General Safety Framework of the Department of Organic Chemistry

General policy

All people working at the Department of Organic Chemistry, temporary and permanent staff must read and adhere to the safety instructions presented in this document. You need to sign that you have read and fully understood all the information presented herein. If you have any doubts, do not hesitate to ask your supervisor or the safety officers at the department. You cannot start any work prior to reading this document and signing that you have understood and is obliged to follow these instructions.
If an accident should happen, it is very important to take immediate and effective measures to reduce the damage. This document describes methods and measures to increase safety and well-being in the laboratories.

Essential safety instructions

Safety hierarchy

The department has two safety officers that can help you with safety concerns and information. For 2017 ***Kristina Romare*** and ***Louise Letho*** are appointed.
Each supervisor is responsible for the safety and routines in their respective lab and for informing new co-workers on group specific risks and routines. In addition, each research laboratory has one person appointed as a **lab boss**. This person is given a direct authority by the supervisors operating in the laboratory and the Head of Department. You need to adhere to the information and routines given by your lab boss, whose name and picture is at the entrance of each laboratory.

Access to the department

Do not let any unauthorized person in through the door. Make sure to close the doors to the labs and office if you leave in order to prevent theft. If you see any suspicious activity, call the security: 08-162216/08-164200.

Personal safety equipment

- ***ALWAYS*** wear safety goggles in the laboratory. Normal glasses do not provide adequate protection against splashing.
- ***ALWAYS*** wear a cotton laboratory coat in the laboratory. *Nylon coats are not permitted*. Avoid using clothes made out of synthetic materials.
- If using gloves, take them off when handling stuff outside the hood in order to avoid contamination of areas that people touch with their bare hands.
- When entering an office don't bring any lab coats, gloves, chemicals etc.
- Always work with the fume hood sash between the face and the experiment. Close the sash properly and turn off the light when the fume hood is not in use to save on energy and ventilation capacity.

Safety cabinets

The department is equipped with orange safety cabinets that are located in each of our corridors. These cabinets should contain protective masks for particularly dangerous operations. They are equipped with additional first-aid supplies and an orange kit, with Diphoterine, special antidotes for chemical splashes. Please use any of these items in case of emergency and notify the safety responsible immediately to organize the replenishment of these essential goods for common use.

General safety considerations and routines of high importance

- Know where to find the first aid kit, fire extinguisher, fire blanket, emergency shower, eyewash, absorption paper, gas mask, the chemical splash antidote kit and chemical accident kit and know how to use them.
- Solo lab work is not permitted. There must be someone within earshot.
- Undergraduate students are not allowed to work alone in the lab at any time or to work during red days and weekends.
- Go through in advance how the different stages of an experiment should progress and which measures may be required if the experiment does not progress as planned.
- Make a risk assessment in the lab-book when working with dangerous chemicals. Check the MSDS of the chemicals you use, and the appendixes to this document for regulated listed compounds. This has to be approved and signed by the supervisor or the team member in lieu of the supervisor.
- Consult your supervisor and/or someone in the lab if you have safety concerns or need advice for an experimental setup. It is better to ask one time too much!
- Dispose of, and quench reagents or waste properly, consult your supervisor.
- Handle all chemicals and solvents in a ventilated area. This is particularly important for reactive and toxic substances. Open desiccators containing chemicals that may form gases in a fume hood.
- For compounds lacking an MSDS, such as novel compounds, you need to make an assessment of potential risks based on the chemical structure and similar compounds - handle with care.
- Always keep work surfaces, fume hoods and balances clear of superfluous glass objects, equipment and chemicals.
- Do not store solvents, flasks and chemicals on the floor, on benches or in the fume hood.
- Do not hurry. Stress is a safety hazard in itself and will produce poor results.
- Do not smoke or light open flames in the laboratory.
- Clean up chemical spills immediately.
- Collect any broken glass and dispose of properly.
- Collect sharps in an assigned plastic container.
- Dispose of drying agents and silica gel in the appropriate container (zip-bags).
- Dispose of all solvent in the appropriate container. Ethers should be evaporated.
- Always label bottles and flasks with contents and lab-book number.
- Do not eat, drink, chew gum or use snuff in the laboratory because of the risk of poisoning.
- Do not eat in the offices.

Toxic and hazardous substances

Any particularly hazardous activities or experiments with toxic or hazardous chemicals must: Be commented in the lab-book on the page of the experiment in question. Each supervisor is responsible for introducing new co-workers to the safety rules and routines at the department. Make sure that new co-workers understand the information given by the administrative staff and add specific safety information that is relevant to your group.

Order in the laboratory

Description

The supervisors are responsible for the order in the laboratory, and looking after the good practice and safety policies in the lab. All labs have a dedicated person called the “lab boss”, whose picture can be found at the entry door of the lab. The co-workers have to follow the instructions of the lab-chief. If a co-worker repeatedly defies the instruction(s) of the lab-chief, the co-worker will not be permitted to perform work in the laboratory.

Preventive measures

The lab boss has to contact with the supervisor or the safety officer in case irregularities happen in the lab. The supervisor and the lab boss allocate time to check the proper order in the lab and keeping the safety rules.

- Planning experiments. Add information about waste handling, how to deal with spill, and actions required in case of an emergency or contamination.
- Be communicated with other people in the lab. The people working around you must be aware of any potential risks and how to deal with a potential emergency situation.

Introduction of new co-workers

Presentation of the department and research groups are taken care by a team member or the supervisor. This will give practical information, such as where things are, SU-shop etc. The person should also be presented to the lab boss, see safety hierarchy, which should introduce routines in lab and go through lab safety, emergency exits & fire extinguishers.
When the person has read, and understood the safety information, which the administration personnel has handed out, it must be signed and next of kin given and the safety check carried out, it should be given to Louise or administration personnel. **Each supervisor** should ascertain that the safety and routines have been adequately understood by new co-workers. Kristina will before you get access to the NMR equipment, check that you have performed the ‘safety check’ and shown you the alarm and fume hood videos.

Emergency handling

Emergency phones

In case of an emergency, call **112** for ambulance, fire and rescue, police and poison control.
For security matters call the campus security **08-164200** or **08-162216**.
Save those numbers in your phone.

