# SAFETY REGULATION 2022

Department og Biological and Chemical Engineering

AARHUS
UNIVERSITY

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# Introduction

These safety regulations apply to all employees, guests and students at Department of Engineering, BCE. Everyone working in laboratories at the department must be familiar with the contents of this Safety Regulations. This is approved by a safety test in 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, gases, the safety guidelines on the diploma education, gasses etc., which one must be familiar with the content of if working in these areas. This must be confirmed in written 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.) and use the necessary safety equipment. Make 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. At the same time, it is everyone's responsibility to seek information that is necessary to work safely.

The project manager always has the overall responsibility for 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. By any doubts it is important to ask.

# Calling for help

If fire, accidents, or other life threatening situations occur at Aarhus University, first call:

**Emergency**
Call 112

**Emergency room**
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

I case of fire, bigger accidents, bomb threats etc. 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 all should know when and whom to contact for further information.

**In case of an accident or a "near-by" accident the following procedure must be followed when relevant.**

| Action | Responsibility | Time |
|---|---|---|
| First aid and emergency call | Teachers/instructors/students/employees | Immediately |
| Information to manager and AMR immediately after the accident. | Responsible teacher/supervisor/ employees | Immediately |
| Contact to the injured regarding clarification of the accident. | Work Environment Representative | Immediately |
| Contact to the family of an injured person | Work Environment Manager (Morten Dam Rasmussen) | Varies dependent on the extent of the incident |
| Contact to teachers/instructors regarding clarification of the accident | Work Environment Representative | 3 days after the incident at the latest |
| Contact to 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 are pages with an overview of first aid procedures. These papers can be removed and taken to the site of the accident, or out of the building in case of evacuation. On the back of each page is an overview of relevant emergency numbers Note that the First Aid Procedure does not always follow the order in First Aids three main points (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 plans for specific injuries are formulated by doctors in relation to the individual type of injury.

All laboratories are equipped with emergency showers and hand showers, which can be used to extinguish a fire in/on people or to flush 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**

**Make it safe**

1. **Get an overview**
2. **Secure yourself and the injured person as soon as possible if necessary.**

**e.g. by:**

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

**2**

**Provide firts aid e.g. by:**

- Stop heavy bleeding
- Put the injured person in locked position
- Clear severe blocking of the airways
- Provide heart-lung rescue

**3**

**Alarm by calling 1-1-2**

## Chemical burn in the eye

•Start treatment to avoid further damage

- Make sure there is no contact lenses preventing flushing
- Flushing of the eye, use: eyewash bottles, tap water or other non-corrosive liquids which you have access to
- The eyes must be actively kept open to ensure effective flushing
- Rinse for at least 20 minutes

## Use of eye flush bottles

- Eye flush bottles are either found at the water tap or as disposable bottles. Make sure you know the location of the eye flush bottles before they are needed.

## Working alone

- The bottle are opened by turning the lid
- The eye must be opened completely with 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 flush his 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 hans width away from the eye
- Flush thoroughly by pressing the bottle

## Lying person

- Remove the vertical plastic tube in the bottle
- Helpers open the affected eye with thumb- and forefinger
- The eye cup is kept a hans 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
- Flush the chemical from the skin using 25-34 degrees running water. If the corrosive chemical is a powder-like substance, brush it off before flushing
- Remove clothing and jewelry that has been contaminated with the chemical
- Flush for at least 20 minutes under the tap or emergency shower. Some chemical burns need to be flushed 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 locked side position and watch the person
- Flush remains on the skin with a lot of water
- For residues in the eye, se eye damage

# Poisoning - Gasses

- 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 gasses:

When the person is awake:

- Get the person out in fresh air
- Placed the person warm and comfortably half-seated
- Call for help
- Pay attention to whether the person is breathing. If the person stops breathing, start heart-lung rescue

When the person is unconscious but breathing:

- Get the person out in fresh air
- Provide free airways
- Place the person in locked side position
- Call for help
- Pay attention to whether the person is breathing. If the person stops breathing, start heart-lung rescue

For more information:

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

# Minor BURN

- 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
- 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 form the skin Do not put ice on the burn. If cooled quickly, 30 minutes may be enough. Cooling for more that three hours has often no effect on the skin, but may relieve pain.

For more information:

https://www.youtube.com/watch?v=42oRIGiwDCk

# Major BURN

- Call112

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 rescue
- If possible, immediately cool with water or cover the burned area with a cool, wet, sterile banbage or steril towel
- Look for signs of shock
- Place the injured person with the legs raised, if possible
- Monitor regularly vital functions such as level af 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/

# BURN, 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 breaths
- Place the injured person in locked side position
- 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 rescue
- If the person is unconscious or pale and shows other signs of shock, then place the person with the head slightly lower that the body and legs raised
- Unconscious persons who breathe and have a pulse should be placed in locked side position
- Cover major burns to prevent evaporation

For more information:

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

# IMPORTANT PHONE NUMBERS

| Person/Unit | Name | Phone number |
|---|---|---|
| Emergency Center | | 112 |
| Out of office hours doctor/emergency room (kl16:00-8:00 og i weekender og helligdage) | | 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 | 60 95 07 85 |
| | Maja Staffeldt Pedersen | 93 50 87 21 |
| Building responsible | GWV: Peter Rene Kitler | 23 43 38 63 |
| | Aabogade: Sebastian Bjerge | 93 52 22 67 |
| | Hangøvej: Sebastian Bjerge | 93 52 22 67 |
| | Universitetsbyen: Leif Østergaard | 28 99 20 37 |
| | Foulum: Ebbe Birk | 87 15 12 24 |
| | Biogassen: Ebbe Birk | 87 15 12 24 |
| AU emergency number | | 87 15 16 17 |
| Police (not emergency) | | 114 |

# FIREFIGHTING

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. Push the fire alarm button located in the red boxes (be aware that all locations has a fire button)
2. Put on the yellow vest (Evacuation manager) and follow the instruction on the yellow paper
3. If you come as the second person to the evacuation equipment then put on the orange vest (Site Assembly manager) and follow the instructions on the orange paper

It is everyone's responsibility to evacuate from the building.

