing a Peleus ball on a pipette. Glass slides much more easily through the rubber if it is moistened with water or glycerine. Glass tubes and glass rods must always have round bulbs at the ends.
Broken glass, and other glass waste, shall be thrown into special boxes for sharp and cutting waste and never into ordinary waste bins. The waste paper bins are solely intended for paper waste and similar materials.

VIII. If an accident should happen

In the event of serious accidents, immediately contact:

Fire Brigade: Phone **112** and request the "Fire Brigade".
Or activate the direct alarm using the "Brandlarm" button in the corridor. Even if the "Brandlarm" button has been pressed, you should still call 112 in order to provide additional information to the emergency services.

Ambulance: Phone **112** and request "Ambulance".

State name, address and type of damage or accident as well as number of injured.
Best entry point for the C500 corridor is C12 (Teaching Lab) or C14 (Research Lab).
Best entry point for the F1300/F1400 corridors is F13 (from Regnbågsallén).

Go to Meeting Point, Car Park STIL, C Building.
Go to Meeting Point, Car Park behind F-Building (exit F18).

Swedish Poisons Information Centre: Phone **112** or **08-33 12 31**.
Provide information on the chemical substance's acute toxic properties (and First Aid information, where appropriate).

Be precise/take care in informing hospital personnel about the type of injury, especially in the case of chemical burns, since hospital personnel in these cases cannot always be familiar with all the details relating to such
injuries. If at all possible, take with you the chemical product information sheet. In the case of non-emergency transport to hospital, e.g., by taxi or car, someone else must accompany the injured person even if this person thinks he/she is able to manage alone.

Every accident/incident with personal injury, even where apparently insignificant, must be reported to the head of division without delay. Log_in to Primula to download the incident report form:
https://www.ltu.se/primula/switchToSwe.do

IX. First Aid in case of accident at the laboratory

Injury	*Action*
Cutting wound	Wash with wound cleansing solution or alcohol. Apply a sterile compress.
Burn injury	Cool the burn injury as soon as possible and long enough, ten to fifteen minutes with **cool water**. If possible, you can immerse the injured body part in a bucket of cool water or rinse under the tap. If it continues to hurt, you can add a wet towel or ice pack wrapped in a towel on the injury. If the skin only becomes red no bandage is needed. If you have blisters and sores it is good to protect the injury with a sterile compress that will not stick to the wound. You should seek medical care directly at a medical centre or an emergency clinic if; • the burn injury is on a sensitive area such as the face, hands or feet, genitals, or major joints, i.e. shoulders, elbows, hips and knees • the injury is caused by chemicals or electricity • you have breathed in smoke.
Eye injuries	Rinse properly and for a long period (10-15 min. in case of acid, 20-30 min. acid base). In the case of acid, alkali or similar, use tepid water. Ensure that the eye is open during the rinsing process. If possible, continue rinsing until it has been possible to contact and consult a doctor. Always seek a doctor.
Acid on skin	First wash properly with water and then with 2 % sodium hydrogen carbonate aqueous solution. Disinfect with wound cleansing solution or alcohol.
Alkali skin burns	Wash with plenty of water and then with 1 % acetic acid. Disinfect with wound cleansing solution or alcohol.
Hydrofluoric acid (HF, aq)	First, rinse properly with water. Then administer calcium gluconate gel. When working with HF, an antidote in the form of calcium gluconate gel must always be available to hand.

X. Actions in case of spills on tables, workbenches, floor etc.:

Acids	Rinse properly with water, neutralise where possible with solid $NaHCO_3$, Na_2CO_3 or, where appropriate, $CaCO_3$. For hydrofluoric acid, see below. Check with a pH indicator that neutrality has been reached.
Alkali	Rinse properly with water, neutralise where possible with solid $NaHSO_4$ or other weaker acid, e.g., citric acid. Check with a pH indicator that neutrality has been reached.
Bromine, iodine, chlorine water	Render harmless with a saturated solution of $Na_2S_2O_3$ ($\Rightarrow$ reduction to halides).
Cyanide solutions	Absorb with vermiculite and gather up (gloves!). Store in a gastight vessel and ventilated cupboard. We do not destroy cyanides ourselves; we send the waste away for destruction.
Hydrofluoric acid (HF, aq)	Render harmless with $CaCO_3$ ($\Rightarrow$ neutralisation and precipitation of CaF_2).
Acidic organic compounds (liquids)	Neutralise where possible with solid $NaHCO_3$ or Na_2CO_3. Rinse properly with water,
Basic organic compounds (liquids)	Neutralise where possible with solid $NaHSO_4$ or another weaker acid such as citric acid. Rinse properly with water,
Organic solvents, chlorinated solvents carbon disulphide	Absorb with vermiculite and gather up (gloves!). Store in a gastight vessel and ventilated cupboard. We do not destroy cyanides ourselves; we send the waste away for destruction.
Flammable liquids	Wipe up with absorbent towels or absorbent material such as vermiculite. Use chemical protective gloves and respiratory protection. In the event of small spills, allow the flammable liquid to evaporate in the fume

hood (cupboard). In the event of large spills, the workplace must be blocked off, electronic equipment unplugged and the emergency services contacted.

Vermiculite (found in the lab) can be used to absorb many different chemicals (not HF), but is only used for collection and not destruction. For this reason, vermiculite must also be gathered up thereafter and stored in a safe manner.