First aid

Locate the nearest first aid station and regularly make sure that it is complete. In case of an accident help your co-workers and call the emergency number 112 if judged as a serious injury. If you lack previous first aid training, or if it is not up to date, contact the safety officer to sign up for a course. Remember that a proper first aid may be the difference

between life and death. If you need to go to the emergency yourself, ask a co-worker to help you.

Emergency and Fire alarm

The emergency alarm is activated by pressing the fire alarm buttons in the corridor by the stairs. The alarm is also activated by the smoke detectors in the corridors and labs. The alarm is connected to the emergency services.

The laboratory premises must be left immediately if the emergency alarm is activated. Close any open gas valves, disconnect electrical equipment if you can, communicate with others and leave the building. It is prohibited under any circumstances to re-enter the laboratory premises once you have left them; the only exception is a direct request from the personnel in charge. Take into account that you may not be allowed back into the building for several hours.

When evacuating the building, follow the evacuation leader (yellow jacket) and go to the grass area to the south of Arrhenius building A-C. Assist the evacuation leader by collecting the group at the same spot.

Ventilation alarm

The ventilation alarm consists of a light and a bell in the corridor. The alarm is activated when the ventilation no longer works properly. It is important to keep the fume hood sash closed as far down as possible if the ventilation alarm is activated. Do not perform any hazardous work without fully functioning ventilation.

Burglar and elevator alarms

There are additional alarms for the elevator and a burglar alarm. Watch the alarm video on our website to know which one is which. If the elevator alarm sounds, try to locate any person trapped in the elevator and call security. The burglar alarm will sound if any door is left opened for a prolonged time. Make sure that all doors close after you, this is particularly important after office hours. Call the security (08-162216/08-164200) if you need advice.

Evacuation

When the fire and evacuation alarm is ringing, you must evacuate the building as soon as possible. Follow the evacuation leader's orders and gather in front of the Arrhenius building on the lawn (at least 50 meters from the building). Make sure that you know the evacuation routes possible from your work station, consult the signs and maps in the corridor.

Fire and extinguishers

All the personnel involved with active experimental work is entitled to actively participate in the periodic fire training sessions as soon as places are available (contact Kristina Romare).
If a fire accident occurs, it is essential to act promptly and correctly. Therefore it is vital that everyone knows where the closest fire equipment is. **Fire extinguishers** can be found adjacent to the laboratory doors, and in the corridor. Make sure you know the differences in the different types of extinguishers there are.
A fire blanket can be found by the first aid station.

Emergency measures:
Suffocate fires in small containers by covering the opening with an inert material.

Extinguish larger fires by using a carbon dioxide or powder based fire extinguisher. Water is generally not suitable for laboratory fires, and never when solvents or oils/oil baths are on fire.

***Burning chemicals*:** Extinguish all flames and remove everything flammable, especially solvents.

***Burning clothes*:** Put the person down on the floor and roll him/her into a lab coat or fire blanket. *Put out the fire starting at the head.* The emergency shower can also be used.

If a catastrophic fire occurs:

1. Save colleagues and leave the premises. Bring the evacuation folder if you can.
2. Call the fire brigade (emergency services).
3. Try to extinguish the fire only if safe

Burns: Clothes should be quickly and carefully removed from burns. Rinse with plenty of water for at least half an hour and contact a medical doctor. Burns involve a high risk of chock.

Remember - when someone is hurt: warmth, rest, ventilation and careful handling.

Emergency shower and eyewash station

An emergency shower and eyewash station are located near the lab entrance. In or outside your lab, locate.

Eye injuries

Description

The eyes are very sensitive to most chemicals and objects that enter the eye. Acting quickly is outermost important.

Main Risk

Chemicals and objects may enter the eye by accidents related to the experimental setup. In addition, your hands or gloves may be contaminated, posing a risk of introducing chemicals by touching your eyes.

Preventive measures

Always use safety googles and never touch your eyes with your hands before you have washed your hands.

Actions in case of accident

Use the eye showers located inside or outside your lab. Rinse the eyes with plenty of water and continue to rinse until a medical doctor is consulted. In case of an accident, help out the injured co-worker with the rinsing, calling and transport to hospital.

At each eye shower station, you find a sheet with more information.

Spills and chemical accidents

Description

Cleaning up chemical spills taking care of smaller accidents must be performed as soon as possible to avoid cross-contamination and uncontrolled chemical reactions.

Main Risk

Uncontained chemicals are a serious risk for co-workers as well as one-self for their own toxicity and their potential interaction with other substances present in their surroundings and its own uncontrolled disposal. Inefficient communication may lead to further unforeseen risks and concerns among your colleagues.

Preventive measures

Whenever possible use secondary containers (trays, buckets, boxes, etc…) for storage and transport. General good order in the laboratory is also strongly encouraged. Special care should be taken with larger volumes or particularly toxic substances.

Actions in case of accident

Spill: Inform people around you and contain the area of the spillage. Consult MSDS for specific information. When appropriate, use vermiculite and/or absorption paper to clean up the zone. Absorption paper could be found in the lab emergency/first aid area. For serious accidents if the lab needs to be emptied and closed you can find a chemical accident kit (including gas masks) in the orange safety cupboard in the corridor. A kit for special antidotes for hydrogen fluoride (HF) contamination can be found in lab 8 (A612).

Chemical splash: If you get a chemical splash, remove immediately any affected protective clothing and rinse immediately with abundant cold water (or use the laboratory shower) any other affected areas in the body, unless otherwise indicated on the MSDS of the substance. When safe, take care of the cleaning of the workplace as indicated in the “spill” section above.

Reporting of accidents

Description

Critical emergencies are rare. The first priority (besides calling for help) is to reduce or eliminate the hazard: turn off the gas, open the windows, shut off the power supplies, and so on. If the victim isn't breathing, immediately do what you can to get breathing started (CPR). If the victim is breathing and out of immediate danger, you can wait for help to arrive. Call the ambulance and describe as accurately as possible what happened. Whenever an ambulance is called, someone should wait by the building entrance to guide the medical crew to the accident site.