### The four main principles of firefighting

**1**

## Save People

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

**2**

## ALARM THE FIREFIGHTER

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

**3**

## LIMIT THE FIRE

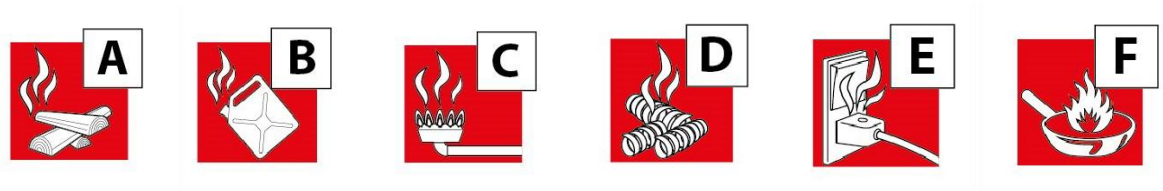
Close doors and windows. Close the gas and remove any pressure bottles and flammable material without endanger yourself or others

**4**

## FIGHT THE FIRE

Use proper extinguishing equipment

# FIRE CLASSES




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

*Depends on the approval of the extinguisher according to DS/EN3. Typically up to 1000V in 1.0 m distance
**Electronics and IT equioment may be damaged
*** Used by fire in pots etc. Used by fire in persons

# RESPONSIBILITIES

## SUPERVISORS; STUDENTS; EMPLOYEES, AND LABORATORY TECHNICIANS

This part is about responsibilities to make it clear who does what and who are responsible for what

### YOUR RESPONSIBILITY AS A STUDENT

- Always **prepare** before teaching. 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 the experiments and experimental design has 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 working alone in the laboratory
- You must always know where the various **safety and emergency equipment** is 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 become **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
- 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 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 ongoing replacement of toxic chemicals with less toxic chemicals when possible
- **Cleaning of laboratory** and disposal of chemical waste daily and after completion of project
- **Information to laboratory technicians** of new students and duration of projects

### LABORATORY TECHNICIANS/ASSISTANTS RESPONSIBILITY

- Everything relating to the **practical work** in the lab
- **Help for 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)

# 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 behavior 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 loos parts. Long sleeved 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 (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

# BEHAVIOUR

- **Hands must be washed** as the last thing before leaving the laboratory
- **Walk quietly.** Never run and do not 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, 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.** 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
- Chemicals with hazard toxic labeling must be stored locked.
- Never pipette by mouth
- Never pour excess chemicals back into the bottle (avoid contamination)
- For acid/water mixtures: acid in water
- 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

# TIDYING UP AND CLEANING

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

Having a tidy and clean laboratory makes the workplace more safe and results in laboratory work of a 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 part with "handling of chemical waste"

**Paper, gloves, glass and syringes**

- Paper and gloves that are not contaminated with microbiology 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
- Glass waste (disrupted glass): must be disposed in "chemical glass waste"
- Syringes are disposed in the yellow buckets intended for syringes and scalpels. **They must never be disposed in any other waste containers**
- Microbiological waste must be autoclaved before it is disposed
- **Everybody must help emptying the normal waste buckets** as required (in the waste container "småt brandbart")

*Yellow container for syringes and scalpels*

**Cleaning of glassware and automatic pipettes**

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

- Use the sorting instructions to make sure your waste is disposed in the right way (see part "handling of chemical waste")
- Leave the equipment to evaporate in the fume hood for the next day (if there has been organic solvents in it)
- 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 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

- 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. 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
- 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
- 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
- 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 for use of some of the equipment at BCE
- The Work Environmental Authorities recommend to use hearing protection if the noise level exceeds 85 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 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

- **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
- 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 are washed in 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

## Hood

- **Protects the environment** from being exposed to contamination and evaporation from the sample
- Use when working with hazardous chemicals, smelly gasses or dust
- The air in the hood is changed and ventilated when the hood is on
- Check the hood is on
- 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 a hood gives an alarm do the following:
  1. Pull the lid 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 lid
  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 persons or for flushing chemical spills pf clothes and body
- **Fire Extinguisher** CO2 fire extinguishers are found at different places in the buildings. See the "fire-fighting" section for when which extinguisher is recommended
- Fire blankets are used 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
- **Safety Cabinets.** Here is material for cleaning up after spills and new clothes for change in case your own clothes has been contaminated

# DAILY SAFETY IN THE LABORATORY

**What can happen to this reaction? How would you react if you or your neighbour get some of the sample in the eye? It is usually seconds not minutes that counts. Get use to think 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 and what safety equipment to use
- Have performed a risk assessment of ypur experiment and experimental setup
- Are sure about waste handeling
- Have received an instruction in 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 are:

- 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 gases, stings from boiling liquids, penetration of gloves

If any of the above mentioned issues are relevant action must be taken to avoid the risk factor. Ask you 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 identify the chemical and they can be considered as a kind of “serial number”.

## CLP REGULATION

CLP is an abbreviation for the English words 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 but you may still come across chemicals that are labelled according to the old system.

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 what safety precautions are to be taken, how the substance or product is to be handled, stores 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 explosives, self-reactive substances and organic peroxides, which may cause an explosion when heated

### GHS02 - **Flammable**

This pictogram warns against flammable gases, aerosols, liquids 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 explosion

### GHS04 – **Gases under pressure**

- **Gasses under pressure may explode upon heating**
- **Cooled gas may cause cold damage**
- **Dissolved gasses**

Also gasses 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 is acute toxic through skin contact, inhalation or ingestion and which can even be fatal

### GHS07 – **Health Hazard**

This pictogram means one or more of the following:

- **Acute toxic (harmful)**
- **Causes skin sensitization as well as skin and eye irritation**
- **Respiratory Irritation**
- **Narcotic, causes lethargy 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**
- **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

## ENVIRONMENTAL HAZARDS

### GHS09 – **Dangerous to the environment**

This pictogram warns that a substance is hazardous to the environment and toxic to the aquatic environment

## LABELING OF MIXTURES AND SOLUTIONS

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

### STORAGE CONTAINERS

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

Minimum:

- **Content**
- **Who made it**
- **Hazard pictograms**
- **H- and P-sentences**
- **Signal words**

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

Date of manufacture

Durability

### WORKING CONTAINERS

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

Minimum:

