SAFETY REGULATION 2024

Department of Biological and Chemical Engineering

AARHUS
UNIVERSITY

Content

SAFETY

AT THE DEPARTMENT OF BIOLOGICAL AND CHEMICAL ENGINEERING AT AARHUS UNIVERSITY

INTRODUCTION

These safety regulations apply to all employees, guests and students at Department of Engineering, BCE. Everyone working in the laboratories at the department must be familiar with the content of this Safety Regulations file. After reading the Safety Regulations, you can evaluate your knowledge by completing the Safety Quiz on Brightspace.

The Safety Regulations describes general safety rules that everyone must be familiar with. In addition, there are specific rules, such as working with GMO, human material, the safety guidelines on the diploma education, gasses, etc., which one must aware of if working in these areas. This must be confirmed in writing before working in the laboratories.

Laboratories may be dangerous workplaces. Therefore, think the work process through and evaluate your working procedure regarding dangerous situations (overpressure, gas development, fire hazard etc.). Use the necessary safety equipment to conduct the experiment safely. To help considering all of the risk, you need to fill out a “Chemical Risk Assessment”.

It is impossible to cover every possible situation and techniques in these Safety Regulations. It is therefore the responsibility of all group leaders to provide instruction in the safe use of special techniques. Concurrently, it is everyone’s responsibility to seek information that is necessary to work safely.

The project manager has always the overall responsibility of ensuring that the work is carried out in a safe and responsible manner. In the event of an accident, it is the responsibility of the project manager to take the necessary action. This may be done in collaboration with the Working Environment Organization.

New employees and students are thoroughly instructed in work procedures and safety rules. If there are any doubts, it is important to ask.

CALLING FOR HELP

In case of fire, accidents, or other life threatening situations occuring at Aarhus University, first call:

Emergency
Call 112

Emergency room (in case of non-life-threatening accidents)
Call 70 11 31 31
You are not allowed to show up at the emergency room without calling the doctor first.

Weekdays between 8-16: call your own doctor.
On weekdays between 16-08, as well as weekends and holidays: call the Emergency Room:
Call 70113131

In case of fire, bigger accidents, bomb threats, and related events, call AU´s emergency number (**after** you have called the Emergency 112 first) - **87 15 16 17**

COMMUNICATION PROCEDURE

If an accident occurs, the procedure for Communication is as outlined below. The advantage of a defined communication system is that everyone should know when and who to contact for further information.

In case of an accident or a "near-by" accident and when relevant, the following procedure must be followed:

Action	Responsibility	Time
First aid and emergency call	Teachers/instructors/ students/employees	Immediately
Information to manager and AMR (Work Environment Representant, WER) immediately after the accident.	Responsible teacher/supervisor/ employees	Immediately
Contact the injured regarding clarification of the accident.	Work Environment Representative	Immediately
Contact the family of an injured person	Work Environment Manager (Morten Dam Rasmussen)	Varies dependent on the extent of the incident
Contact teachers/instructors regarding clarifications of the accident	Work Environment Representative	3 days after the incident at the latest
Contact other students for mental debriefing and information.	Work Environment Manager (Morten Dam Rasmussen)	The day after the incident at the latest
Evaluation of the accident or near-by accident and implementation of actions	Work Environment group	2 weeks after the incident at the latest

FIRST AID

In each lab there is a file with an overview of first aid procedures. This material can be removed and taken to the site of the accident, or out of the building in case of evacuation. There is also an overview of the relevant emergency numbers.

Note that the First Aid Procedures do not always follow the order outlined by the three main points in the First Aids (see below). The reason for this is that First Aid's three main points are general and formulated by the Danish Emergency Management Agency, and the action plan for specific injuries are formulated by doctors in relation to each individual type of injury.

All laboratories are equipped with emergency showers and hand showers, which can be used to extinguish a fire on people or to wash out the chemicals from people in case of chemical spills.

In several places in the building, **safety cabinets are provided with equipment so that emergency aid can continue in the event of an evacuation**. On the next pages are the first aid procedures as found in the laboratories.

THE THREE MAIN POINTS OF FIRST AID:

1

Stop the accident / create safety

1. Get an overview

2. Secure yourself and the injured person

e.g. by:

- Extinguish fire
- Disconnect power
- Relocate an injured person
- Close the fume hood/door
- Evacuate the building

2

Provide first aid

Use the ABC rule

A. – Airway

(Clear blocking of the airways, eg. Tilt head back)

B. – Breathing

(Check for breathing - look, feel, listen)

C.– Circulation

(Check and treat bleeding)

Eg.

- Stop heavy bleeding
- Provide heart-lung rescue

3

Alarm by calling 1-1-2

- State where the accident occurred (name, address, city, telephone number)
- What happened (the incident, chemicals, trapped people, special help)
- How many injured
- Send a person out to receive the ambulance

CHEMICAL BURN IN THE EYE

- Start treatment as fast as possible to avoid further damage
- Make sure there is no contact lenses that prevent rinsing
- Rinse the eye(s) by using: eyewash bottles, tap water or other non-corrosive liquids which you have access to
- The eyes must be actively kept open to ensure effective rinsing
- Rinse for at least 30 minutes

Use of eye wash bottles

Eye wash bottles are on the wall in a box or integrated at the water tap. Make sure you know the location of the eye wash bottles before they are needed.

Working alone

- The bottle is opened by turning the lid or by simply taking it down from its holder
- Bend over the bottle
- The eye must be opened completely with the help of thumb- and forefinger
- The eye cup is gently pressed against the eye – still with the eye open
- Flush thoroughly by pressing the bottle repeatedly
- In severe chemical burns, an reflective eye closure follows, which is why the affected person cannot adequately wash his/her own eye and the nearest person must help

Standing or sitting person

- Helpers open the affected eye with thumb- and forefinger
- The eye cup is kept a hands-width away from the eye
- Flush thoroughly by pressing the bottle

Person is lying down

- Open the bottle
- Helpers open the affected eye with thumb- and forefinger
- The eye cup is kept a hands-width away from the eye
- Flush thoroughly by pressing the bottle

For more information:
https://www.youtube.com/watch?v=-P9CUT1XS5k

CHEMICAL BURNS ON SKIN

- Remove the cause of the chemical burn
- Wash the chemical off from the skin using 25-34 degrees running water. If the corrosive chemical is a powder-like substance, brush it off before washing
- Remove clothing and jewelry that has been contaminated with the chemical
- Wash for at least 20 minutes under the tap or emergency shower. Some chemical burns need to be washed for many hours
- Minor chemical burns (typically a few centimeters) usually heal without further treatment
- For larger chemical burns, contact the emergency room

For more information:
https://www.sundhed.dk/borger/patienthaandbogen/akutte-sygdomme/foerstehjaelp/varme-og-kulde/brandskade-kemisk-aetsninger/

POISONING

CALL THE POISON INFORMATION – **82 12 12 12**

Base and acid chemicals

- Remove any visible matter residue. Give something to drink (water or milk) quickly, but **do NOT induce vomiting**.

  Call a doctor. While waiting for help you can:

  - Place the person in recovery position and watch the person
  - Wash remains of the chemical on the skin with a lot of water
  - For residues in the eye, see eye damage

For more information:
https://www.sundhed.dk/sundhedsfaglig/laegehaandbogen/akut-og-foerstehjaelp/tilstande-og-sygdomme/foerstehjaelp/forgiftninger/forgiftning/

POISONING - GASES

In general, when working with gases, it is important to assess the situation before approaching an unconscious person. There may be a potential risk that there will still be gas leaks and thus toxic gas present in the laboratory.

Toxic gases:

When the person is **awake:**

- Get the person out in fresh air
- Place the person warm and comfortably half-seated
- Call for help
- Pay attention to whether the person is breathing or not. If the person stops breathing, start cardiopulmonary resuscitation (CPR)

When the person is **unconscious but breathing**:

- Get the person out in fresh air
- Provide free airways
- Place the person in recovery position
- Call for help
- Pay attention to whether the person is breathing or not. If the person stops breathing, start cardiopulmonary resuscitation (CPR)

For more information:
https://www.sundhed.dk/sundhedsfaglig/laegehaandbogen/akut-og-foerstehjaelp/patientinformation/forgiftninger/

MINOR BURNS

- Cool the burn as soon as possible by immersing the burned area in cool water or alternatively under running temperate water (12-18 degrees) for at least 30 minutes
- If the above is impractical, cool with cold towels. Cooling down the burn reduces swelling by transferring heat away from the skin. Do not put ice on the burn. If cooled quickly, 30 minutes may be enough. Cooling for more than three hours has often no effect on the skin, but may relieve pain.

For more information:
https://www.youtube.com/watch?v=42oRlGiwDCk

MAJOR BURNS

- Call 112

While waiting for the ambulance or the doctor, follow these advices:

- **Do not remove burned clothes**. Ensure that the injured person is no longer in contact with burned material or exposed to strong smoke or heat
- Ensure that the injured person is breathing. If the person stops breathing, ensure that there is nothing blocking the airways. If necessary, start mouth-to-mouth resuscitation
- If possible, immediately cool with water, or cover the burned area with a cool wet sterile bandage/clean cloth.
- Look for signs of shock (confusion, decreased consciousness, weak pulse, rapid breathing, cool pale skin, clammy skin).
- Place the injured person with the legs raised, if possible
- Monitor regularly vital functions such as level of awareness, heart rate and breathing until help arrives

For more information:
https://www.sundhed.dk/borger/patienthaandbogen/akutte-sygdomme/foerstehjaelp/varme-og-kulde/forbraendinger-brandskader/

BURNS TO THE FACE AND HEAD

Call 112 immediately:

- Explain that you suspect respiratory injury and that the person has respiratory problems
- Improve air supply by e.g. loosen tight clothing around the neck

When the person is unconscious:

- Make sure the injured person breathes
- Place the injured person in recovery position and continue to monitor the breathing
- Prepare to begin resuscitation if necessary
- Cool down the burned area
- For cooling use a bottle or jug so that you can pour the water. Put a towel or similar over the shoulders to collect water. Let it run for 10-20 minutes

For more information:
https://www.sundhed.dk/borger/patienthaandbogen/akutte-sygdomme/foerstehjaelp/varme-og-kulde/forbraendinger-brandskader/

ELECTRIC SHOCK

- Call 112
- Look first. Do not touch the person who may still be in contact with the electrical source. By touching the person you can also get an electric shock
- Disconnect power if possible. If this is not possible, move the source away from the injured person using a non-conducting object e.g. cardboard, plastic or wood
- As soon as the person is free of the electrical source, check if the person is breathing and has a heart rate
- By no or very weak pulse, initiate heart-lung resuscitation
- If the person is unconscious or pale and shows other signs of shock, place the person with the head slightly lower than the body and with the legs raised
- Unconscious people who breathe and have a pulse should be placed in recovery position
- Cover major burns to prevent evaporation

For more information:

www.sundhed.dk/borger/patienthaandbogen/akutte-sygdomme/foerstehjaelp/varme-og- kulde/elektrisk-shock/

PUNCKTURE WOUNDS

Puncture wounds are defined as the type of wounds sustained by injuries from pointed, sharp objects.

First aid

- Stop bleeding. You can, if necessary: Press a clean bandage or cloth against the area, keeping the wound site high.
- Clean the wound and remove foreign objects. Use water and preferably a disinfectant cloth at the end.
- Cover with dressing/patch.

Medical care?