Actions in case of accidents

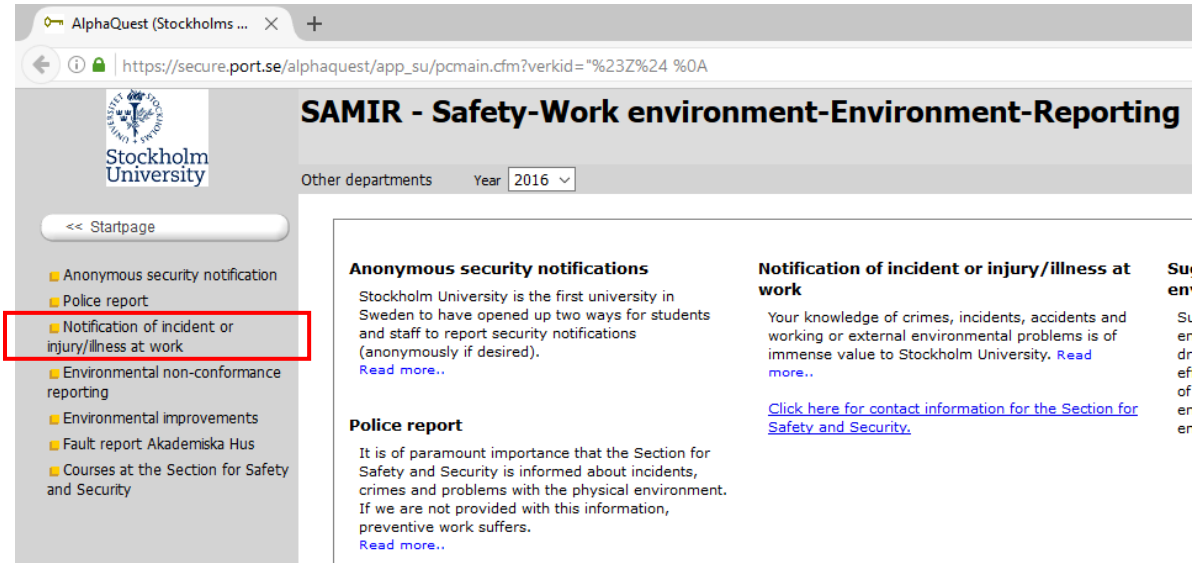
Report all accidents immediately, no matter how small, to the laboratory instructor or a staff member. If practical, the staff member should administer first aid.

After first-aid measures taken an incident report form should be completed as soon as possible, so the description is as accurate as possible. The accidents are reported by using the web form, available at the universities webpage.

www.su.se -> Medarbetare -> Mitt universitet, portal -> SAMIR – Säkerhet-Arbetsmiljö-Miljö-InRapporttering

Or direct via:

https://secure.port.se/alphaquest/app_su/pcmain.cfm?verkid=%22%23Z%24%20%0A


AlphaQuest (Stockholms ...
https://secure.port.se/alphaquest/app_su/pcmain.cfm?verkid="%23Z%24 %0A
Stockholm University
SAMIR - Safety-Work environment-Environment-Reporting
Other departments
Year 2016
<< Startpage
Anonymous security notification
Police report
Notification of incident or injury/illness at work
Environmental non-conformance reporting
Environmental improvements
Fault report Akademiska Hus
Courses at the Section for Safety and Security
Anonymous security notifications
Stockholm University is the first university in Sweden to have opened up two ways for students and staff to report security notifications (anonymously if desired).
Read more..
Police report
It is of paramount importance that the Section for Safety and Security is informed about incidents, crimes and problems with the physical environment. If we are not provided with this information, preventive work suffers.
Read more..
Notification of incident or injury/illness at work
Your knowledge of crimes, incidents, accidents and working or external environmental problems is of immense value to Stockholm University. Read more..
Click here for contact information for the Section for Safety and Security.

Experimental workflow

Routine for the new co-workers

Each supervisor is responsible for introducing new co-workers to the safety rules and routines at the department. Make sure that new co-workers understand the information given by the administrative staff and add specific safety information that is relevant to your group.

Order in the laboratory

Description

The supervisors are responsible for the order in the laboratory, and looking after the good practice and safety policies in the lab. All labs have a dedicated person called the “lab boss”, whose picture can be found at the entry door of the lab. The co-workers have to follow the instructions of the lab-chief. If a co-worker repeatedly defies the instruction(s) of the lab-chief, the co-worker will not be permitted to perform work in the laboratory.

Preventive measures

The lab boss has to contact with the supervisor or the safety officer in case irregularities happen in the lab. The supervisor and the lab boss allocate time to check the proper order in the lab and keeping the safety rules.

Planning experiments

Personal safety protection

Lab coat

Description

Many clothing items made with synthetic fabrics will melt in heat or fire causing severe burns. Lab coats are generally made of cotton or specialized fabrics that will not melt.

Main Risk

Spreading contaminates from the laboratory to your home or the common areas of the department, *e.g.,* the kitchen.

Preventive measures

Lab-coats and protective glasses must be used in the lab and the rotavapor room.

Actions in case of accident

If something splashes onto your lab coat or your coat catches on fire take the rapidly the coat off, which will always be easier than to remove contaminated conventional clothing.

Safety googles

Description

Your eyes are particularly sensitive areas that require special protection to avoid irreversible injuries.

Main Risk

Irreversible injuries in the eyes may lead to decreased or loss of vision with obvious consequences in the development of your personal and professional life.

Preventive measures

Safety googles must be worn always in experimentation areas. Familiarization with the location and operation of eye washers is mandatory.

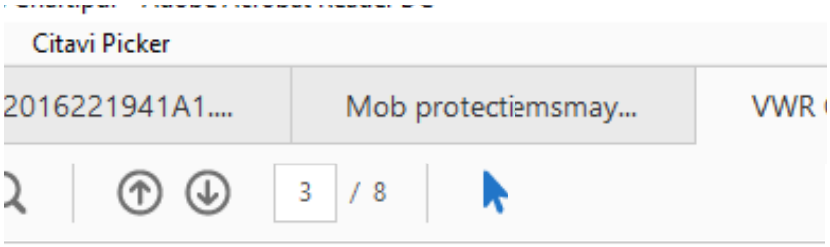
Actions in case of accident

Wash your eyes with abundant water and the help of the eye washer in case it is necessary. Please refer to the Eye injuries section in this document.