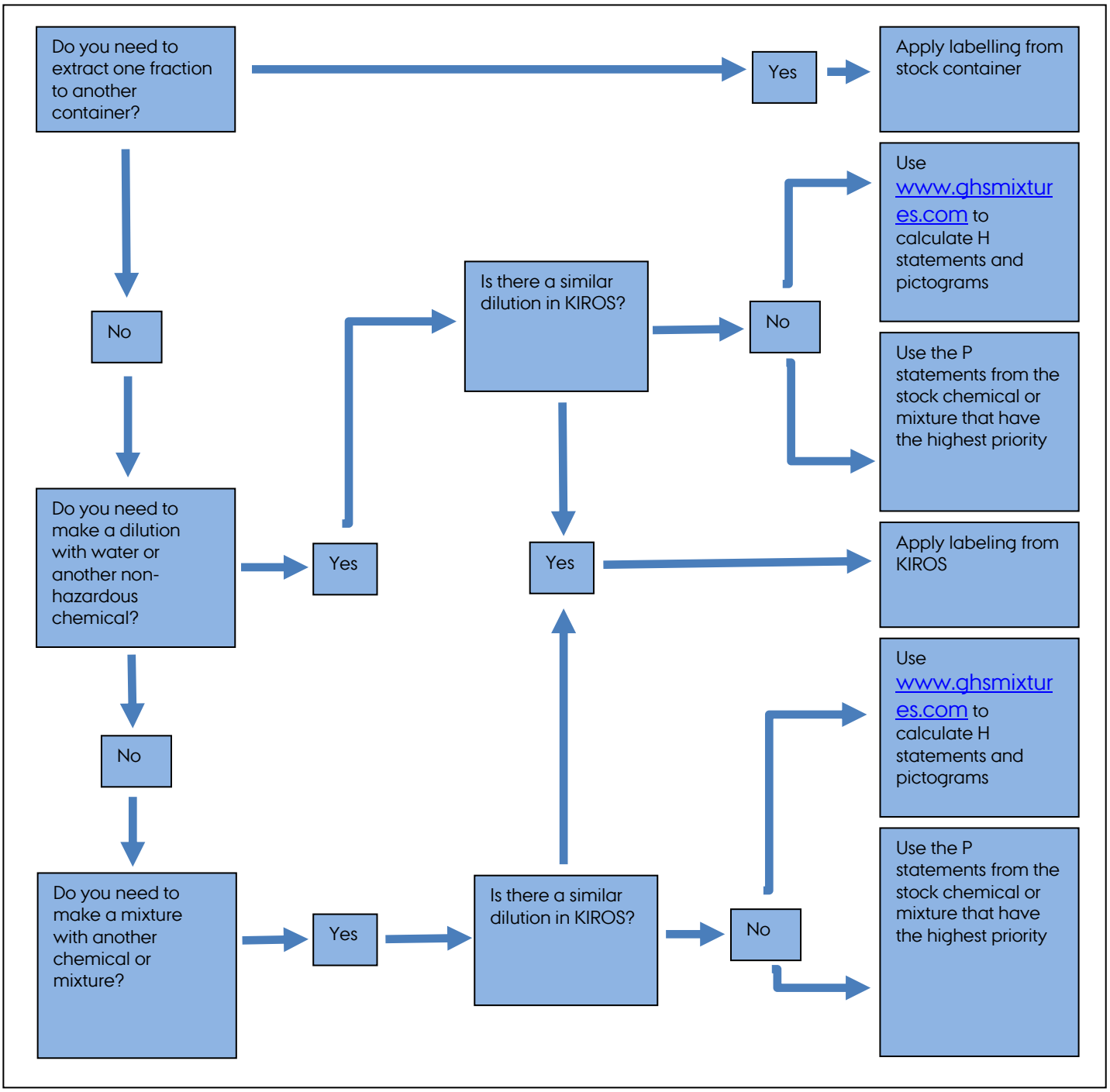
- **Content**
- **Who made it**
- **Hazard pictograms**
- **Date of manufacture**

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.

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, expose control/personal protection equipment, physic and chemical properties, stability and reactivity, toxic information etc.

## METHOD OF LABELING OF CHEMICALS AT BCE

Labelling of chemicals is complicated and requires experience. To facilitate the overview you can use the flow chart below.



# KIROS

We use the KIROS chemical registrations system at AU. In KIROS you can find hazard pictograms, signal words and H- and P-sentences on almost all chemicals used in the laboratory. You can also find waste group, UN number, boiling point and synonyms on many chemicals. You can also print a safety label, and find guides for peroxides, gloves etc.

If you are logged in to a specific research group/education, you can also see the location of the chemicals registered for that group.

## Use of Kiros

- Open **www.kiros.dk**
- Search for your chemical, you can either wrute the name or the CAS number. Sometimes it can be easier to search via 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.

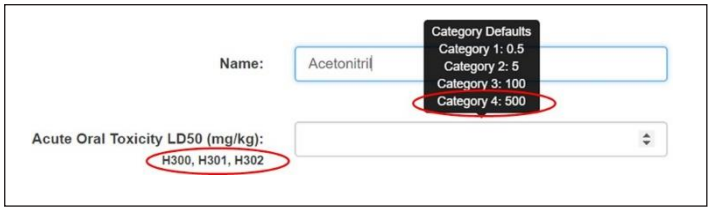
## CALCULATION OF H SENTENCES, HAZARD PICTOGRAMS AND SIGNAL WORDS USING GHSMIXTURES.COM

The calculation is done by entering the information you have for the pure chemical (e.g. Acetonitrile 99.9% or formic acid 96%). %). Next, a mixture of the pure chemical is made by specifying what weight percentage of the chemical constitutes the final mixture. The calculator assumes that the percentages stated are a non-hazardous chemical (e.g. water). This, a 10% acetonitrile solution in water, is calculated by making a "mixture" with 10% acetonitrile as the only "compound".

- Find the safety data sheet for the chemical. There are several options:
- Search KIROS: www.kiros.dk
- Download from the suppliers homepage (e.g. www.sigmaaldrich.com)
- Open a browser and go to https://ghsmixtures.com/
- Create a ne user by pressing "Get started"
- Log in
- Click "Add a compound/mixture" and select "Add A Compound"
- Enter relevant information on the chemical. Below is the information on the hazard statements (H-statements) that can be read from the safety data sheet section 2 and 3 (see figures below). If you do not have all information leave the space empty. Notice that physical H sentences cannot be calculated (H2xx). In these cases, the sentences on the stock chemicals are used.
- Repeat for each chemical you need to work with. Note: The free version has a limited number of compounds or mixtures that can be entered per user. Create new user if you need to create more.
- Click "Add a compound/mixture" and select "Add A Mixture"
- State percentage of each chemical in the final mixture. Do not include non-dangerous solvents like water.