- Most needlestick wounds can usually be treated yourself, however, in the following circumstances they may be necessary to go to a doctor/emergency room:
- If the puncture wound is deep or unclean.
- If there is suspicion of metal or glass splinters or other foreign body deep in the wound.
- If the bleeding does not stop.
- If the wound yawns widely, it should be stitched or glued at the doctor's office.
- If the wound is on the face or close to joints.
- If tendons or bones are visible.

If the wound does not heal, or you see that the surrounding skin becomes red, swollen, suppurate, and warm, or you get a fever - you should consult a doctor immediately.

More info:
https://www.sundhed.dk/borger/patienthaandbogen/akutte-sygdomme/foerstehjaelp/saar-og-bloedninger/punktsaar-stiksaar/

IMPORTANT PHONE NUMBERS

Person/Unit	Name	Phone number
Emergency Center		112
Out of office hours doctor/emergency room (16:00-8:00 and weekends and hollidays)		70 11 31 31
Poison Information		82 12 12 12
Out of hours dentist (At acute tooth damage, out of office hours)		40 51 51 62
Work Environment Manager	Morten Dam Rasmussen	25 15 27 55
Work Environment Representative	Trine Thomsen Maja Staffeldt Pedersen	60 95 07 85 93 50 87 21
Building responsible	GWV: Peter Rene Kitler Aabogade: Sebastian Bjerge Hangøvej: Sebastian Bjerge Universitetsbyen: Leif Østergaard Foulum: Ebbe Birk Biogassen: Ebbe Birk	23 43 38 63 93 52 22 67 93 52 22 67 28 99 20 37 87 15 12 24 87 15 12 24
AU emergency number		87 15 16 17
Police (not emergency)		114

FIREFIGHTING

Fire alarm button

For firefighting, you must have the knowledge and skills needed to act appropriately in the event of a fire.

If it is necessary to evacuate:

1. Press the button in the red boxes hanging around (the fire alarm button) – they call the fire department. Then, start the evacuation of the building.

   If there is no fire pressure, call 112 and get help from others who can help the building evacuation procedures
2. Put on the yellow vest (evacuation leader) and follow the laminated instructions on the yellow paper.
3. If you are number two at the evacuation equipment, put on the orange vest (assembly point leader) and follow the laminated instructions on the orange paper.
4. Otherwise, make sure to get out and go to the assembly area.

It is everyone's responsibility that the building is evacuated.

Vests for Evacuation Manager and Site Assembly Manager

THE FOUR MAIN PRINCIPLES OF FIREFIGHTING

1

SAVE PEOPLE

Warning of endangered people - including evacuation of the building - by activating the fire alarm. Rescue of people who cannot move by themselves. If injured, first aid e.g., mouth to mouth should be included in this step

2

CALL THE FIREFIGHTERS

Call 112. Be prepared to provide information regarding the reason of your call (that the building is burning), where is the incident (exact address), details of any injured person and the phone number you are calling from. Remember to inform if the fire is due to chemicals

3

LIMIT THE FIRE

Close doors and windows. Close the gas and remove any pressure bottles and flammable material without endanger yourself or others

4

FIGHT THE FIRE

Use proper extinguishing equipment

FIRE CLASSES

Type of fire extinguisher		 **Fire class A** Solid materials like wood, paper, textiles etc.	 **Fire class B** Liquids	 **Fire class C** Gasses	 **Fire class D** Metals like magnesium, aluminium etc.	 **Fire class E** Power plants	 **Fire class F** Vegetable oils, fat etc.
Water (pressure extinguisher/ Fire hose)		YES	NO	NO	NO	NO	NO
Powder extinguisher ABC		YES	YES	YES	YES/NO***	YES**	YES
CO2 extinguisher		NO	YES	YES	NO	YES	NO
Foam extinguisher		YES	YES	NO	NO	YES/NO*	NO
Fire blanket		YES	YES	NO	NO	NO	YES

* Depends on the extinguisher's approval according to DS/EN3, typically up to 1,000V at a distance of 1.0m.
** Electronics and IT equipment can be damaged.
*** Some metals, such as magnesium, it is not good for this extinguisher. Here it is better to use sand, for example, which is in the safety cabinet.

RESONSIBILITIES

SUPERVISORS, STUDENTS, EMPLOYEES, AND LABORATORY TECHNICIANS

This section is about the responsibilities. The idea is to make sure that it is clear who does what and who is responsible for what.

YOUR RESPONSIBILITY AS A STUDENT

- Always **prepare** before class. Your must have **read the protocols** beforehand, assessed the risk of the experiment and experimental design, and take the necessary precautions
- Before starting up experiments, you must have considered **waste management** (how to collect and dispose waste)
- Make sure that the experiments and experimental design have been **approved by your supervisor** before you go to the laboratory
- **Never work alone** in the laboratory. Bachelor, master and PhD projects must be approved by the researcher or supervisor before the students would be working alone in the laboratory
- You must always know where the various **safety and emergency equipment** are located before working in the laboratory
- Students at Danish universities are not covered by the University insurance. **As a student, you have to have your own insurance**
- You should inform your supervisor if you are **pregnant** so we can help planning your laboratory work
- You should inform your supervisor if you have an **illness** that may affect your laboratory work
- In the first semester you must attend a **mandatory safety course**
- Each semester you must perform and pass a **mandatory safety quiz and comprehend the safety cabinet** before you can start up your laboratory work
- Inform the Work Environmental Organisation of any irregularities
- You should have obtained the necessary guidance on all laboratory equipment before use. This applies to standard laboratory equipment (centrifuges, scales, pipettes, etc.) and to special equipment (GC, cell sorter, etc.)
- Daily **safety in the laboratory**

RESEARCHER AND SUPERVISORS' RESPONSIBILITY

- Ensure that the **Safety Tour** has been performed (with a signature) by everyone working in the laboratory
- **Risk assessment** of the given protocol/method/chemicals. This must be available for all experiments and experimental setups and be signed by the student and researcher or supervisor
- **The risk assessment** must be sent to the laboratory technician for their information
- **Choice** of analysis/equipment
- Advice of what chemicals to purchase and use
- **Risk assessment** of chemicals before purchase
- Accommodate the **principles of substitution**. The substances that are the least toxic must always be used. This means on-going replacement of toxic chemicals with less toxic chemicals, whenever it is possible
- **Cleaning of laboratory** and disposal of chemical waste daily and after completion of project
- **Notifying laboratory technicians** of new students and duration of projects

LABORATORY TECHNICIANS/ASSISTANTS RESPONSIBILITY

- Everything related to the **practical work** in the labs
- **Help with purchasing** of laboratory equipment and chemicals
- Information of equipment in storage (including pots, buckets etc.)
- **Guidance to the practical** work of standard equipment (pH, centrifuges, HPLC, GCMS etc.) – this means no design of protocols/methods
- Introduction to the safety equipment including the Safety Cabinets
- Control of cleaning after completion of projects (bachelor, master, PhD)

It is EVERYONE's responsibility to create a safe place to work! If you see something inappropriate/dangerous, raise your voice!

GOOD LABORATORY PRACTICE (GLP)

THE DO´S AND DONT´S

GLP describes the THE DO'S AND DON´TS in the laboratory. It is the most important approach to good behaviour which ensures not only safety but also that you become a better engineer/researcher. GLP is a very important part of the working culture in Denmark.

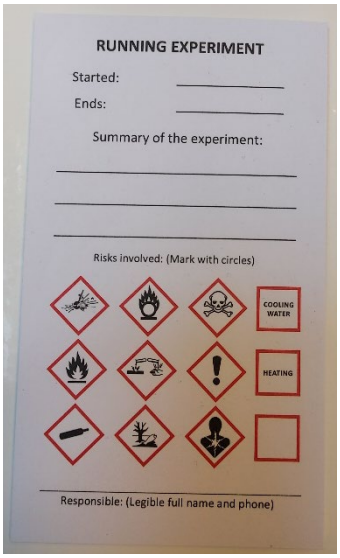
DRESS

- Always wear **safety glasses and a sealed lab coat** where required
- Take off your lab coat when leaving the laboratory
- Wear **long pants**
- Safety shoes might be required
- Transport the lab coat outside the laboratory in a sealed plastic bag
- No high heals or open shoes
- Scarves are allowed if there are no loose parts. Long sleeved clothing must be covered with the lab coat. The lab coat must be made of cotton or similar fire inhibiting material. It should be possible to remove the lab coat quickly in the event of an accident (e.g. acid). It must be possible to comply with other safety regulations (e.g. safety glasses)
- **Contact lenses are not recommended** in the laboratory (it prevents proper rinsing of chemicals in the eyes). If you wear contact lenses, wear a note on your lab coat ("I wear contact lenses")
- **Long hair** must be set up so that it is not caught by rotating machines or ignited by open fire e.g. a Bunsen burner
- **Do not wear jewellery during the work**. It might be damaged by chemicals and it may prevent efficient rinsing and hereby bring chemicals and microorganisms in contact with the skin

AU Foto, Lars Kruse

BEHAVIOUR

- **Hands must be washed** as the last thing before leaving the laboratory
- **Walk calmly.** Never run or make sudden movements
- Ensure **tidy- and cleanliness.** Clean and leave the work area as you wish to find it yourself
- Do not store things on the floor (equipment, boxes, waste etc.)
- Experimental setups that should be used more days must be marked with name, group number/name, e-mail/phone. Unmarked setups will be removed without warning.
- **Bags are forbidden in laboratory and process areas,** and preferrable not in the hallways
- Cell phones and labtops can only be in the laboratory if agreed with supervisor
- **No food or drinks in the laboratories and process hall.** Laboratory glassware or other equipment are prohibited for use with beverages or food
- It is forbidden to work in laboratories **after consuming alcohol or narcotics**
- Wipe tables before and after work. Use a cloth with the required detergent
- Dispose waste properly. If any doubts, contact your supervisor/the laboratory technician
- At the end of the day, chemicals are either put back in the chemical cabinet or in a temporary storage room
- Certain chemicals with the hazard/ skull pictogram and the "Ray Man" (GHS06 and GHS08) must be kept locked. After use, these chemicals must be returned to laboratory technician or supervisor.
- Never pipette by mouth
- Never pour excess chemicals back into the bottle (avoid contamination).
- For acid/water mixtures: put the acid in water, not the other way around.
- Water on the floor must be wiped up immediately to prevent slippery floors
- Chemical spills must be removed immediately in accordance with instructions for the specific chemical
- If you use headphones/earpods/earbuds in the laboratory, if possible, only fit it in one ear and keep the sound volume down. Using earbuds can reduce your awareness of the surroundings, which can increase the risk of accidents. It is also important that you are able to hear warning alerts and important instructions.



You can use these post-it notes to mark your experiment when you leave your setup.

AU-foto – Jesper Rais

TIDYING UP AND CLEANING

Everybody has the responsibility to keep the laboratories nice and clean. All emergency exits must be accessible and not blocked by e.g. boxes or trolleys.

Having a tidy and clean laboratory makes the workplace safer and results in laboratory work of higher quality

Chemicals

- Chemicals must always be stored in cabinets or on shelves and never on the floor
- When you finish your day-to-day work in the laboratory, all chemicals should be stored in chemical cabinets
- Regarding chemical waste, see more in the "handling of chemical waste" paragraph.