Gloves

Description

Be aware that “protective gloves” in the organic laboratory may not offer complete protection beyond small splashes. They are generally very permeable to many organic liquids. The time that a glove protects the user versus the effects of a solvent is a function of the chemical nature of the solvent, as follows (these are orientative values, for details consult the specifications from the manufacturer):



		Nitrile		
Chemical Name	CAS No.	D	BT	PR
Hexamethylene	110-82-7	F	I/D	I/D
Perchloromethane	56-23-5	F	3.4 hrs	5
*Hydrochloric Acid (37%)**	7647-01-0	E	>6 hrs	N/D
Hydrofluoric Acid (48%)	7664-39-3	G	1 hr	0.49
Iodomethane	74-88-4	I/D	I/D	I/D
Isobutyl Alcohol	78-83-1	E	>8 hrs	N/D
*Isopropyl Alcohol**	67-63-0	E	>6 hrs	N/D
Ketohexamethylene	108-94-1	P	I/D	I/D
Methacrylonitrile	126-98-7	P	7 min	560
*Methanol**	67-56-1	F	32 min	11.8

D= degradation; BT= breakthrough time; PR= Permeation rate.
P= poor; G= good; F= fair; E= excellent.
Source VWR Glove Chemical Resistance Guide

Main Risk

Prevent skin-contact with chemicals while avoiding cross-contamination of common areas. Gloves with an undetected pinhole can lead to un-noticed long-time contact with the chemicals and needs to be avoided.

Preventive measures

Handle solvents and chemicals with care even when using gloves and remove the gloves if they get contaminated, avoiding any unprotected contact with the contaminated area. Gloves are only to be used when working in the fume hood and balance areas. Avoid to any extent possible using them when getting chemicals from the storage facilities or using the rotary evaporators and other analytical instruments.

Actions in case of accident
Rapidly remove the gloves, avoiding any unprotected contact with the contaminated area. For a demonstration of the correct technique to do this, please refer to online videos (for example YouTube – Glove Removal)

Regulated substances
Any regulated substances at the department require special permits from the appropriate national regulatory agency to allow storage and experimentation. The research groups must have the appropriate documentation in place, elaborate a risk assessment and inform the safety officer.

Risk assessments
The analysis of the risks that are specific to each research project must be elaborated before the experimentation and revised/approved (signed) by the supervisor or the team member in lieu of the supervisor. This analysis should be documented by including the main risks associated with the experimentation, any relevant preventive measures and the actions in case of accident.

Pregnancy awareness
Our department has a routine to accommodate special safety demands for pregnant women. Contact the administration as soon as possible in order to call attention to pregnancy or breastfeeding, since health risks are greatest during early pregnancy. After the contact with administration, it is the department's responsibility to immediately carry out an individual risk analysis (safety officers, supervisor and the employee)
Pending the analysis, the employees cannot go into the lab. See information on our website.

Handling chemicals
Transport and borrowing
Collegial borrowing of chemicals is common and based on the good will and mutual benefit of the researchers in our institution. However, this leads to an additional source of disorder in our potentially hazardous goods. To keep track of the location of each chemical at anytime, we have lists of borrowed chemicals in each lab that must be filled in (after getting permission from at least one of the members of the research group) before the chemical is transported out of the laboratory where it belongs.
To transport chemicals between laboratories, appropriate secondary containers like buckets must be used for transportation. This limits the chance of uncontrolled spillage of potentially smelly, explosive, corrosive and irritant substances in our corridors.

Registering chemicals
Description
All groups have a dedicated person that is responsible to keep track of the inventory of the group in KLARA.
Main Risk
If major accident happens the authorities (fire-workers, police etc.) need explicit knowledge about the chemicals stored in every place of our building. Particularly, the exact location of oxidizing, flammable, explosive, pyrophoric, water-sensitive substances is vitally important for extinguishing fires. Violation of the above rules for registration of chemicals may put fire-workers or other rescue personal in a dangerous situation

Preventive measures

Keeping up to date information of all chemicals via registration in KLARA.

The person, who ordered the chemical (and/or received it) is responsible to inform the person who makes the KLARA registration. At least once a year all chemicals linked to the projects of a certain research group have to be checked. In case the status of the chemical changes (for example it has been used up) the change has to be registered in KLARA.

Actions in case of accident

In case of major accident, the KLARA information will be used by the authorities.

Storage of chemicals

Description

Most the time our chemicals are stored and thus choosing the best storage location is essential to minimize the risks of their native reactivity and avoid uncontrolled decomposition reactions.

Main Risk

Thermo-unstable chemicals can decompose even at room temperature. Therefore, internal overpressure can be generated in the bottles. During long time storage the containers can be cracked and the chemicals may leak. This is particularly dangerous for air-unstable and pyrophoric chemicals (see section Pyrophorics).

Preventive measures

All thermo-instable chemicals have to be kept in refrigerator (see the sign on the package, pictogram and the attached description). The thermo-stable chemicals have to be kept in ventilated cupboards. Air sensitive chemicals can be stored in glove box. The use of vacuum desiccators may be a source of additional risks and it is thus discouraged.

Check the stored chemicals frequently but at least once a year. In particular, when the laboratory temperature increases (summer) the thermo-unstable substances may decompose and the containers can be cracked (see above). Immediately remove and destroy chemicals with cracked bottles or lids. In summer time refrigerators may easily broke down, often because of the overloading of the compressor. In this case the refrigerator's alarm sounds. Immediately move all chemicals to another refrigerator.

Actions in case of accident

In case of smaller accidents contact with the lab-chief and the lab-chief will contact with the supervisor. If the refrigerators or cupboards are contaminated the decontaminating substance has to be removed and the storage place must be cleaned. In case of serious accidents see the measures above.