**2.1 Classification of the chemical or solutions**
**Classification according to regulation (EC) No 1272/2008**
Flameable liquids (Category 2). H225
Acute toxicity, Oral (Category 4), H302

*Part from H-sentences from SDS for Acetonitrile*




*Information regarding H302 from the SDS for acetonitril is entered by typing the value (500) related to Cat. 4.*

## CALCULATION OF P-SENTENCES

P-sentences cannot be calculated of a mixture or dilutions because they cannot be put in a formula. The consequence is that there is no "right" way to find P-sentences, and there will always be a certain element of personal assessment.

To make it easier, we have decided that two approaches can be used to identify the relevant precautions to be taken from a given set of H-sentences.

**Method 1:**

- Use all P-sentences indicated on the stock chemical
- Remove doublets
- Remove sentences with low priority (e.g. P261 "avoid inhalation of powder# has lower priority than P260 "Do not inhale powder"

**Method 2:**

- Use the Excel programme "P-sentences" to find the P-sentences that corresponds the H-sentences found using ghsmixtures.com
- Remove sentences with lower priority

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

## EXAMPLE OF A LABEL WITH CORRECT INFORMATION

There are many ways to build a correct label, but common to all is that they should at least be labelled with:

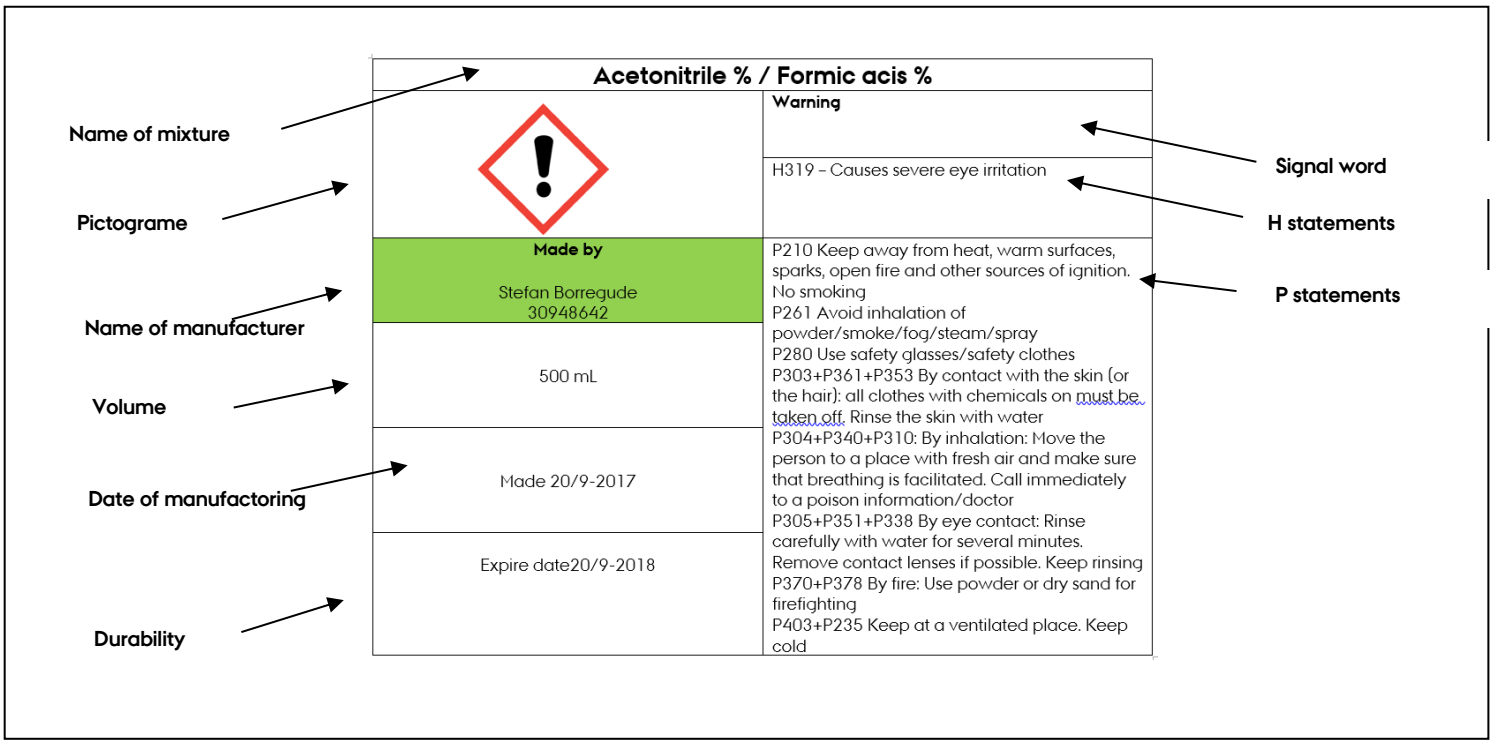
- **Content**
- **Who made it**
- **Hazard pictograms**
- **H- and P-sentences**
- **Signal words**

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

- Date of manufacture
- Durability

It is possible to use your own computer to print labels. At ghsmixtures.com, the label can be copied or transferred by hand to a sticker. Danger pictograms and labels can be used for this, which can be handed out by a laboratory technician.

The following is an example of an approved label for a 10% Acetonitrile/0.1% Formic Acid solution.




*Example of a label with correct information*

## 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.

This must be something you are used to daily without thinking about it.

For example, when you ride a bike, you assess whether you should wear a bicycle helmet, whether the brakes work, whether there is light in the bicycle and whether there is enough power on the batteries. All of which can help reduce the risk that always is involved with biking.