Paper, gloves, glass and syringes

- Paper and gloves that are not contaminated with microbiological or toxic and smelly chemicals must be disposed in the normal waste bin
- Paper and gloves that are contaminated with organic solvents must be left for evaporation in the hood over night before it must be disposed as normal waste. Remember to come up and have it thrown away yourself or make an appointment with one.
- Glass waste (disrupted glass): must be disposed in "chemical glass waste"
- Syringe needles are disposed in the yellow buckets intended for syringe needles and scalpels. **Never disposed needles or scalpels in any other waste containers.**
- Microbiological waste must be autoclaved before it is disposed. (there is some exceptions - discussed with group leader to be sure)
- **Everybody must help emptying the normal waste buckets** (in the waste container "smått brandbart")
- As much as possible, avoid having paper or cardboard in the lab – as it can potentially absorb and thus spread it unsuspectingly to unwanted places and people.

Yellow container for syringes and scalpels

Cleaning of glassware and automatic pipettes

Glassware and pipettes must always be cleaned after use. Chemical residues on the glassware can affect your experiments.

- Use the sorting instructions to make sure your waste is disposed in the right way (see "handling of chemical waste" section)
- Leave the equipment to evaporate in the fume hood for the next day (if there has been organic solvents in it). Remember to come back and have it thrown away yourself or make an appointment with one.
- Washing up manually: wash with tap water, rinse three times with demineralized water, put aside for drying (in a rack or in the oven)
- Washing up using a dishwasher: Follow the manual placed at the dishwasher. Put the dirty things in a tray or on a trolley and it will be taken care of. Not all locations has this agreement.

Empty solvent bottles

- Note the date on the bottle
- Leave in the fume hood over night
- Dispose in "chemical glass waste"

SAFETY EQUIPMENT

PERSONEL PROTECTION, VENTILATION AND EMERGENCY EQUIPMENT

Safety equipment covers all the equipment that protect you both preventively and in case of accidents. It is split into personal protective equipment (e.g. safety glasses, gloves, lab coats), ventilation (e.g. hoods, point suction, LAF-benches) and emergency equipment (e.g. fire extinguisher, fire blanket, emergency shower).

PPE (Personal Protective Equipment)

Safety glasses

- **Safety glasses must always be used** unless a clear dispensation has been granted
- **Contact lenses are not recommended.** If they are used, there must be a clear sign on the lab coat "I wear contact lenses""
- Safety glasses must have a **side shield** and a **cover on the top,** so splashes are less likely to hit the eye
- Safety glasses must be made of clear resistant plastic (polycarbonate) with certificate EN166F
- Safety glasses have the following rating of safety classes: EN166S < EN166F < EN166B
- EN166F means that the safety glass can withstand a steel ball of 6 mm, weight 0.86 g and speed 45 m/s

Gloves

- Gloves are intended for **protection against absorption of skin penetrating substances.** Wear gloves with care. One should be aware that excessive use of gloves can cause skin irritation. It should always be used when working with corrosive, harmful or infectious substances
- Chemicals can break through the glove and then we talk about **breakthrough time.** Breakthrough information can be found online. (see point 8.2 in the safety data sheet (SDS) for the chemical used)
- Change a contaminated glove immediately. Never recycle disposable gloves
- Change gloves immediately if cracks/holes occur
- We use TouchNTuff nitrile gloves that is a good all round glove
- 4H gloves are also available (See the Safety Cabinet or contact the local lab. Tech.).
- The gloves are removed after lab work to avoid contaminating handles, objects, etc.

Always remove the gloves when leaving the laboratory

Lab Coat

- Lab coats are not only used to protect the clothes but also to protect against harmful substances and against fire
- The lab coat should be washed or disposed after contact with hazardous substances and materials
- The lab coat must have buttons in the front so it allows for quick removal in case of emergency. Push buttons are preferred as they are quicker to get off.
- The lab coat must be made of cotton or other fire resistant material

Safety Shoes

- Must be approved according to safety class S1 or higher
- Safety shoes has the following ranking of safety classes: S1 < S1P < S2 < S3
- Safety class S1: Steel or aluminium cap over forefoot, shock absorbing, closed heel, antistatic sole, oil resistant

Hearing Protection

- Hearing protection may be required when using some of the equipment at BCE.
- The Work Environmental Authorities recommend to use hearing protection if the noise level exceeds 80 dB (average over an 8 hours working day), if peak values exceed 130 dB, or the noise load is otherwise harmful or annoying.
- You should always use hearing protection if the noise level is so high that it hurts the ears or if ultrasounds baths are used
- If you are in doubt about the noise level, you should always wear hearing protection. Alternatively, you can test this with an app (e.g. https://www.av.se/en/health-and-safety/noise/mata-ljud-och-buller/noise-exposure-app/)

VENTILATION

LAF bench

- Laminar flow (LAF) bench **protects the samples** against being exposed to environmental contamination
- Some LAF benches also protect the person against contamination from the sample. Look at the LAF bench to see what it covers
- LAF are used for microbial work to ensure the biological purity of the sample
- Sterile air is blown into the bench and traps particles
- Before starting work on the LAF bench, switch it on for 10 minutes to reduce the number of germ counts in the work area

To ensure sterile conditions:

- Avoid violent arm movements (turbulence)
- Unnecessary bottles and equipment must be removed
- Always work with the smallest possible opening
- Wash hands before and after work to avoid contamination
- Table is washed with 70% ethanol before and after work
- Waste racks with autoclave bags are placed in the back of the cabinet and when the work is finished, the bag is closed with autoclave tape and autoclaved
- Avoid movements that interfere with the material to be kept germ free

Fume hood

- **LAF protects the environment** from being exposed to contamination and vapours from the sample /chemicals.
- Use when working with hazardous or smelly chemicals, fumes, gasses or dust.
- The air in the hood is changed and ventilated when the hood is on.
- Check the hood is on when working in it.
- To ensure optimal conditions:
  - Avoid violent arm movements (turbulence)
  - Unnecessary bottles and equipment must be removed
  - Always work with the smallest possible opening
  - Make sure to always keep head and face above the bottom edge of the hood lid
- If an alarm go off in the fume hood, do the following:
  1. Pull the sash window down and see if the alarm stops
  2. Check the ventilation using a small piece of paper taped to the edge of on the bottom of the sash window.
  3. In case of any defect, place a sign on the bench "Out of order, must not be used"
  4. Contact a laboratory technician or a supervisor

Point suction

- **Partly protects** the environment from being exposed to contamination from the sample
- Can only be used for reduction of non-hazardous gasses
- Suction is only efficient within 15 cm from the sample

EMERGENCY EQUIPMENT

- **Safety Shower.** Optimal for extinguishing fire in people or for rinsing chemical spills of clothes and body.
- **Fire Extinguisher** CO2 fire extinguishers are at different places in the buildings. See the "fire-fighting" section for when which extinguisher is recommended
- **Fire blankets** are for extinguishing small fires in pots, trash bins etc. They are very suitable for extinguishing fire in lying persons. Standing persons must be laid down in order to prevent the flames from spreading to the face
- **Eye flush bottles** are located in several locations in each laboratory. After use, dispose the rest of the bottle
- **Eye showers** are located by the sink in many laboratories and is used just like a rinse bottle – however, it uses water from the tap so it does not run out
- **Safety Cabinets.** Here is material for cleaning up after spills and new clothes for change in case your own clothes have been contaminated.

DAILY SAFETY IN THE LABORATORY

What can happen to this chemical reaction? How would you react if you or your neighbour get some of the sample in their eyes? It is usually seconds and not minutes that counts. Get used to thinking about safety as a normal part of your work.

Safe work in the laboratory implies that you:

- Consider whether the chemicals you work with are dangerous or not and what **safety equipment** to use
- Have performed a **risk assessment** of your experiment and experimental setup
- Are sure how to **handle waste.**
- Have received an **instruction** on using the equipment. This is especially important regarding equipment that can get very hot, has rotating parts or otherwise can be of any risk
- Know the **locations of emergency equipment and exits** and know the procedure for using them

Before starting the laboratory work, the following must be ensured:

Make sure you know the location of safety equipment such as fire extinguishers, fire blankets, eye flush bottles, emergency showers, emergency exits, safety cabinets etc.

For all of your experiments evaluate if there is:

- Risk of burns (e.g. heating large quantities of water or oil, dilution of acids and bases, exothermic reactions)
- Risk of burns using open fire (e.g. tightness of hoses, loose clothing/hair, development of flammable gases)
- Risk of accidental contact with hazardous chemicals/gasses (stings from boiling liquids, penetration of gloves, development of gasses)

If any of the above-mentioned issues are relevant, action must be taken to avoid the risk factor. Ask your supervisor or the laboratory technician if in doubt.

In the following section, we will go through labelling of chemicals prevention and risk assessments, Chemical Risk Assessment, sorting of chemical waste and electrical safety. These are all factors that will increase the safety of the laboratory.

CHEMICALS

All chemicals are stored in ventilated cupboards. All chemicals are labelled with a unique number - **CAS number** – that identifies the chemical and that can be considered as a kind of "serial number".

CLP REGULATION

CLP is an abbreviation for Classification, Labelling and Packaging of substances and mixtures. The regulation was introduced in Europe in 2009 and replace a former regulation (the one with the orange danger symbols). The old regulation is phased out. If you come across the old labelling, let your

supervisor/laboratory technician know so that the chemical can be removed or updated. You will only be taught the new system.

The CLP regulation is based on the UN Global Guidelines regarding classification and labelling - GHS (Globally Harmonised System). It ensures that workers and customers in the European Union are clearly informed of the dangers associated with chemicals through the classification and labelling of the chemicals. All chemical substances and materials must be classified and labelled in accordance with the rules of the CLP Regulation.

H-sentences

Hazard sentences indicate the hazards associated with handling the hazardous substance or product

- **H200-H299** Indicate physical hazards
- **H300-H399** Indicate health hazards
- **H400-H499** Indicate environmental hazards

P-sentences

Precaution sentences indicate which safety precautions are to be taken, how the substance or product is to be handled, stored and disposed, and what to do if you experience a spill or an accident.

- **P200-P299** Indicate preventive measures
- **P300-P399** Indicate precautions regarding reactions that may occur
- **P400-P499** Indicate precautions regarding storage
- **P500-P599** Indicate precautions in connection with disposal

Hazard Pictograms

PHYSICAL HAZARDS

GHS01 – EXPLOSIVE SUBSTANCE
This pictogram means explosive, self-reactive substances and organic peroxides, which may cause an explosion when heated.

GHS02 – FLAMMABLE
This pictogram warns against flammable gases, aerosols and solids.

- Self-reacting substances and mixtures.
- Pyrophoric liquids and solids that can ignite on contact with air.
- Substances and mixtures which, in contact with water, develop flammable gases.
- Self-reactive substances or organic peroxides which can cause a fire when heated.

GHS03 – COMBUSTIBLE
This pictogram indicate a fire nutrient gas, solid or liquid, which may cause or exacerbate fire and explosions.

GHS04 – GASES UNDER PRESSURE
This pictogram warns about:

- Gases under pressure may explode upon heating.
- Cooled gas may cause cold injuries.
- Dissolved gases.

Gases that are usually safe can be dangerous when under pressure.

HEALTH HAZARDS

GHS05 – CORROSIVE
When using a chemical with this pictogram, be aware that it is corrosive and can cause severe skin burns and eye damage. It can also etch metals.

GHS06 – ACUTE TOXICITY
Chemicals that have this pictogram is acute toxic through skin contact, inhalation or ingestion and can be fatal.