Chemicals requiring extra precaution

Reactive chemicals

Please consult any MSDS and the lists in the appendices prior to lab-work.

Some chemical compounds are particularly reactive and may, if not handled with care, give rise to highly exothermic reactions. If these compounds end up in the disposal containers for solvents, exothermic and/or dangerous reactions may occur.

Clean-up any spills and use proper methods for their destruction. A few examples are presented below.

Alkylating

Description

Substances like *methyl iodide* (CH_3I), boiling point 42°C, and *benzyl bromide* are commonly used in synthetic chemistry and should be handled with great care to prevent harming yourself and others around you.

Main Risk

These substances are lachrymators, allergenic and potentially carcinogenic.

Preventive measures

When using alkylating substances, these should be handled with great care in ventilated areas. All contaminated equipment should be cleaned with the antidote before it can be taken out of the fume hood. Thus, a beaker of recently mixed antidote (see below) should always be available in the fume hood when operating with these substances.

Actions in case of accident

Alkylating substances can be rendered harmless by a mixture of **NH_3(aq) : ethanol 1:1** (v/v). Contaminated laboratory equipment shall be cleaned immediately with the same mixture.

Acids-bases

Description

Acids and bases are very common reagents in chemistry laboratories. Despite being normally handled in low concentrations, these solutions are prepared in our premises from very concentrated / saturated solutions. The corrosive nature of these substances highlights the importance of being handled appropriately.

Main Risk

The solvation of strong acids and bases are largely exothermic, that can lead to aggressive boiling and bumping that may result in a corrosive splash on the researcher.

Concentrated solutions may always produce acidic and basic fumes that require a ventilated fume hood to avoid exposure to them.

Preventive measures

Dilution of acids shall be carried out by carefully pouring the acid into water. Dilution of solid bases should be performed with gentle stirring and portion-wise addition.

Actions in case of accident

Wipe off any spillage of corrosive substances **immediately** and rinse (flush) with large amounts of water.

For the decontamination of acyl chlorides, acid anhydrides and strong acids, use an aqueous solution of $NaHCO_3$ or Na_2CO_3 until the formation of CO_2 gas ceases. The salts formed shall be collected or flushed down the drain.

For the decontamination produced by strong bases and small amounts of amines may be done using dilute hydrochloric acid solutions. Large amounts of amines may be decontaminated using diluted hydrochloric acid to adjust the pH to below 5 and then collecting the solution for proper disposal.

Spillage - person

If you get an acid or base on the skin, always stop what you are doing immediately and flush with large amounts of water for a long time. More specifically:

1. *Acid or base on the skin:* Rinse (flush) with large amounts of water for a long time. Rinse at the site of the accident, during transportation to hospital and in the waiting room. Never try to neutralize an acid or base on the skin. *It is **not possible** to titrate to neutral pH in a porous mass without effective stirring!*

2. *Acid or base in the eye:* As above but use the emergency eye wash.

3. *Acid or base which has been swallowed:* Drink a lot of water, or milk if it is available. Immediately contact a medical doctor. Do *not* induce vomiting.

Bromine

Description

Bromine (Br_2) is a useful and cheap reagent that is commonly used for the preparation of building blocks in a stereoselective fashion. However, this red liquid produces toxic and reactive vapors that can damage your skin and the respiratory system and any other soft tissues (like your eyes).

Main Risk

Bromine is a volatile and corrosive liquid which produces corrosive vapor.

Preventive measures

In the fume hood, with rubber gloves and your arms covered by the laboratory coat sleeves. When working with bromine, a saturated sodium thiosulfate solution ($Na_2S_2O_{3\ (aq)}$) must always be ready and available in the fume hood (thiosulfate is a reducing agent; $Br_2 \rightarrow 2Br^-$). Use this solution to destroy any spillage and to clean all laboratory equipment that has come into contact with bromine.

Actions in case of accident

In case of having skin contact with bromine, wash the affected zone with the above thiosulfate solution (alternatively sulfite solution) and then rinse with plenty of water.

Hydrides

Description

Hydrides and hydride sources are clean and reactive bases and reducing agents but are also a potential source of H_2 gas that may cause a fire or explosion.

Main Risk

Hydride reagents like KBH_4, $NaBH_4$ and $LiAlH_4$ will produce hydrogen gas, H_2, when coming into contact with protic compounds/solvents.

Preventive measures

Contact with water is a fire hazard. Such compounds shall be slowly destroyed in alcohol unless other directions are given.

Actions in case of accident

Any spillages shall be collected with paper which is then soaked in alcohol for destruction.

Gases (H_2, CO, O_2, O_3, NH_3)

Hydrogen, H_2

Description

Hydrogen (H_2) is a colorless and tasteless gas contained in steel bottles under high pressure. It is much lighter than air (therefore will collect in roof spaces).

Main Risk

It forms explosive mixtures with air and oxygen. Mixtures with air between 4% and 74% hydrogen by volume are explosive. It takes very little energy to ignite an air/hydrogen mixture- an electrostatic spark is often enough.

Preventive measures

The department has installed high-pressure apparatus for use of hydrogen under controlled conditions in the high-pressure lab A675a. This room is EX-classified, it have four fume hoods with separate ventilation and is equipped with two locked, steel cabinets that houses up to four gas bottles as well as the valves controlling the flow of gases to the separate fume hoods. There are special hydrogen and CO detectors installed inside the cabinets and

also in the room. Experiments are carried out in high-pressure steel bombs that are installed in the fume hoods. Access to the cabinets and the valves that control the gases are restricted to the technician who replaces empty bottles with new ones and one PhD student who is appointed to train any new users of the pressure apparatus.
The low-pressure apparatus can be used after training and following the instructions that are kept in the room (see appendix "Instructions for the glass pressurized reactor").

Actions in case of accident

If the leak is small, attempt to close off the cylinder valve but **do not endanger yourself**. Eliminate all sources of ignition, ventilate and evacuate the laboratory. BEWARE of approaching a possible hydrogen leak since the gas burns with an almost invisible flame - carry a rolled up newspaper in front of you to check for a flame.