When you must make a risk assessment in the laboratory or in the process hall you can use the form below, which are 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 scheme 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 can happen?)
- Estimate the probability that the dangerous situation will occur
- Assess the most extreme consequence of the dangerous situation (how bad is the damage if the accident occurs?)
- Calculate the Risk (Risk = Probability x Consequence)
- Make precautions that can either reduce the probability, the consequence or both, so that the risk is reduced to an acceptable level (≤2/green mark)

## Example of a risk assessment from an every-day life:

A danger 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 from the laboratory:

A danger by organic synthesis could be inhalation of vapour 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. 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 to evaluate 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 outlets)

**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.

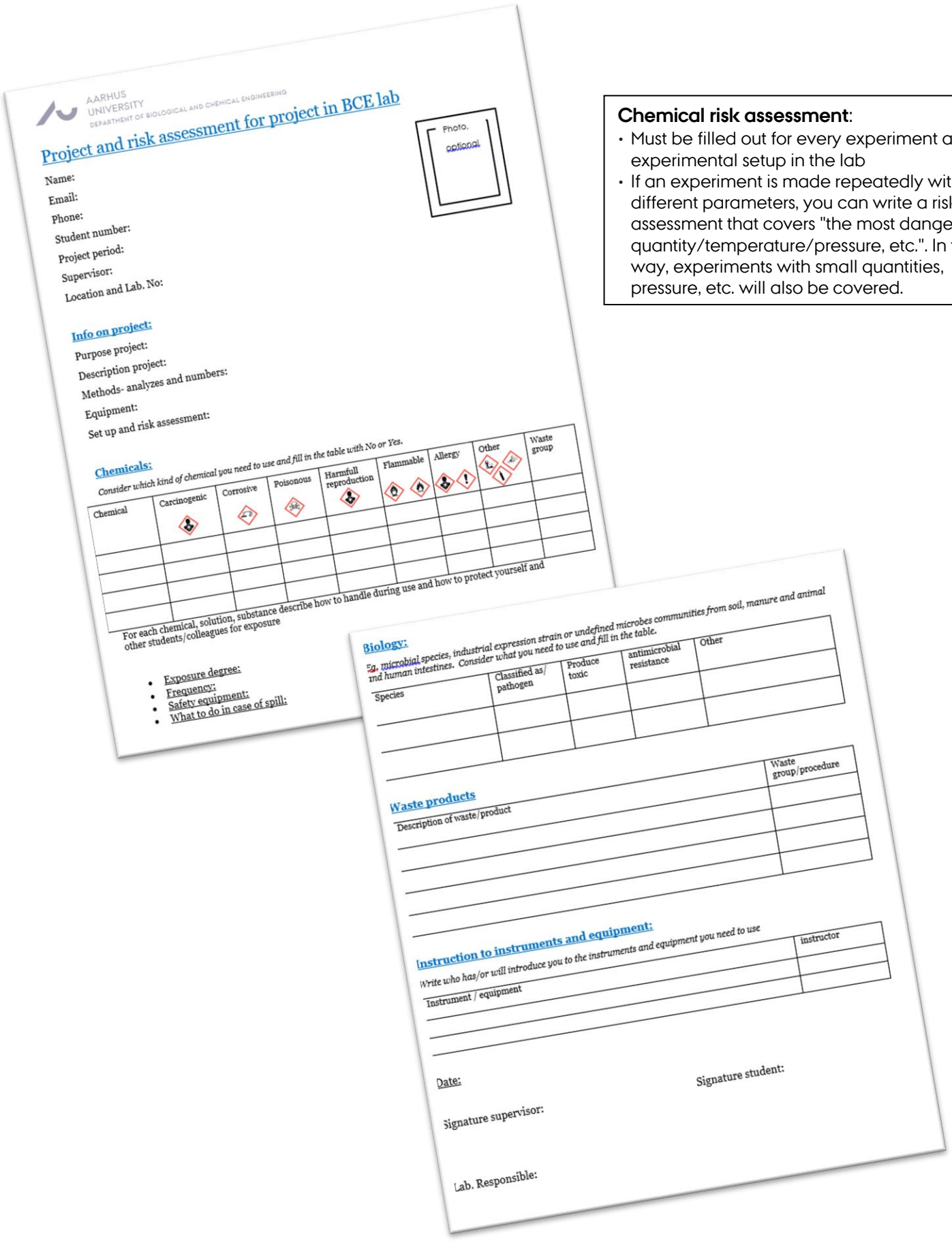
In the event of an accident occurring, before you begin your studies, you must be informed about the location of protective equipment such as fire extinguishers, fire blankets, eye-wash cylinders, emergency shower, emergency exits, safety cabinets, etc.

## CHEMICAL RISK ASSESSMENT

When working with dangerous chemical substances and materials (dangerous chemistry) or with work processes where hazardous chemistry is developed, a chemical risk assessment must be carried out. The purpose is to assess where and how you are exposed to hazardous chemistry, so that this risk can be removed/minimised or prevented.

In short, you have to look up your chemicals and investigate for health hazards and whether they react dangerously with other substances. You must also assess the risk for the whole process and maybe change your setup, safety equipment etc. to prevent dangerous situations. Finally, think about what to do in case of an accident. E.g. if you drop a bottle of chloroform, should you just pick it up as a simple spill, or should you evacuate the room? In case of spills on your gloves, do you have 15 seconds to change them before there is a penetration, or is it 30 minutes? It is good to consider these things before the damage occurs as it is difficult to assess when you are in the situation.

It is a requirement from Work Environment officials that before you conduct an experiment, you must prepare a chemical risk assessment. To make it easy and tangible the department has chosen to fill out a sheet.



AARHUS UNIVERSITY
DEPARTMENT OF BIOLOGICAL AND CHEMICAL ENGINEERING

Project and risk assessment for project in BCE lab

Photo, optional

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

Info on project:
Purpose project:
Description project:
Methods- analyzes and numbers:
Equipment:
Set up and risk assessment:

Chemicals:
*Consider which kind of chemical you need to use and fill in the table with No or Yes.*

| Chemical | Carcinogenic | Corrosive | Poisonous | Harmfull reproduction | Flammable | Allergy | Other | Waste group |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

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:
*E.g. 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 |
|---|---|
| | |
| | |
| | |
| | |

Instruction to instruments and equipment:
*Write who has/or will introduce you to the instruments and equipment you need to use*

| Instrument / equipment | instructor |
|---|---|
| | |
| | |
| | |

Date:

Signature student:

Signature supervisor:

Lab. Responsible:

**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.

## 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).

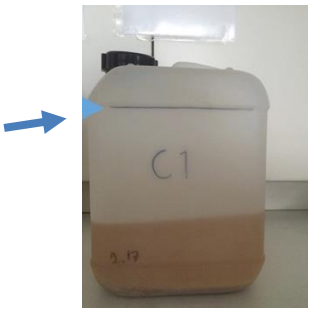
If a mixture of chemicals is used, the sorting key is taken into use. Each statement from the top is considered in relation to the given type of waste. The waste must be disposed in the waste bin, which is consistent with the first waste category in which the waste can be identified.