GHS07 – HEALTH HAZARD
This pictogram means one or more of the following:

- Acute toxicity (harmful)
- Causes skin sensitization
- Respiratory irritation
- Narcotic, causes letharagy or dizziness
- Harmful to the ozone layer

GHS08 – SERIOUS HEALTH HAZARD
A substance with this pictogram has one or more of the following effects:

- Carcinogenic, or suspected carcinogenic.
- Affects fertility and fetus.
- Causes mutations
- Respiratory sensitizing and may cause allergy, asthma or respiratory distress through inhalation.
- Toxic to certain organs
- Harmful by inhalation. May be fatal or harmful if ingested or in contact with the respiratory tract.

ENVIROMENTAL HAZARDS

GHS09 – DANGEROUS TO THE ENVIROMENT
This pictogram warns that a substance is hazardous to the environment and toxic to the aquatic environment.

Foto: AU Foto, Lars Krus.

LABELING OF MIXTURES AND SOLUTIONS

A prerequisite for being able to work safely in the laboratory is that you can correctly label your containers with chemicals so that others can see the content and what safety precautions you need to take.

STORAGE CONTAINERS

Includes all containers that contain a chemical for a longer period (> 1 working day) and must be labelled according to the CLP regulation (see below).

Minimum:

- Content
- Who made it
- Hazard pictograms
- H-sentences
- Signal word
- Date of manufacture

In addition, it is a good idea to mark with:

- Durability
- P-sentences

WORKING CONTAINERS

Includes all containers that only contain a chemical for a short time **(< 1 working day).**

Minimum:

- **Content**
- **Who made it**
- **Hazard pictograms**
- **Date of manufacture**

All chemicals are labelled by the supplier according to the CLP Regulation. All these information can be found in the safety date sheet that comes with the chemical. Alternatively, they can be downloaded from the supplier website or on kiros.dk (see page 24) under the source section.

Safety Data Sheets are also known as **MSDS** or **SDS** that are abbreviations for **Material Safety Data Sheet** and **Safety Data Sheet,** respectively. A SDS contains information regarding hazards, ingredients, first aid needs, precautions by spill or accidents, handling and storage, exposer control and personal protection equipment, physic and chemical properties, stability and reactivity, toxicity information etc.

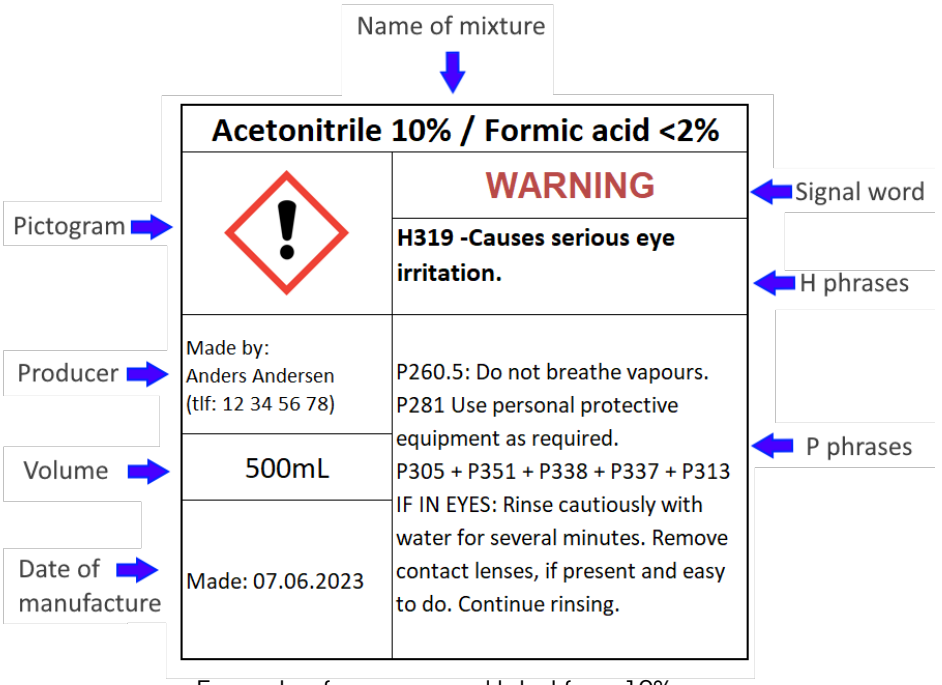
EXAMPLE OF CORRECT LABELING

There are many ways to create a **correct label for a storage container,** but common to all is that they must be labelled with, as a minimum:

- **Contents**
- **Who produced it**
- **Hazard pictograms**
- **H phrases**
- **Signal word**
- **Date of manufacture**

In addition, it is a good idea to label with:

- Durability
- P-phrases



Example of an approved label for a 10% Acetonitrile/<2% Formic acid mixture.

KIROS

At AU, we utilize the KIROS chemical registration system. KIROS provides comprehensive information on the chemicals used in our laboratory, including hazard pictograms, signal words, and H- and P-sentences. Additionally, you can access details such as waste group, UN number, boiling point, and synonyms for many chemicals. KIROS also allows you to generate safety labels and provides guides for handling peroxides, gloves, and more.

If you are logged in to a specific research group or education, you can even view the precise location of the chemicals registered for that particular group.

Usage of Kiros

- Open **www.kiros.dk** (in the right top corner you can change the language between English and Danish)
- Search for your chemical, you can either write the name or the CAS number. Sometimes it can be easier to search using the CAS number as many chemicals have many names and spellings.
- Use common sense – it is not always that the chemicals in KIROS are labeled 100% correctly.

Print safety labels in Kiros

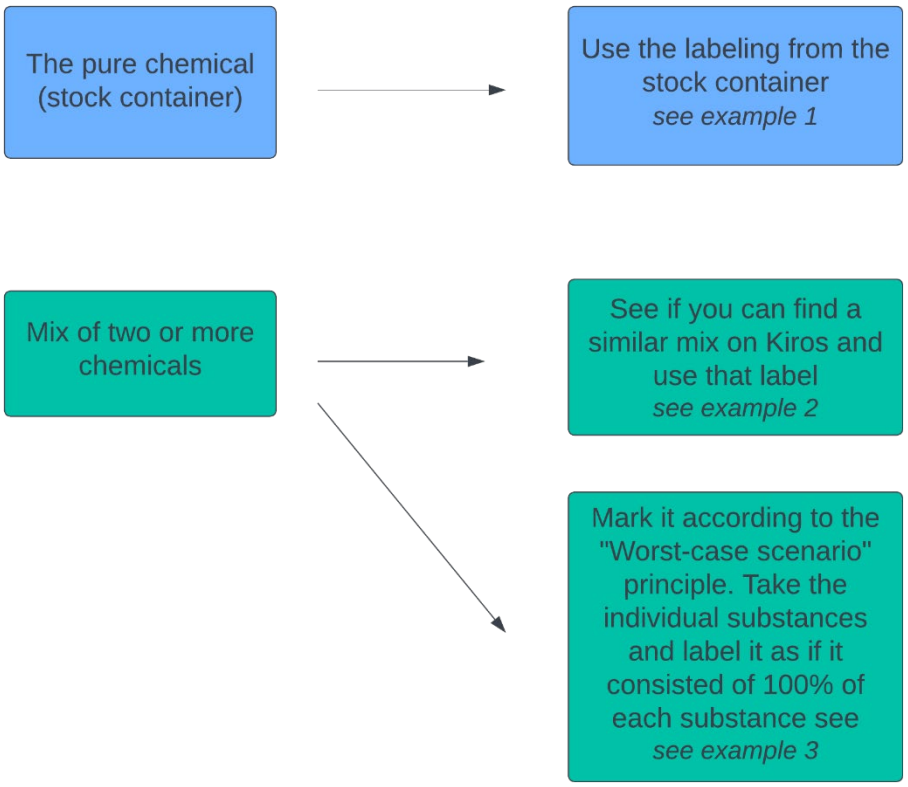
• Log in to Kiros as a navigator (username: Undervisning password: Undervisning).

• Find your chemical/solution on Kiros and note its "key" (see the top when you have entered the solution/chemicals page).

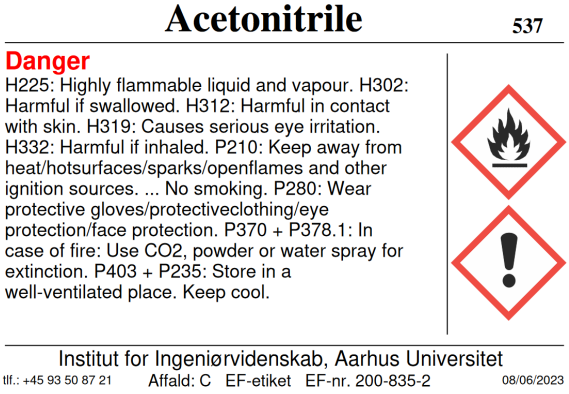
• Go to the front page of Kiros and press "Show the label machine". Now write down the "key" that you noted earlier, and press start. You will now receive your chemical label in PDF format.

METHOD OF LABELING OF CHEMICALS AT BCE

Labelling chemicals is complicated and requires experience. To make it easier, you can use the flow diagram below.



Example 1:
You have a bottle of 2.5L acetonitrile (ACN) that you would like to transfer to a small 200mL bottle. Here you do not dilute or mix your chemical with anything, so you can use the labelling that ACN has. You can find the label on the ACN bottle, or in its SDS or in Kiros.



Acetonitrile 537

Danger

H225: Highly flammable liquid and vapour. H302: Harmful if swallowed. H312: Harmful in contact with skin. H319: Causes serious eye irritation. H332: Harmful if inhaled. P210: Keep away from heat/hotsurfaces/sparks/openflames and other ignition sources. ... No smoking. P280: Wear protective gloves/protectiveclothing/eye protection/face protection. P370 + P378.1: In case of fire: Use CO2, powder or water spray for extinction. P403 + P235: Store in a well-ventilated place. Keep cool.

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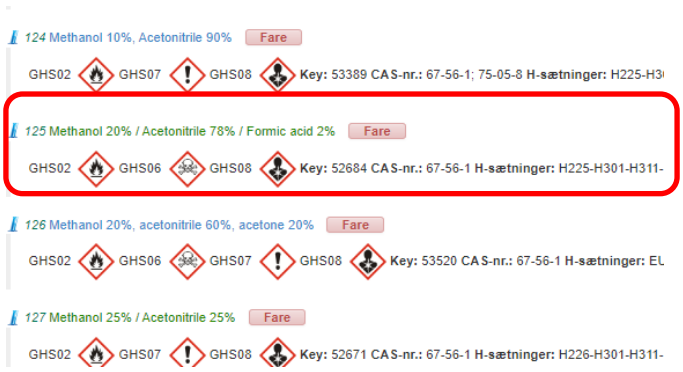
tlf.: +45 93 50 87 21 Affald: C EF-etiket EF-nr. 200-835-2 08/06/2023

Example 2:
You have decided to make a mobile phase for a HPLC application. You make one consisting of 20% methanol, 79% ACN and 1% formic acid.

You then go into Kiros and search for one of the chemicals in the mixture. Here you look at the list until you find a solution similar to the one you have.



124 Methanol 10%, Acetonitrile 90% Fare
GHS02 GHS07 GHS08 Key: 53389 CAS-nr.: 67-56-1; 75-05-8 H-sætninger: H225-H3

125 Methanol 20% / Acetonitrile 78% / Formic acid 2% Fare
GHS02 GHS06 GHS08 Key: 52684 CAS-nr.: 67-56-1 H-sætninger: H225-H301-H311-

126 Methanol 20%, acetonitrile 60%, acetone 20% Fare
GHS02 GHS06 GHS07 GHS08 Key: 53520 CAS-nr.: 67-56-1 H-sætninger: EL

127 Methanol 25% / Acetonitrile 25% Fare
GHS02 GHS07 GHS08 Key: 52671 CAS-nr.: 67-56-1 H-sætninger: H226-H301-H311-

You will find one called methanol 20%, ACN 78% and formic acid 2%. This solution is very close to the mixture you have, so you use its hazard labelling and adjust to the correct percentages.