Carbon monoxide, CO

Description

Carbon monoxide (CO) cost efficiency compared to other routes of CO incorporation into organic molecules. For this reagent several safety concerns are accompanying its use, like acute toxicity when inhaled and its fire hazards. In particular, carbon monoxide (CO) gas is a colorless and tasteless poisonous gas contained in steel bottles under high pressure.

Main Risk

Exposure to carbon monoxide can lead to toxic effects on the central nervous system and heart, ultimately also to death. Danger of serious damage to health by prolonged exposure. Symptoms of CO-poisoning are many and are not only evident at high concentrations. Low concentrations (500-1000 ppm) of the gas cause headache, fatigue, weakness, dizziness, nausea, and mental confusion. Skin, mucous membranes and lips appear a bright red color due to the formation of carboxyhaemoglobin in the blood. Exposure to high concentrations (4000 ppm and above) causes coma and death. People suffering from heart problems are especially affected by the exposure to low concentrations of CO.

Preventive measures

Before use, you must contact personnel in charge of CO at the department for formal training. The carbon monoxide needs to be handled and stored in well ventilated areas (e.g. fume hood) and in the presence of a CO detector. Any transportation of CO gas has to be in a safe and sealed container (not just a balloon) together with a CO-detector. More information will be given by personnel in charge of the CO gas.
High-pressure lab A675a. The department has installed high-pressure apparatus for use of CO under controlled conditions in the high-pressure lab A675a. This room is EX-classified, it have four fume hoods with separate ventilation and is equipped with two locked, steel cabinets that houses up to four gas bottles as well as the valves controlling the flow of gases to the separate fume hoods. There are special hydrogen and CO detectors installed inside the cabinets and also in the room. Experiments are carried out in high-pressure steel bombs that are installed in the fume hoods. Access to the cabinets and the valves that control the gases are restricted to the technician who replaces empty bottles with new ones and one PhD student who is appointed to train any new users of the pressure apparatus.

Actions in case of accident

Turn off the source of the CO-leakage without putting yourself or anyone else in danger, if not possible evacuate the area close to the source and inform personnel. Remove from source of exposure. If breathing stops or shows signs of failing apply artificial respiration. Give oxygen where necessary or move to an area with fresh air. If you are indoor go outside. Call 112, if you or anyone shows any symptoms of CO poisoning.

Oxygen, O_2

Description

Oxygen gas is used as the oxidant in many laboratory scale reactions and so far only found limited applications in industries. It is an environmentally friendly oxidant, however, in high concentration together with flammable materials it can become explosive. Materials that are significantly not flammable under air, can become flammable when oxygen levels reach 100%.

Main Risk

Since it is an oxidant, intensive fires are the main concerns. All compressed gases can upon heating be an explosive (see section Compressed gases)

Preventive measures

If you are not accustomed to use gas regulators, ask responsible personnel for training. Only use the oxygen in ventilated areas. Beware of the increased risk of fire when heating reactions under the atmosphere of oxygen and only a moderate increase of oxygen in the air can result in an increased risk of fires. Keep away from source of ignition.

Actions in case of accident

In case of leakage, try to close the cylinder valve without putting yourself or any other person in danger. Eliminate all sources of ignition, ventilate and evacuate the laboratory. In case of exposure move to an area with fresh air. In case of fire see further guidelines in the section Fire and extinguishers.

Ozone, O_3

Description

Ozone is a strong oxidizer gas that is generated using very high electrical potentials using oxygen as a source and applied to solutions that are normally cooled at very low temperatures.

Main Risk

Beyond the oxidizing properties of ozone, there are important risks associated with the use of oxygen (see above), high electric potentials (see section Electrical equipment) and cryogenic equipment (see section Cryogenics). Therefore, the risks of handling ozone should be assessed particularly thoroughly.

Preventive measures

If it is the first time you use the ozone generator, seek the supervision of the ozone generator responsible person (PhD responsibility list) and the floor technician to move the oxygen tank.

Safely transport to a clean and cleared ventilated fumehood the ozone generator, a pressurized oxygen tube and any required cryogenic equipment. Make sure there is a grounded electrical connection for any electrical equipment close to your experiment. Check that the ventilation of the fumehood is strong and set it in high-flow (emergency-mode) if required. Set the connections so that the sash can be low and the experiment can be visually monitored from outside the fumehood.

When ready to apply ozone in the experiment, make sure you wear thick rubberized gloves, open the flow of oxygen making sure that the outlet is secured inside the fumehood and check that the flow is within the recommended thresholds. Start the electrical generator and check that ozone is being generated. Then apply it to your experiment.

When deemed complete, displace any excess ozone out of the piping system by keeping the glass flow with the electrical generator off (1-2 minutes should suffice in most cases). Then turn of the gas flow (in order until you close the main valve) and disconnect the ozone generator from the electrical supply.

Actions in case of accident
Depending on the nature of the accident, refer to the corresponding section for oxygen in this document.

Ammonia gas, NH_3
Description
Ammonia gas (NH_3) is a colorless gas contained in steel bottles under medium pressure. It is severely irritating to eyes and lungs.
Main Risk
It is irritating to the eyes and lungs; breathing it can lead to severe poisoning. However, the human nose can detect ammonia at well below danger levels. For a 15-minute exposure, the concentration in the atmosphere should not exceed 25 mg per m^3.
Preventive measures
The department stores medium-pressure 2 liter steel bottles with ammonia gas in a special gas cabinet inside the EX-classified storage room A673.
Any work with ammonia gas is to be carried out in ventilated fume hoods, being temporarily marked with a warning sign "Gas bottle - Ammonia". To reduce risks, the smallest volume possible should be used and proper eye-protection worn at all times. No laboratory equipment is taken out of the fume hood until all remaining ammonia has evaporated completely.
Actions in case of accident

- in eye: Flood the eye with gently-running tap water for at least 20 minutes (for alkalis). See a doctor. If it is necessary to go to hospital, continue washing the eye during the journey in an ambulance.
- vapor breathed: Remove the casualty to fresh air. Call a doctor if breathing is difficult.
- spills on skin and clothes: Remove contaminated clothing. Drench the skin with plenty of water. If a large area is affected or blistering occurs, see a doctor.