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

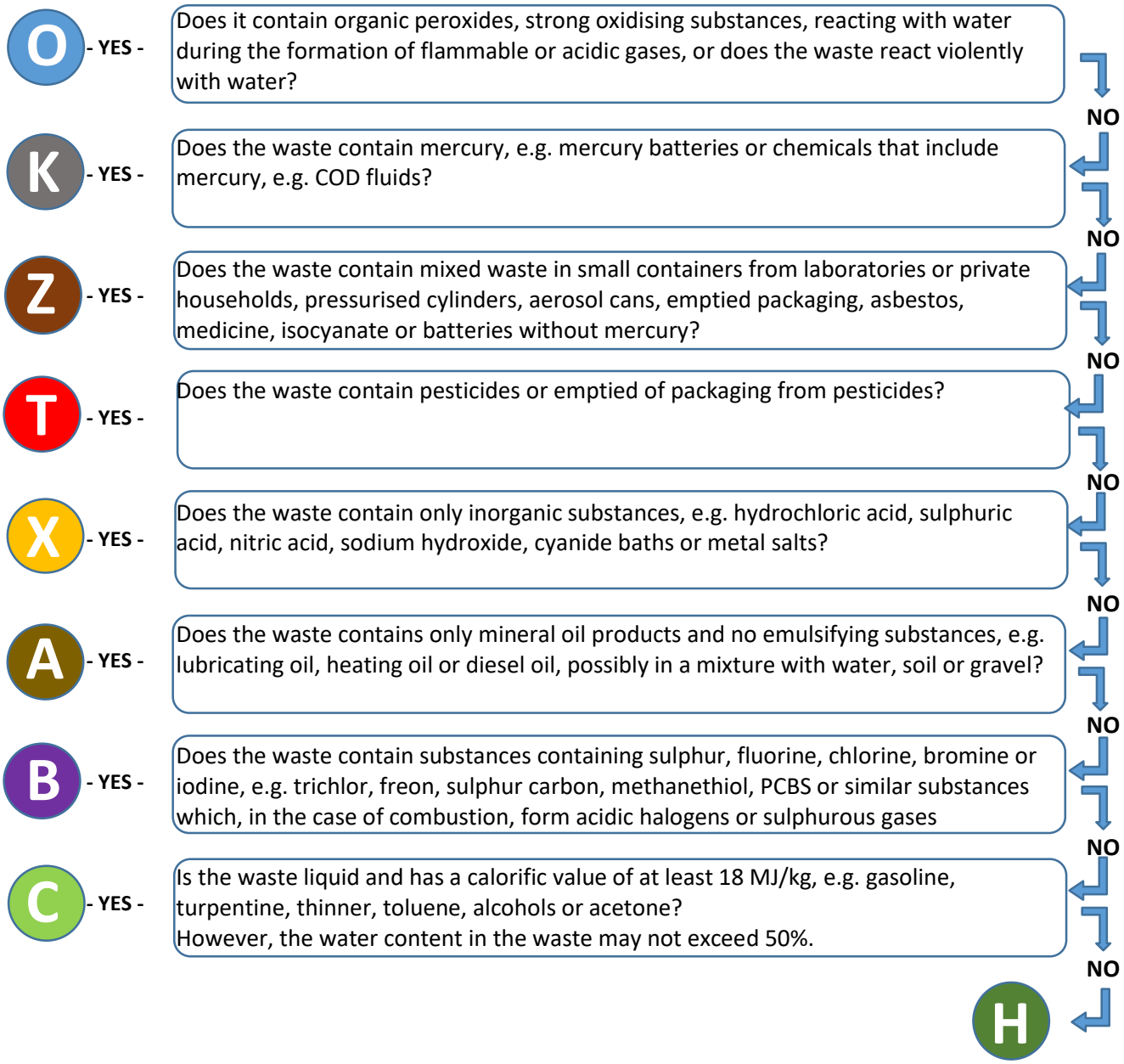
## SORTING KEY

The sorting key provides an overview of the individual waste groups and is used 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 waste group is not specified, then the sorting key must be used.
- **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 is 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 right 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. 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!**
    - The transfer of chemical waste to plastic containers is always carried out in a fume hood. The waste is transferred carefully to the correctly labelled waste containers. Used glass items must be place in the fume hood for evaporation overnight (mark with date). After evaporation of the glass ware it can be washed or disposed.
    - Empty evaporated glass ware must be disposed in "chemical glass waste" (blue clamps in the laboratories).



## WASTE SORTING KEY




Pay special attention to these types of waste:

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

**Waste category H**
Here, a distinction is made between H1 – liquid waste, H2 – solid waste (to be used in zip bags) and H3 – which is vials with organic fluids (C and H), usually from HPLC or GC samples.

**Waste category X. Distinguish between the sub-groups:**
• X1-acid, inorganic acid, where the solution has pH < 7
• X3-base, inorganic base, where pH > 7
• X2-base, nitric acid

If there is any doubt about which to use, the pH value is checked and the waste is disposed in the appropriate waste category.

Further information and examples of substances that end up in the various waste categories can be found at https://www.fortum.dk/sites/default/files/documents/sorteringsvejledning.pdf

## 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.
- 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.
- 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.
- Wash the tools when you are done and place them in the right place.

### Use of HPLC, GCMS, Fermenters, autoclave

- 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 log book at 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.