79 1
Methanol 20% / Acetonitrile 78% / Formic acid 2% **52684**

Contents: Methanol [20%], Acetonitrile [78%], Formic acid [2%],

Danger

H225: Highly flammable liquid and vapour. H301: Toxic if swallowed. H311: Toxic in contact with skin. H315: Causes skin irritation. H319: Causes serious eye irritation. H331: Toxic if inhaled. H370.1: Causes damage to organs <or state all organs affected, if known> <state route of exposure if it is conclusively proven that no other routes of exposure cause the hazard>. P210: Keep away from heat/hotsurfaces/sparks/openflames and other ignition sources. ... No smoking. P243: Take action to prevent static discharges. P281: Use personal protective equipment as required. P301 + P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician.P302 + P352: IF ON SKIN: Wash with plenty of soap and water. P304 + P340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. P308 + P311: IF exposed or concerned: Call a POISON CENTER or doctor/physician.

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Example 3:
We would like to analyse iodomethane on HPLC, so we make a stock solution with iodomethane dissolved in methanol. We cannot find the labelling for a similar mix in Kiros, so we have to make our own. To make it simple, we mark it according to the "worst-case scenario principle".
It means that we would look up the two substances, find their labels and add the hazard pictograms for both chemicals

Iodomethane has the pictograms:

Methanol has the pictograms:

This means that our mixture gets the label:

Iodomethane has the H-phrases:
H226: Flammable liquid and vapour.
H301+H331: Toxic if swallowed and inhaled.
H312: Harmful in contact with skin.
H315+H319+H335: Causes skin irritation. Causes serious eye irritation. May cause irritation of respiratory system.
H351.1: Suspected of causing cancer.
H410: Very toxic with long lasting effects to aquatic life.

Methanol has the H-phrases:
H225: Highly flammable liquid and vapor.
H301: Toxic if swallowed.
H311: Toxic in contact with skin.
H331: Toxic if inhaled.
H270.2: Causes damage to organs by inhalation, skin contact and ingestion.
H319: Causes serious eye irritation.

Our blend gets the worst of the H phrases. Iodomethane has H226: Flammable liquid and vapor. While methanol has H225: Highly flammable liquid and vapor. That means that methanol is "worst" so it gets the H phrase H225.
If we follow this principle for the mixture, we end up with the following H phrases:
H225: Highly flammable liquid and vapour.
H301+H311+H331: Toxic by ingestion, skin contact and inhalation.
H270.2: Causes damage to organs by inhalation, skin contact and ingestion.
H351.1: Suspected of causing cancer.
H410: Very toxic with long lasting effects to aquatic organisms.
H319: Causes serious eye irritation.

<u>The final label:</u>

Iodomethane 1M dissolved in Methanol 08.06.23 MSP

Danger

H225: Highly flammable liquid and vapour.
H301+H311+H331: Toxic by ingestion, skin contact and inhalation.
H270.2: Causes damage to organs by inhalation, skin contact and ingestion.
H351.1: Suspected of causing cancer.
H410: Very toxic with long lasting effects to aquatic life.
H319: Causes serious eye irritation.

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It is your own responsibility to make sure that the dilutions and solutions that you make are labelled correctly.

PREVENTIONS AND RISK ASSESSMENT

To ensure that the possible risk of working in the laboratory or in the process hall are minimized, it is extremely important that you make a risk assessment before starting your work.

Risk assessment is something you are used to in a daily basis without thinking about it. For example, when you ride a bike, you assess if you should wear a bicycle helmet, if the brakes work, if there is light in the bicycle and if there is enough power in the batteries. All of the factors that can help reduce the risk that always is involved with biking.

When you make a risk assessment in the laboratory or in the process hall, you can use the form below, which is widely used in the industry to assess hazards.

RISK = PROBABILITY x CONSEQUENCE			
	Consequence		
Probability	**1** (No/minimal damage)	**2** (Noticeable damage)	**3** (Serious damage)
3 (High probability)	Moderate risk	Significant risk	Serious risk
2 (Medium probability)	Low risk	Moderate risk	Significant risk
1 (Low probability)	Insignificant risk	Low risk	Moderate risk

Before starting a new experiment, hazards must be identified, after which they are risk assessed and necessary precautions are taken. Hereby, the risk can be reduced to an acceptable level.

Risk assessment schemes for estimation of risks are necessary to make precautions that minimizes the probability of dangerous situations.

Imagine that you must do an experiment and no assessment has been performed.

- Identify the **dangers** (what could happen?)
- Estimate the **probability** that the dangerous situation would occur
- Assess the most extreme **consequence** of the dangerous situation (how bad is the damage if the accident were to occur?)
- Calculate the Risk (Risk = Probability x Consequence)
- Make **precautions** that can either reduce the probability, the consequence, or both. Therefore, the risk is reduced to an acceptable level (≤2/green mark)

Example of a risk assessment of an every-day life situation:

A risk could be that you may crash if you ride a bike. The probability will probably be Cat. 1 (you are an experienced biker, but an extreme consequence could be very serious so that would be Cat. 3. This makes the calculated risk 1x3 = 3 (moderate risk).

Prevention to reduce the consequence would be to wear a helmet. We now evaluate that the consequence is Cat. 2 making the calculated risk 2 (low risk).

Example of a risk assessment of a laboratory activity:

A danger by organic synthesis could be inhalation of vapor from acetonitrile – H-sentence (harmful by inhalation). The probability of this could easily be 3, and the consequence could be 1 (headache). The calculated risk would be 3x1 = 3 (moderate risk). Prevention could be to work in a fume hood, which will minimize the risk to 0-1. By doing this, the risk will decrease to an insignificant risk.

PREVENTION:

Ask yourself:

- Do I know all the dangers related to this task?
- Is there tidy and safe surroundings (can I easily escape if things go wrong)?
- Do I have the competence to perform the task?
- Do I have the right equipment?
- What precautions are stated in the P-sentences?

Assess all your experiments for the:

Risk of accidents with hot substances e.g.:

- Heating of huge amounts of water or oil
- Dilution of acids and bases (exothermal reactions)

Risk for burns e.g.:

- Leakage in gas hoses
- Loose clothing/hair
- Hot surfaces of equipment

Risk for explosions, e.g.:

- Development of dust
- Development of flammable gasses
- Pressure formation in closed containers (e.g. reactions with gas development, heat generation, unintentional closing of vents)

Risk of unintentional contact with hazardous substances e.g.:

- Reactions with massive gas development
- Splashes from boiling liquids
- Penetration of gloves
- Risk of electric shock e.g.:
  - Lack of earth connection
  - Poorly insulated wires
  - Sockets on floors or other places where there may be water

Risk for mechanical accidents e.g.:

- Heavy racks that are not securely fastened
- Rotating parts
- Danger of crushing in presses, doors etc.

In the event of an accident occurring, before you begin your experiments, you must be informed about the location of protective equipment such as fire extinguishers, fire blankets, eye-wash cylinders, emergency shower, emergency exits, safety cabinets, etc.

CHEMICAL RISK ASSESSMENT

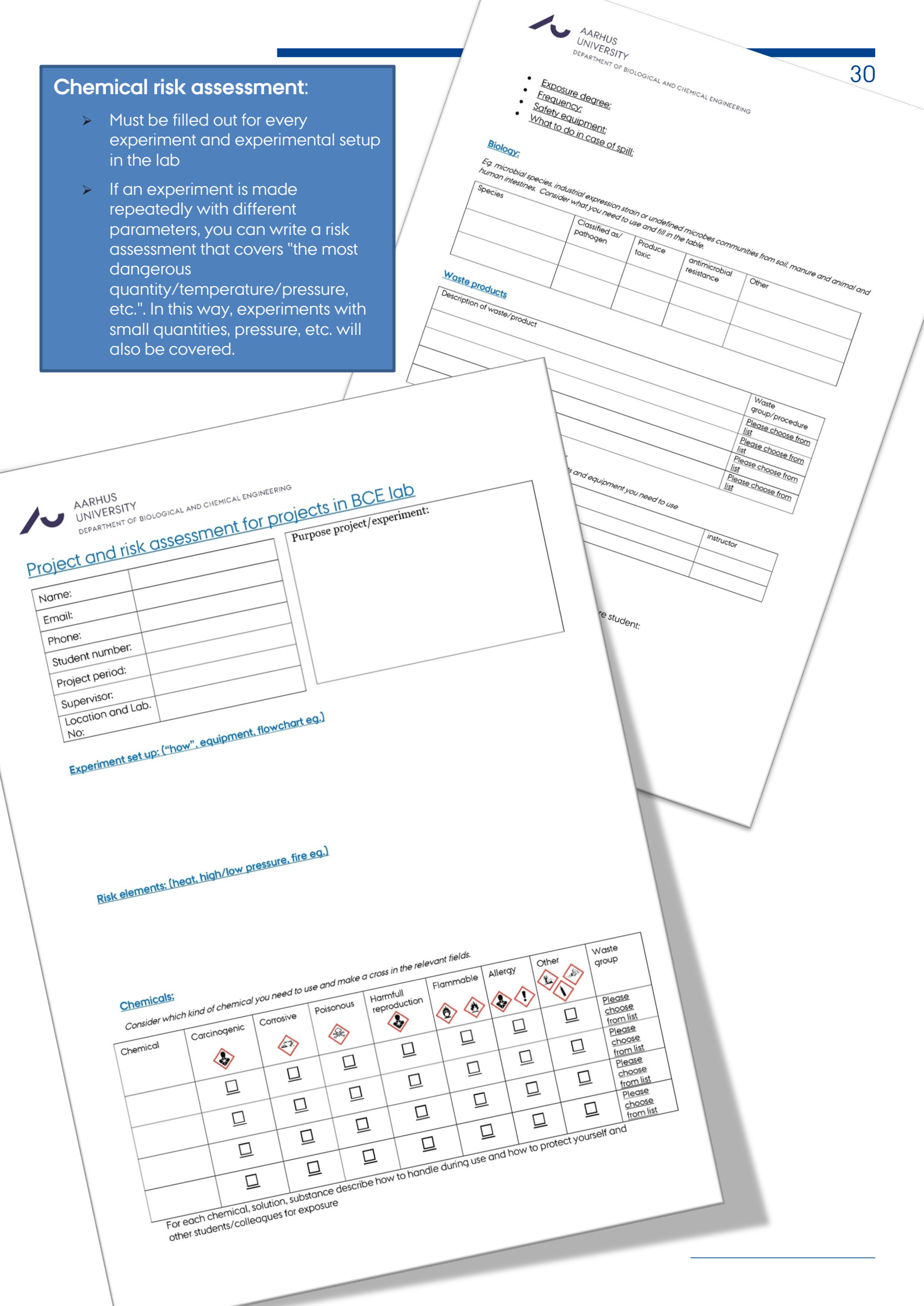
When working with hazardous substances and materials or engaging in processes that involve the development of hazardous chemistry, it is essential to conduct a chemical risk assessment. The objective of this assessment is to evaluate the areas and methods of exposure to hazardous chemistry, enabling the removal, minimization, or prevention of associated risks.