Silica dust
Description
The silica powder used for column chromatography generates a lot of dust when handled that is harmful for the researcher and others around him.
Main Risk
The silica dust particles collect in the lungs and may cause silicosis in the long term. Silica also dries out the skin.
Preventive measures
Silica must therefore always be handled in the fume hood and with gloves. Breathing mask must be used if handling outside the fume hood is necessary. Used silica shall be disposed of in the solid waste container using zip-bags.
Actions in case of accident
Seek medical advice and report the accident to take further actions.

Reactive metals
Description
Reactive metals (like elemental sodium or lithium) are used commonly as strong reducing reagents. Their excellent reactivity however are also a source of risk as they may react violently with abundant chemicals like water, producing heat, sparks and highly explosive hydrogen gas that may auto-ignite.

Main Risk

Reactive metals will react violently with water, amines and alcohols, releasing hydrogen gas (explosive) that can be auto-ignited.

Preventive measures

Let at least one of your laboratory colleagues and/or laboratory boss know that you will be using/destroying these reagents.

Alkali metals must therefore be stored suspended on hydrocarbons with high boiling points (e.g. petroleum ether, paraffin oil). Any remaining metals must never be disposed of into sinks, drains or buckets and should be chemically destroyed in a fume hood before disposal. For example, sodium metal is destroyed by placing **small** pieces into a beaker of ice-cold ethanol. The reaction can be sluggish and may have a lag time so do this operation slowly. Seek advice if necessary.

Actions in case of accident

Reactive metals produce basic solutions (when reacted with water) and should be rinsed with abundant water. In case of fire produced by reactive metals, use the **powder extinguisher**.

Heavy metals

Description

Our Department does directly and indirectly a lot of research using transition metal catalysts. Beyond their utility in synthesis, it is important to be aware of their effects in our health in the long term and in our surrounding environment.

Main Risk

Chronic poisoning and accumulation in tissues and the environment.

Preventive measures

Strict personal safety protection must be used when using heavy metal containing substances and ventilated fume hoods should be using particularly strictly when using liquid and/or volatile heavy metal reagents.

Actions in case of accident

Any mercury spillages must be immediately and carefully captured since the vapors can cause chronic poisoning. Spilled mercury shall be captured using mercury tongs, or amalgamated using a zinc plate. (Amalgamation; dip a zinc plate into concentrated HCl, rinse with H_2O and then place the zinc plate at the edge of the mercury droplet.). No mercury-containing equipment should be present in the lab, contact your supervisor if you find any.

Explosives

Description

Explosive (and potentially explosive) substances have obviously, a unique safety status in the risk evaluation and execution of synthetic chemistry. This is due to the fatal risk associated for your colleagues and the rest of the building.

Main Risk

Explosions may lead to fatal injuries and are a risk for thousands of people in the building.

Preventive measures

Experiments involving explosive reagents should be conducted in the smallest scale possible under a blast shield or similar physical barrier between the researcher and the experiment. Preparative-scale experiments (even if previously described in scientific publications) should be conducted in small scale first to familiarize the researcher with the procedure and

handling. Under any circumstances should a preparative experiment involving explosive substances be conducted without informing the Head of the Department.

Actions in case of accident

Small explosions should be immediately reported to the laboratory boss, the safety officer and the research supervisor. No further related experimentation is allowed until further evaluation and actions are taken to design and execute future experiments.

Pyrophorics

Description

Pyrophoric reagents have an excellent reactivity and may not be possible to be replaced by safer reagents. Thus, in organic synthesis we use them often using standard and/or advanced inert atmosphere techniques.

Main Risk

Pyrophoric materials ignite spontaneously in air at temperatures below 55°C.

Preventive measures

Any handling of pyrophoric reagents and explosives must be clearly documented in the lab-book, AND discussed with your supervisor in advance. Identify in your risk assessment the correct type of extinguisher to be used in case of fire.

Handling

Pyrophoric Solids: Seek advice on how to use Schlenk techniques to handle solids under inert atmosphere. Consider the possibility of using them in a glove box flushed by inert gas with permission of the glove box responsible. Flush containers with inert gas before storage

Pyrophoric Liquids: By using proper needle and syringe techniques, these reagents can be handled safely in the laboratory. Always transport them using a solid cap in a secondary container (bucket or similar).

Pyrophoric Gas: see the relevant section on this document.

You must demonstrate that you know how to work with those types of substances prior to use. For potential explosives such as azides and diazo compounds you must be trained by your supervisor before you can work with them.

Actions in case of accident

Apply the contingency measures planned in your risk assessment agreed with your supervisor.

Flammables

Description

Flammability is the ability of a substance to burn or ignite, causing fire or combustion normally requiring an external ignition source (spark, flame or hot surface).

Main Risk

Flammable compounds are an evident fire hazard.

Preventive measures

Be aware of the emergency procedures in case of fire and the status and location of the nearby extinguishers. Handle flammable substances wearing appropriate personal protection and work as far as possible from ignition sources such as ovens and hot surfaces.

Actions in case of accident

Apply the contingency measures planned ahead in your risk assessment and the emergency procedures in case of fire. In case it is required, use the personal shower that is present in the safety area of every laboratory.

Toxics and carcinogenics

Description

These substances are a threat to your health and those around you in both the short and the long term. Therefore, precautions are to be taken to avoid exposure to their effects.

Main Risk

Toxics and carcinogenics are harmful both acutely and chronically.

Preventive measures

These substances must be stored in ventilated cabinets and should be handled in well ventilated areas with strict personal protective equipment. Specific toxicity/carcinogenicity level should be assessed before experimentation by consulting the MSDS for the substance and/or any relevant appendixes in this document.

Actions in case of accident

Apply the counter-measures advised in the MSDS and other relevant sources that have been used in the special risk assessment mentioned above.

Corrosives

Description

Several common reagents are corrosive, such as for example: Sulfuric acid, nitric acid, hydrochloric acid, **alkaline hydroxide solutions** (e.g. sodium hydroxide), bromine etc.