### Process equipment

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

## Electricity safety

As engineer, you are expected to master more than 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**

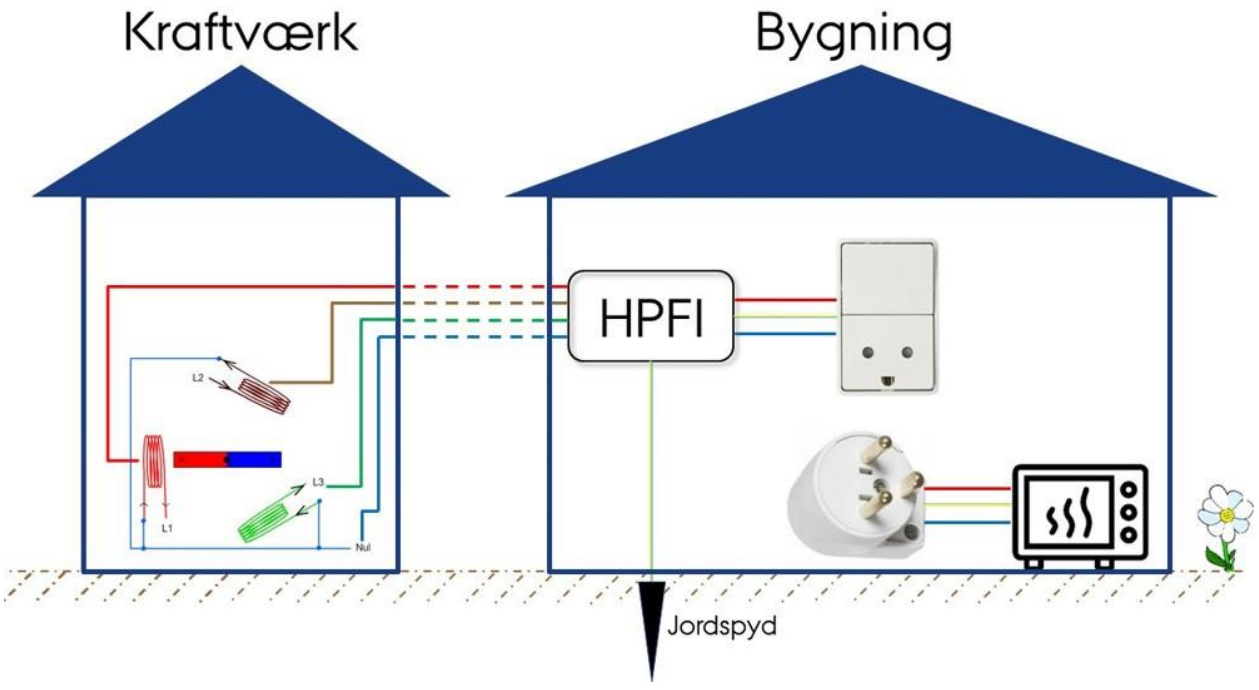
- **HPFI-relay:** Ensures that the power is led quickly and safely away in the event of a short-circuit.
- **Fuse groups:** Group a certain number of sockets in a group. Each group is protected by one fuse (230 V) or three fuses (400 V).
- **Fuses:** Ensures that the wires do not melt if too much power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

## Theory

The power of a power-leading cable is created by the plant pulling and pushing the electrons with frequency of 50 Hz. The pull and push is always 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 sockets also hold a wire that goes back to the power station making it possible to have a closed circuit. This wire is called "zero" or “neutral” and it only carries power when it is connected to the phases through a power consuming unit. This is happening when you connect a plug (and an electrical equipment) to the outlet and turn on the switch.

All sockets must also have a cord that protects against fatal accidents. This wire is called "ground", and in case of a short-circuit, such as a person who receives an electric shock, the flow is diverted via this wire to the ground. The unit that detects when a short-circuit occurs is called a HPFI relay (or a fault voltage switch). The HPFI relay is compulsory and is located in the distribution panel. The HPFI relay measures the amount of power (in amps) that enters in and out of a building and if these are not identical, this is due to the fact that the power is derived from a short circuit (for example, a person). The HPFI relay will immediately register this, and by a difference of just 30 milliamps the power (via the earth pipe) will be routed away from the short end. In other words, safety in electrical installations is completely and entirely dependent on the ground connection.



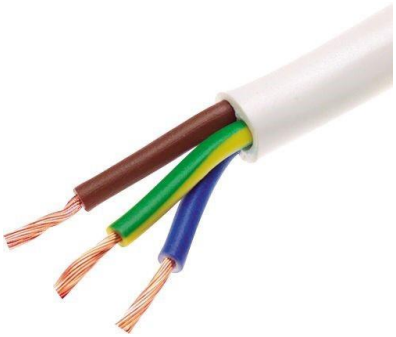

*Overview of how power is distributed from a power station (Kraftværk) to consumers (Bygning). In the buildings the consumer is ensured against the effects of a short-circuit by the HPFI relay that via the ground connection (Jordspyd) directing the short-circuit power to the ground.*

*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)*

# MISFORTUNE AND ACCIDENTS IN THE LAB

An "misfortune" 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 misfortune or an accident.

It is impossible to protect yourself 100% against misfortunes and accidents driving a car and it is not possible to protect yourself 100% in a laboratory either. **The most frequently occurring types of misfortunes and accidents in the laboratory are stabs and cuts or build up pressure in closed containers.** Waste of chemicals, splashes of fluid in the eye and fires in liquids are also causes accidents. 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 simpel 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.

## SPILL OF CHEMICALS WITHOUT HUMAN INJURIES (ACCIDENTS)

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

In biotechnology and chemistry laboratories, we work with two types of waste: 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 waste must be considered as a complex spill.

**Examples of simple spills outside 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 outside the fume hood**

- Organic solvents such as Methanol, Acetonitril, Xylene, Toluene, THF, Phenol (poisonous vapours)
- Several substances which are lost at the same time (possibility of unforeseen reactions due to mixing)
- $KMnO_4$ powder (destroys fixtures 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. 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 persons 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 button is turned on
  - In laboratories press "Max" on fume hoods
- Liquids are prevented from spreading. If necessary, make a dike 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) 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 persons 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 if you have waste 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 paragraph 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


*Fire alarm*

- **Call 1-1-2** and report 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
- Take off contaminated clothes and take a shower (there are boiler suits in the safety Cabinet that you can wear)


*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 misfortune or accident
- You must only use content of the Safety Cabinet in emergency situations – otherwise you should contact one of the staff
- 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
- **Boiler suit, 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
- **Cover joints** to prevent shoes comes into contact with spilled chemicals
- **Rubber boots** 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 for minor burns)
- **Resuscitation Mask**
- Always contact a member of the **Work Environment Committee** if the Safety Cabinet has been open

## EKSAMPLES OF MISFORTUNES AND ACCIDENTS

The following misfortunes 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 is then 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.