Essentially, the process involves researching the chemicals involved in the experiment or activity to identify potential health hazards and their compatibility with other substances. Additionally, assessing the overall risk of the entire process is necessary, which may require modifications to the setup and utilization of safety equipment to prevent hazardous situations. It is also crucial to consider appropriate actions in case of accidents. For instance, if a bottle of chloroform is accidentally dropped, should it be treated as a simple spill, or should the room be evacuated? Likewise, in the event of spills on gloves, is there a 15-second window to change them before penetration, or is it 30 minutes? Considering such factors in advance is prudent as it becomes challenging to assess them accurately when faced with a real-life situation.

According to Work Environment regulations, it is mandatory to prepare a chemical risk assessment prior to conducting any experiment. To simplify and facilitate this process, the department has provided a standardized sheet for completion.

Chemical risk assessment:

- Must be filled out for every experiment and experimental setup in the lab
- If an experiment is made repeatedly with different parameters, you can write a risk assessment that covers "the most dangerous quantity/temperature/pressure, etc.". In this way, experiments with small quantities, pressure, etc. will also be covered.



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DEPARTMENT OF BIOLOGICAL AND CHEMICAL ENGINEERING

Project and risk assessment for projects in BCE lab

Name:	
Email:	
Phone:	
Student number:	
Project period:	
Supervisor:	
Location and Lab. No:	

Purpose project/experiment:

Experiment set up: ("how", equipment, flowchart eg.)

Risk elements: (heat, high/low pressure, fire eg.)

Chemicals:

Consider which kind of chemical you need to use and make a cross in the relevant fields.

Chemical	Carcinogenic	Corrosive	Poisonous	Harmfull reproduction	Flammable	Allergy	Other	Waste group
	☐	☐	☐	☐	☐	☐	☐	Please choose from list
	☐	☐	☐	☐	☐	☐	☐	Please choose from list
	☐	☐	☐	☐	☐	☐	☐	Please choose from list
	☐	☐	☐	☐	☐	☐	☐	Please choose from list

For each chemical, solution, substance describe how to handle during use and how to protect yourself and other students/colleagues for exposure

- Exposure degree:
- Frequency:
- Safety equipment:
- What to do in case of spill:

Biology:

Eg. microbial species, industrial expression strain or undefined microbes communities from soil, manure and animal and human intestines. Consider what you need to use and fill in the table.

Species	Classified as/ pathogen	Produce toxic	antimicrobial resistance	Other

Waste products

Description of waste/product

	Waste group/procedure
	Please choose from list
	Please choose from list
	Please choose from list
	Please choose from list

s and equipment you need to use

	instructor

re student:

HANDLING OF CHEMICAL WASTE

Waste management is an important part of safety in the laboratory. A large part of the accidents is due to improper handling of chemicals. If waste is not handled correctly, there is a risk that two incompatible substances are mixed in the waste bin, and that there may be unintended chemical reactions with the risk of very serious work-related accidents.

Companies and public-sector institutions that produce hazardous waste have a responsibility to dispose waste legally. You are responsible for ensuring that one category of hazardous waste is not mixed with other categories of hazardous waste. The hazardous waste is sorted into waste groups (see the sorting key on the next page).

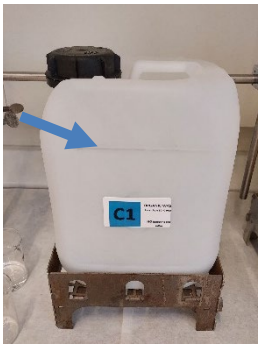
If a mixture of chemicals is used, the sorting key is taken into use. Each statement from the top is considered in relation to the given type of waste. The waste must be disposed in the waste bin, which is consistent with the first waste category in which the waste can be identified.

Biological material must be inactivated. Waste (syringes, used petri dishes, etc.) is collected in autoclave bags, closed with autoclave tape and autoclaved. After autoclaving, the waste must be disposed as ordinary waste. Remember to loosen the lids on the containers before autoclaving.

SORTING KEY

The sorting key (on the next page) provides an overview of the individual waste groups and how to identify how waste is prioritised and sorted correctly.

- Before working with chemicals, you must obtain information about the "danger" of the chemicals and consider how to handle the waste.
- Most chemicals and chemical solutions are listed in KIROS, stating which waste group the chemical belongs to. If the chemical hasn't been listed a waste group in KIROS then use the sorting key.
- **There may be sub-categories under each waste group, depending on how the substances react with each other, solid/liquid form, halogens, acid/base, etc. For correct waste handling, contact your group leader, course coordinator, or laboratory technician.**



- Liquid waste should be handled in fume hoods where the chemical waste is carefully poured into plastic containers marked with the waste's group symbol.
- When the waste container is filled to the collar, the container must be disposed. The container must NOT be filled up to the lid.
- When the waste container is placed in the fume hood, the lid must be placed loosely. This is to prevent pressure from being built up in the container which might happen if the lid is screwed too tightly. The lid is tightened only immediately before the bottle is disposed.
- New waste containers must be marked with the waste category at a least of two of the sides.
- Solid waste is handled in accordance with current procedures at the individual locations.
- **If a substance is not to be labelled according to CLP – i.e. it does not have signal words, hazard pictograms or H-and P-sentences (since it is very diluted or is harmless as a product), it can be poured into the sink or disposed as normal waste. However, double check this as it cannot be re-done!**
- Transferring chemical waste to plastic containers should always be done under suction in fume hoods. The waste should be carefully transferred to the labelled plastic containers indicating the waste group symbol. Rinse if necessary to ensure everything is emptied into the waste container. If the container has been used for organic solvents, leave the used glassware in the fume hood for evaporation overnight (label with date). Afterwards, the used equipment can be washed in the sink.
- Empty evaporated solvent bottles must be placed in the "chemical glass waste bin" and in the glass and plastic waste bin..

WASTE SORTING KEY

Pay special attention to waste category O

If you suspect that you have some O waste, talk to the local laboratory technician, as this group has special packing rules.

Further information and examples of substances that end up in the various waste categories can be found at https://www.fortum.dk/filer/pdfsorteringsvejledningda/download?attachment

EXAMPLES OF WASTE SORTING

- An aqueous solution of 4M sulphuric acid must be poured into the container labelled X1 acid. Since none of the above-mentioned waste categories are consistent with the solution.
- A titration with iodine in a starch solution is poured into B waste because iodine is a halogen, and none of the above-mentioned waste categories are consistent with the solution.
- Solutions containing peroxides such as hydrogen peroxide or potassium peroxide sulphate must be in O waste as they are oxidizing. O waste has the highest priority in the sorting key, so no further consideration is required. Contact the local laboratory technician, if you have O waste.
- Disposal of alcohol, ethers and most HPLC chemicals, e.g. methanol and acetonitrile are C waste, as they are organic compounds without halogens and with a calorific value of at least 18MJ/kg. In the event of dilution with more than 50%, it must be disposed of as H waste.
- Apart from weak solutions of organic compounds, such as alcohols and ethers, organic acids (e.g. acetic acid) are also disposed of in H waste (not to be mistaken for X1 acid, which may contain only inorganic acids).
- Disposal of solid waste, e.g. excess salts from weighing on a scale must be collected in a zip bag that is found at all stationary scales. The bag is marked as H2-solid waste.

See more examples of waste management in the section "Extra material"

USE OF EQUIPMENT

It is important to be instructed in the following equipment before use. This is not just for safety reasons, but also to ensure the equipment does not break.

See videos at YouTube:

"BioChemFoodASE" (in Danish).

https://www.youtube.com/channel/UCR2fqmbK5WQs2e_16QOXCiw/videos

Using the scales

- Scales must be placed exactly horizontal to weigh correctly – **do not move scales.**
- Pay attention to max weight load. Many analytical scales can break if you put too heavy things on them – so always check before putting anything heavy (100g+) on the weighing plate. They can be expensive to replace.
- Always leave scales clean. Use brushes to clean the scale if you spill. Collect spills in a piece of kitchen paper and dispose in the correct waste container (H2 waste)
- Excess chemicals must not be put back into the stock. Instead, it must be put in small plastic bags and handled as chemical waste.
- Be careful when balancing. Only take small quantities at a time and use only clean tools.
- It is important that you leave the scale clean and ready for new use

1. **Remove samples and containers:** Remove all samples and containers from the scale. Make sure that there are no residues left on the weight bucket.
2. **Wash utensils** (spoons, spatulas, tweezers etc.) after you are done and put in place correctly.
3. **Clean the scale**: Use the brushes/paper towels/wet wipes that are at the scale to remove spilled chemicals. Put the collected waste in the table-top bins by the weight (H2 waste).
4. **Clean around the scale**: There is often spillages around the weight – this is also important to remove before leaving the weight.
5. **Turn off and uncover** (if necessary): If no one needs the scale, turn it off and cover it with plastic.

Use of HPLC, GCMS, Fermenters, Autoclave

- Before you start using them, it is important that you receive instruction in how to use them.
- You must not start screwing or doing maintenance if the equipment is not running optimally. First, contact a laboratory technician or your supervisor.
- Make a note in the logbook of the equipment when you are doing an analysis and if you experience problems.

Centrifuges

- Centrifuges must always be balanced before starting. If a centrifuge is shaking while running, it must be stopped immediately. Weigh centrifuge tubes with content so you are sure that the tubes weigh the same. Make a counterbalance by filling a tube with water and make sure that the weight is the same as the sample.
- Make notes on logs/books at the centrifuge when you centrifuge and if problems arise.

Process equipment

- This applies to all pilot-scale process equipment (freeze dryer, spray dryer, extraction unit, crane, brewing equipment, etc.) that may not be used until after oral or written instruction.

ELECTRICITY SAFETY

As an engineer, you are expected to master more than just chemicals and biological matters. You are also expected to have a minimum understanding of power and safety.

Single-phase power outlet

- Voltage: 230 V alternating
- Frequency: 50 Hz
- Current: 10-13 amps
- Wires: 1 hot phase (typically brown), 1 neutral (blue), 1 ground (striped yellow/green)

Three-phase power outlet

- Voltage: 400 V alternating
- Frequency: 50 Hz
- Current: 16 amps or 32 amps (and more for higher demands)
- Wires: 3 hot phases (typically brown, white and black), 1 neutral (blue), 1 ground (striped yellow/green)

Distribution panels include

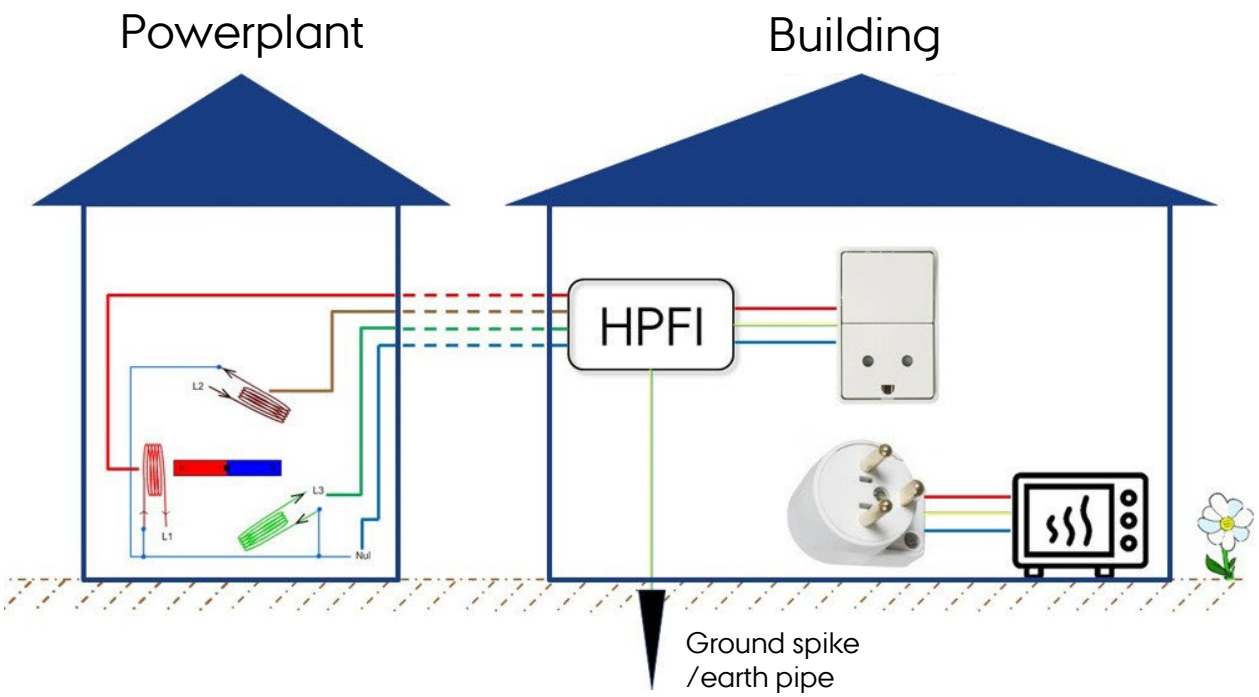
- **HPFI-relay:** Ensures that the power is led quickly and safely away in the event of a short-circuit.
- **Fuse groups:** Group a certain number of sockets in a group. Each group is protected by one fuse (230 V) or three fuses (400 V).
- **Fuses:** Ensures that the wires do not melt if too much power is used. For example, if you connect two kettles to the same group, the fuse interrupts the power to protect the wires.

Theory

The electricity of a power-carrying cable is generated by the power plant, which pulls and pushes the electrons at a frequency of 50 Hz. This pulling and pushing occurs in three separate wires. These are called "phases", and the electricians always connect either one phase (230V) or all three phases (400V) to an outlet.

The outlets also have a wire connected to them that goes back to the power station, creating a closed circuit. This wire is called the "neutral" or "zero," and it carries power only when it is connected to the phases through a power-consuming device. This connection happens when you plug in an electrical device and turn on the switch.

Additionally, all outlets must have a wire called the "ground" that provides protection against fatal accidents. In the event of a short-circuit, such as when a person experiences an electric shock, the flow of electricity is redirected through this wire and into the ground. A device called an HPFI relay (or a fault voltage switch) detects short-circuits. The HPFI relay is mandatory and is typically located in the distribution panel. It measures the amount of power (in amps) entering and leaving a building, and if there is a discrepancy, it indicates the presence of a short circuit caused by, for example, a person. The HPFI relay promptly detects this difference, and with just a 30 milliamp difference, the power is redirected away from the short circuit via the ground wire. In other words, the safety of electrical installations relies entirely on the proper grounding connection.



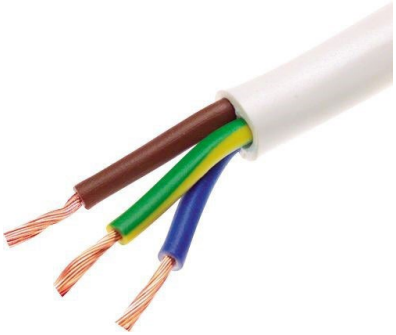
Overview of how power is distributed from a power station to consumers. In the buildings the consumer is ensured against the effects of a short-circuit by the HPFI relay that via the ground connection, directing the short-circuit power to the ground.

Figur 11:
Socket without ground

Figure 12:
Socket with ground

Figure 13:
Plug without ground

Figure14:
Plug with ground



Figur 15: Power cord with three wires; 1 hot phase (brown), 1 neutral (blue), 1 ground (striped yellow/green)

MISHAP AND ACCIDENTS IN THE LAB

A "mishap" is defined as a sudden event that results in less serious damage to an object or person.

An "accident" is defined in the same way, but the severity is greater.

A "near-by-event" is a situation that could potentially have evolved into a mishap or an accident.

It is impossible to protect yourself 100% against mishaps and accidents driving a car and it is not possible to protect yourself 100% in a laboratory either. **The most frequently occurring types of mishaps and accidents in the laboratory are stabs and cuts or build up pressure in closed containers.** Chemical spills, splashes of fluid in the eye and fires in liquids are accidents that happens sporadic. Fortunately, accidents are rare, but you should always be aware of the precautions you need to take in case of accidents. Normally, there will be **no time to read procedures and approaches once you are in the situation.**

A **simple spill** is something that:

- Does not spread quickly
- Does not endanger people or equipment, except in the event of direct contact
- Does not endanger the environment

A **complex spill** may contain one or more of the following parameters:

- Risk of fire or explosion (e.g. a heating source close to flammable material)
- Chemicals with hazard labelling GHS06 (Acute tokcisite) or GHS08 (serious health hazard)
- Powerful oxidants (e.g. HNO3, permanganinates, Perchloratate, peroxides, nitrites, chlorites)
- Environmentally damaging substances
- Concentrated acids/bases in larger volumes

SPILL OF CHEMICALS WITHOUT HUMAN INJURIES (ACCIDENTS)

All spills are different, and there is no definitive guide or guidelines for how to handle all types of spills. **Therefore, you must always use your own common sense and assessment.**

In biotechnology and chemistry laboratories, we work with two types of spills: simple spills, which you can clean up yourself, and complex spills that require assistance of a laboratory technician or your supervisor.

Below are examples of simple and complex spills. If you are not aware of the material or chemical that has been spilled or if you are not aware of the reaction that may occur in the event of mixing with water/air, the spill must be considered as a complex spill.

Examples of simple spills <u>outside</u> the fume hood

- 100 mL concentrated acids/bases
- 0.5 L diluted acids/bases (< 2 molar)
- 0.5 L ethanol
- 100 g $NaHSO_3$ powder

Examples of complex spills <u>outside</u> the fume hood

- Organic solvents such as Methanol, Acetonitril, Xylene, Toluene, THF, Phenol (poisonous vapours)
- Several substances which are spilled at the same time (possibility of unforeseen reactions due to mixing)
- $KMnO_4$ powder (destroys furniture/equipment due to staining)
- Large amounts of concentrated acid/base (oxidising reactions, harmful vapours)

If the spill happens in a fume hood, you must assess in each individual case if it is a complex spill. As a rule of thumb, you can assume that you can multiply with a factor 5 before it is considered as a "complex spill". For example, organic solvents will not be considered as a health hazard due to vapours in a fumehood. However, they can quickly pose a fire risk if it is spread over a large area, and there is a heat source nearby. If the spill spreads outside the fume hood, it should of course be considered as spills outside the fume hood.

HANDLING OF SIMPLE SPILL

- **Stay calm and analyse the situation**
- Inform all people nearby that there is a chemical spill
- Dust and vapours are prevented from spreading by closing doors and increasing ventilation: In the process hall, the ventilation knob is turned - in laboratories by pressing "Max" on the fume hoods.
- Liquids are prevented from spreading. If necessary, make a dike/barriers of granules (vermiculite or sand) from the Safety Cabinet.
- Liquid acids and bases are neutralised with sodium bicarbonate (for acids) or citric acid (for bases). These are available in all laboratories. Use indicator paper to check if the final pH is between 6-8. **Be aware of heat development and risk of boiling**
- Fluids are absorbed with granules (vermiculite or sand) or absorbing mats/pillows - starting from the edge of the spill and working towards the middle
- Granular residues, chemical powders or the like are removed with a broom and dustpan and placed in the waste container from the Safety Cabinet (blue barrel with buckle lid)
- Always inform a member from the Work Environment Committee of the spill

HANDLING OF COMPLEX SPILL

- **Stay calm and analyse the situation.**
- **Inform** all people nearby that there is a chemical spill and evacuate the room/building if necessary
- Leave the room and close the door to the room where the spill has happened
- Set up a sign from the Safety Cabinet: "Cleaning is done after chemical accidents – no unauthorised access is allowed!"
- Contact your supervisor, laboratory technician or member from the Work Environment Committee
- In case of uncertainty about vapours that can be spread in the building call 112
- Replace the lab coat and/or clothing if you have spill on it

After cleaning up

- The area is cleaned with soapy water
- If the broom and dustpan have been used, the dustpan should be cleaned in soapy water, and the broom cleaned or discarded depending on what it has been used for.

SPILL OF CHEMICALS INCLUDING HUMAN INJURIES (ACCIDENT)

- Follow the guidelines for first aid (see the section First Aid)

EVACUATION

Consider whether the entire building should be evacuated, or whether it is sufficient to evacuate part of the building.

If the whole building is to be evacuated:

- Pres the fire alarm, (ie press the button on the alarm). If there is no fire alarm button - call 112 and get help from others to empty the buildings.

Fire alarm

- **Call 1-1-2** and report the reason why the fire alarm was activated. You must also call 112 if it is a false alarm, which unfortunately costs **6.000,- DKK**
- Put on the **yellow vest (Evacuation leader)** and ensure that somebody wears the **orange vest (Assembly point leader)**
- Follow the instructions coming with the vests
- If you have contaminated clothes; take a shower and changed to some fresh clothing (there are overalls in the safety Cabinet that you can wear)
- Watch the video from AU concerning evacuation: https://www.youtube.com/watch?v=jzgDh6rzNlo

Vests for the evacuation leader and assembly point leader

SAFETY CABINETS

A Safety cabinet is an emergency cabinet that contains safety equipment and aids that you need in case of a mishaps or accident.

You must only use content of the Safety Cabinet in emergency situations – otherwise you should contact one of the staff members.

There are extra eyewash cylinders for each Safety cabinet.

Content of a safety cabinet:

- A sign "**Cleaning is done after chemical accidents – no unauthorised access is allowed!**" and tape to fix the sign on the door
- **Overalls, disposable lab coats** that you can us, in the event that someone needs to have their own clothes changed – e.g. if the clothes are wet with chemicals
- **Shoe covers** to prevent shoes comes into contact with spilled chemicals
- **Wellies** instead of using your own shoes
- A **blanket** to keep a person warm. Can also be used as a pillow
- **5-litre containers with demineralised water, foam sponge and bucket**. You can pour water into the bucket and use the sponge to wet a burned area if it is not possible to reach an emergency shower
- **First Aid Kit**
- **Nitrile gloves** for simple spills and **4H gloves** for complex spills
- **Bucket with sand**, which is used to collect oil liquids or to extinguish metal fires
- **Bucket with vermiculite**, which is soft granules that are used to absorb liquids
- **Blue barrels with buckle lid** for collecting chemical waste, including granules and sand
- **Broom and dustpan** to collect spills in sacks and bucket
- **Burn Gel** (palliative spray/gel for minor burns)
- **Resuscitation Mask**

Always contact a member of the Work Environment Committee if the Safety Cabinet has been open

EXAMPLES OF MISHAPS AND ACCIDENTS

The following mishaps and accidents have been registered over an 8-year period on The Bachelor of Engineering programme. The first two are from before the introduction of our current security concept. In each case, a comprehensive assessment is made of the probability that this will happen again, as well as the worst consequence. A specific safety protocol and procedure are written and implemented.