**Incised 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 ensure conformity (FAMU)

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, advise and solve specific work environment problems (LAMU)

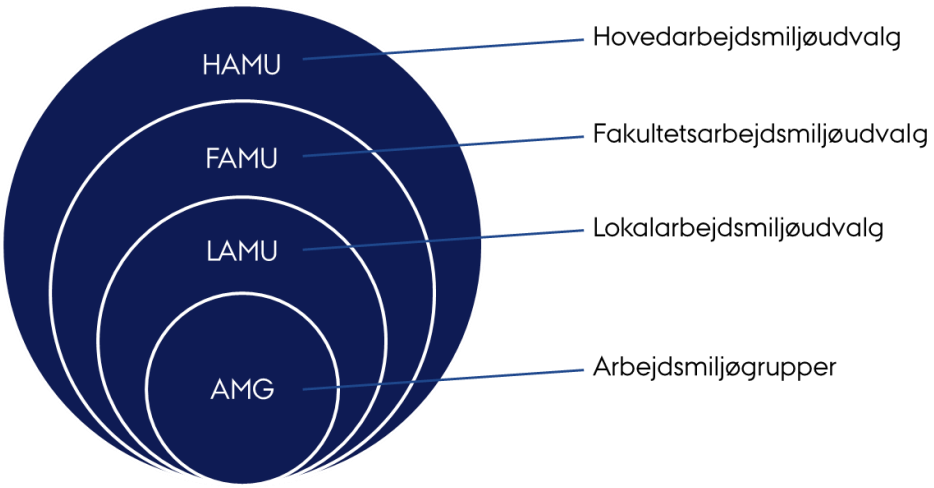
The occupational health and safety groups can get help and support for their work via the local Occupational health and safety Committee. The Committee analyses the occupational Health and Safety initiatives, advises on solving specific work environment problems, and follows up on whether the work environment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

### The occupational Health and Safety group helps colleagues and students on a daily basis (AMG)

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/

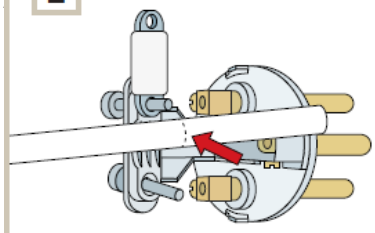
The Bachelor of Engineering programmes in chemistry, biotechnology and food technology have a YouTube channel in which instructional videos are placed on an ongoing basis.
See: https://www.youtube.com/channel/UCR2fqmbK5WQs2e_16QOXCiw

## Examples of handling of chemical waste

| | | | | | |
|---|---|---|---|---|---|
| $X_{3\ (BASE)}$ | Ammonia water<br><br>0,5-100% | $X_{3\ (BASE)}$ | 4M NaOH | $X_{1\ (SYRE)}$ | 4M Hydrochloric acid |
| C | Methanol | O | Hydrogen peroxide | K | Mercury thermometer |
| B | Chloroform<br><br>0,1-100% | $X_{2(NITRIC\ ACID)}$ | Nitric acid<br><br>5-100% | H | Methylene blue |
| H | Acetic acid<br><br>5-100% | C | Acetonitrile | B | Lugols reagent (Iod) |
| O | Silver nitrate | H | Bradford reagent | Z | Unmarked container (mixed waste) |
| H | HPLC mobil fase: 30% meOH + 70% vand | O | Zink powder | C | HPLC mobil fase:<br><br>60% MeOH + 40% water |
| O | Aluminium chloride | B | DMSO | $X_{1\ (SYRE)}$ | 4M Sulphuric acid |
| H | Fluka Gram staining | $H_{2(FAST)}$ | Used TLC plates | B | Dichloromethane<br>0,1-100% |
| H | Crystal violet | C | Acetone | C | Hexane |
| Z | Spray cans | H | Used oil from pumps | T | Pesticides<br><br>0,1-100% |

## GUIDE TO CHANGE OF AN ELECTRIC PLUG (IN DANISH)

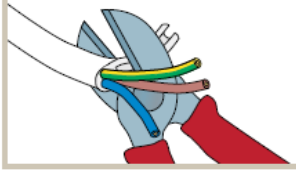
**1**



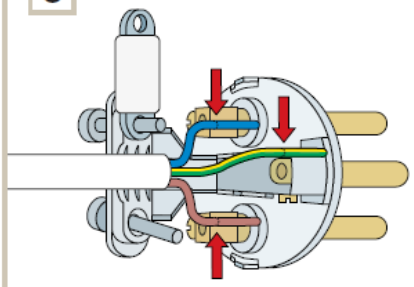
Løsn aflastningsbøjlen og skruerne på klemmerne. Placer ledningen i stikproppen/forlængerleddet, som vist på tegningen, og sæt et mærke på ledningen, jf. pilen.

**2**

Fjern ledningens yderste kappe frem til mærket.

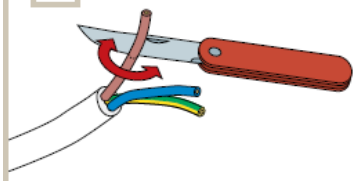


**3**

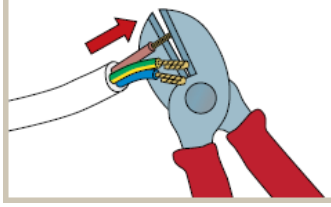


Læg ledningen, så kappen går forbi aflastningsbøjlen og marker, hvorfra der skal afisoleres.

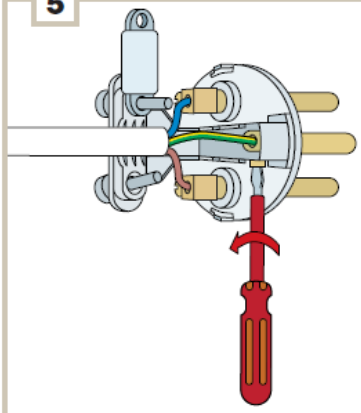
**4**



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

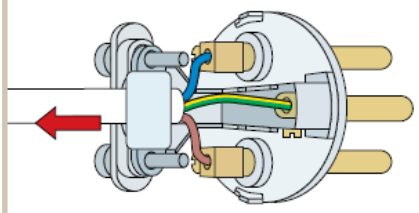


**5**



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.