Eye damage
A student added acid to a solution of CaCO3. The mix was carried out in a 5 L blue cap bottle with a tightly screwed lid. The carbonate converted into CO_2 gas, resulting **in high pressure in the bottle**, which splintered. The student did not wear safety glasses and one of the glass splinter hit the eye. The person was taken to hospital and checked by a doctor. The result was a permanent eye damage.

Solution: All experiments must be approved by the supervisor. A chemical risk assessment must be made. Strict adherence to comply with the rules to always wear **safety glasses**.

Burn damage
In connection with an exercise involving the heating of a glass container with a Bunsen burner, the experimental setup was not checked before the experiment started. At one point, **the gas hose fell off the Bunsen burner**. This resulted in a flame hit the student on the body and in the face. The student wore a lab coat and safety glasses but caught two-degree burns on the nose and around the lips. The student received ordinary first aid and was subsequently checked by a doctor. No permanent injuries.

Solution: Clear division of responsibilities. All Bunsen burners were removed and replaced with small gas burners.

Lesion with a syringe
In connection with the fermentation course, a student had to use a syringe to inject a liquid through a septum. **The needle was unused and was firmly stuck** in the protective cap. It took an effort to pull out the needle. When the needle was pulled out of the protective cap, the student reflectively made a reverse-oriented movement, which caused the student to punch the finger. The student was given ordinary first aid. No permanent injuries.

Solution: Attention to using the correct technique when pulling needles.

Incisional wound
In connection with the fermentation course, a group would clean the glass reactor's heating mantle. To clean the heating cap, tap water was connected to the bottom of the heating cap while the hose, which normally leads the cooling water back to the controller unit, was still attached to the upper end of the heating cap. However, this hose is designed so that it is only open when it is connected directly to the controller unit. This led to a **build-up of pressure in the mantle, which was finally blown** and spread glass fragments over a large area. The student was given ordinary first aid for incision injuries on the arm and hand. No permanent damage, but potentially the damage could have been much worse.

Solution: Clear information that the glass reactor's heating mantle should never be cleaned by students.

Eye damage
A student had to clean some containers with 0.1 M HCl and 0.1 M NaOH. During cleaning, a plastic hose slipped and swirled some drops of liquid into the eye of the student. The student was not wearing safety glasses. The eye was flushed quickly and as the student did not know whether it was base or acid, the person was taken to the hospital for control. No permanent injuries.

Solution: Stricter adherence to **comply with the safety regulations.**

Near-by accident
A group heated a mixture with KI in a 1000 mL flask. The flask was closed with a rubber plug, and when the reaction required heat, the flask was placed on a heating plate, which was turned up to 130 degrees Celsius. After a while, the **pressure structure was so great that the cork fell off**. The flask did not break, but the warm content was spread across the entire fume hood. There were no people nearby when the accident happened.

Solution: Mind the danger when heating of a closed system.

WORK ENVIRONMENT ORGANISATION

The working environment – including safety – is handled in all companies in Denmark by the Occupational Health and safety organisation. At AU, the Occupational Health and safety organisation or Work Environment Organisation has four levels:

Main Occupational Health and Safety Committee (HAMU)

The main Occupational Health and Safety Committee advises the management on work environment at AU. The main occupational Health and Safety Committee is an important player, as it determines and together considers the overall line in the university's work environment efforts across the main academic areas.

Occupational Health and Safety Committee for the faculty and administration (FAMU) ensures conformity

The Faculty/Administration occupational health and safety committee plans and coordinates the work environment of the faculties and the administration. FAMU lays down the objectives for the initiative and makes sure that decisions are implemented throughout the faculty/administration.

Local occupational health and safety committee plan (LAMU) advises and solves specific work environment problems

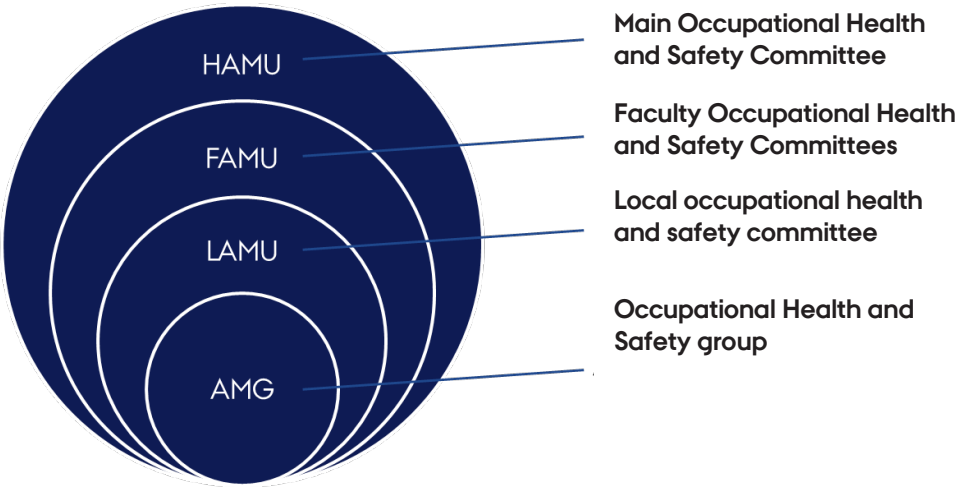
The occupational health and safety groups can get help and support for their work via the local Occupational health and safety Committee. The Committee analyses the occupational Health and Safety initiatives, advises on solving specific work environment problems, and follows up on whether the work environment is effective and preventative.

The occupational Health and Safety group (AMG) helps colleagues and students daily

All departments and administrative divisions at AU have one or more occupational health and safety groups (AMG). The occupational Health and Safety Group is responsible for the working environment at the department/Unit. A successful occupational health and safety group requires the support from colleagues and students, and the group must be visible and continuously handle and solve the work environment problems that are raised.

Room responsible

At each location there is a sign on the door, where you can see who is the room responsible.



WORK ENVIRONMENT COMMITTEE, BCE

Contact information

Link: https://bce.medarbejdere.au.dk/en/organisation/committees/occupational-health-and-safety-committee

Head of Work Environment Committee

Morten Dam Rasmussen

Tel. + 45 2515 2755

E-mail: Mdr@bce.au.dk

Work Environment representative

Trine Thomsen (teaching labs)

Tel. + 45 6095 0785

E-mail: tt@bce.au.dk

Maja Staffeldt Pedersen (research labs)

Tel. + 45 9350 8721

E-mail: majasp@bce.au.dk

EXTRA MATERIAL

Copenhagen University has produced some very good, easy understandable videos about safety.
See: https://absalon.ku.dk/courses/23466/pages/laboratoriesikkerhed-for-studerende-interaktive-videoer

Chemical Safety Board in USA has produced several informative videos about dust explosions.
See: https://www.csb.gov/recommendations/combustible-dust-investigations/

The Bachelor of Engineering programmes in chemistry, biotechnology and food technology have a YouTube channel in which instructional videos are placed on an ongoing basis.
See: https://www.youtube.com/channel/UCR2fqmbK5WQs2e_16QOXCiw

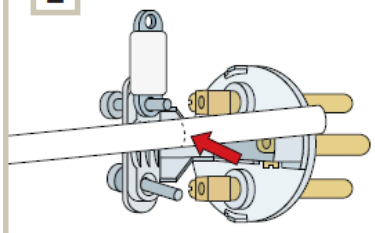
EXAMPLES OF CHEMICAL WASTE HANDLING

X_3 (BASE)	Ammonia water 0,5-100%	X_3 (BASE)	4M NaOH	X_1 (SYRE)	4M Hydrochloric acid
C	Methanol	O	Hydrogen peroxide	K	Mercury thermometer
B2	Chloroform 0,1-100%	X_2(NITRIC ACID)	Nitric acid 5-100%	H1	Methylene blue
H1	Acetic acid 5-100%	C	Acetonitrile	B2	Lugols reagent (Iod)
O	Silver nitrate	H1	Bradford reagent	Z	Unmarked container (mixed waste)
H1	HPLC mobil fase: 30% meOH + 70% water	O	Zink powder	C	HPLC mobil fase: 60% MeOH + 40% water
O	Aluminium chloride	B2	DMSO	X_1 (SYRE)	4M Sulphuric acid
H1	Fluka Gram staining	H_2 (FAST)	Used TLC plates	B	Dichloromethane 0,1-100%
H1	Crystal violet	C	Acetone	C	Hexane
Z	Spray cans	H1	Used oil from pumps	T	Pesticides0,1-100%

GUIDE TO CHANGE OF AN ELECTRIC PLUG (IN DANISH)

Gør det el-sikkert, Elektricitetsrådet, den 4. februar 2002

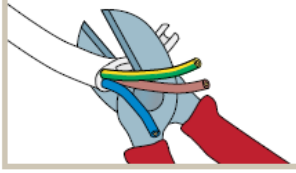
1



Løsn aflastningsbøjlen og skruerne på klemmerne. Placer ledningen i stikproppen/forlængerleddet, som vist på tegningen, og sæt et mærke på ledningen, jf. pilen.

2

Fjern ledningens yderste kappe frem til mærket.



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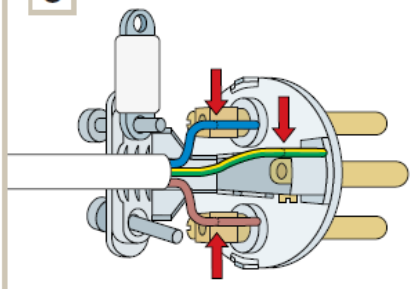
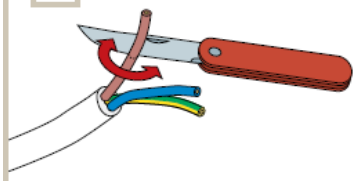
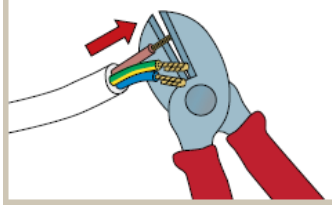


Læg ledningen, så kappen går forbi aflastningsbøjlen og marker, hvorfra der skal afisoleres.

4



Afisoler uden at skade kobbertråden og sno kobbberenderne. Kort dem af, så de er ca. 6 mm lange.



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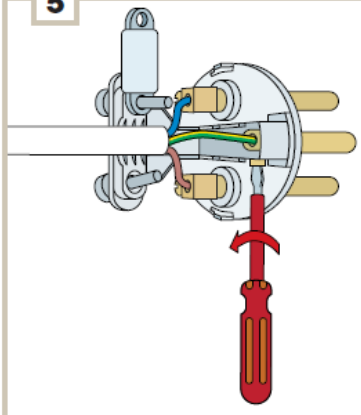
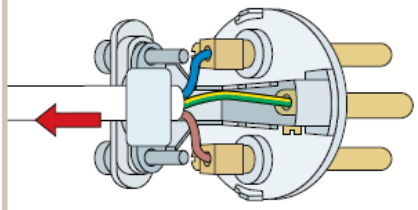


Stik lederne ind i klemmerne. Vær opmærksom på, at alle kobbertråde skal ind i klemmen. Stram skruerne på klemmerne. Træk i lederne for at tjekke, at de sidder fast. Husk, at den grøn/gule leder kun må forbindes, hvis der er en klemme med jordsymbol ⏚

6



Læg ledningen, så den ydre isolering (kappen) kommer ind under aflastningsbøjlen. Skru bøjlen fast og træk i ledningen for at tjekke, at den sidder fast. Skru dækslet på.