Main Risk

Corrosive substances can cause severe injuries and harm to the body (especially to the eyes) and the clothes. The concentrated reagents are the most hazardous.

Preventive measures

Carefully identify corrosive reagents at the planning stage of your experiments (risk assessment) by consulting the MSDS and plan the actions to be taken in case of accident before conducting the experiment. Handle these substances with strict protective equipment and select this equipment (particularly gloves) according to its resistance to the specific substance.

When the containers of these chemicals are damaged or severely aged, seek immediately advice from your supervisor to transfer the substance safely into a new appropriate container. If the appearance is inhomogeneous or there is any other sign or educated suspicion that the reagent has decomposed or may be unsafe to handle, consult MSDS and/or other online material and agree with your supervisor on the procedure to destroy it safely. Remember that some of these reagents may be most safely destroyed outdoors by a group of experienced chemists.

Actions in case of accident

Apply the actions planned in your risk assessment, seek medical advice (if required) and report the accident to your supervisor and the safety officer.

Oxidizing

Description

Oxidant reagents can cause or contribute to the combustion of another material. Therefore special considerations are to be taken when using these reagents together with combustible compounds like pyrophorics and flammables.

Main Risk

Oxidizing agents, e.g. potassium permanganate ($KMnO_4$) and fuming nitric acid (HNO_3) may cause fires in flammable materials.

Preventive measures

Careful inspection of MSDS must be performed and evaluation of the risk of the specific oxidizing reagent to be used needs to be done before the experiment is performed.
It is highly dangerous to mix ethanol and HNO_3 as severe explosions can occur. This also applies to other alcohols.
When the containers of these chemicals are damaged or severely aged, seek immediately advice from your supervisor to transfer the substance safely into a new appropriate container. If the appearance is inhomogeneous or there is any other sign or educated suspicion that the reagent has decomposed or may be unsafe to handle, consult MSDS and/or other online material and agree with your supervisor on the procedure to destroy it safely. Remember that some of these reagents may be most safely destroyed outdoors by a group of experienced chemists.

Actions in case of accident

Dilute any spillages of fuming HNO_3 with water. Destroy potassium permanganate with a fresh water solution of sodium pyrosulfite ($Na_2S_2O_5$).

Allergenic

Description

These include most organic solvents, halogenated hydrocarbons, aromatic nitro compounds and many amines. Some metals can be allergenic too – for example nickel and chromium. These substances can easily cause an allergic reaction and it is best to protect the skin against direct contact by wearing gloves. It is also important to take particular care with any spillages, e.g. on scales, work benches etc. Remember that substances which are not harmful to you may cause severe harm to others.

Main Risk

Some of the above substances can very easily penetrate the skin and cause poisonous effects even at very low concentrations.

Preventive measures

Solid chemicals shall be taken from the container using a spatula or spoon (NEVER use your fingers). Liquid chemicals shall be handled using a clean pipette. Any spillages must be removed immediately! See also the text on clean-up of reactive chemicals. Wash off all smelling compounds and irritant (to skin or eyes) compounds and reagents in the fume hood (e.g. pyridine, benzyl bromide, benzoyl chloride).

Actions in case of accident

Should an allergic reaction occur, contact your supervisor, safety officer or the closest medical center immediately for advice.

Solvents

Description

Many organic substances are flammable. Organic solvents are the most hazardous in this respect. Many organic solvents are volatile. The vapors produced are heavier than air and may therefore flow along work benches and be ignited by warm objects nearby (e.g. diethyl ether, toluene and petroleum ether).
Definitions: The *flash point* of a volatile liquid is the lowest temperature at which it vaporizes to form an ignitable mixture in air. The *autoignition temperature* is the lowest temperature at which a flammable liquid will self-ignite in the absence of sparks or flames.

Main Risk

Some organic solvents have low ignition temperatures (e.g. carbon disulfide 100° C and ether 180° C) and can be ignited through contact with an electric water bath, hot plate or similar.

Preventive measures

No solvent bottles can be stored outside the yellow cabinet. Make sure that the bottles return in the right place after use, and don't leave any bottles on the bench. The amount of flammable solvents (flash point <100^{0}C) should not exceed 10 liters per fire cell (in the lab, non-ventilated areas). The amount of flammable solvents (flash point <100^{0}C) should not exceed 50 liters per fire cell (in the lab, both ventilated and non-ventilated areas).

The yellow cabinets (90 min) are separate fire cells for storage – unlimited storage amount. Organic solvents must ***never*** be heated over an open flame or on the hot plate directly – use an oil or water bath.

Because of the risk of explosion, compounds with low flash points (ether, petroleum ether and carbon disulfide) must be stored in special refrigerators or freezers. Most solvent vapors are poisonous or harmful. Solvent must therefore always be handled in fume hoods and with great care. Chloroform and dichloromethane, for example, are allergenic and included in the C-list of carcinogenic substances of the Swedish Work Environment Authority. All solvents shall be disposed of in specific marked containers (halogenated and non-halogenated respectively) – with the exception of ethers, which shall be placed in a beaker and left to evaporate in the fume hood.

Ethers which have been left for a while, especially in the light, may produce peroxides that can explode without being exposed to a flame or sparks. Ethers (e.g. diethyl ether, dioxane, diisopropyl ether and tetrahydrofuran (THF)) must therefore be regularly tested for peroxide content. If the test is positive, the batch cannot be used under any circumstances and should be appropriately labelled and reported to the safety officer.

***Test for peroxide content in ethers:*

Peroxide test sticks are recommended for testing, refer to the instructions on the packaging. The alternative is to use an acidified (dilute hydrochloric acid) potassium iodide solution, *KI solution*. Swirl the KI solution together with the ether in a test tube. The ether will turn brown immediately (dark brown, not yellow brown) in the presence of peroxide. *Note: The ether will also turn dark on standing due to oxidation by air.*

Actions in case of accident

In case of fire, toxic inhalation or explosion, apply the policy described in the relevant section in this paper.

Compressed gases

Description

Gaseous substances are conveniently stored in gas cylinders that are normally highly pressurized to maximize the storage capacity and a practical schedule of supply. However, the high pressure requires special routines for its handling.

Main Risk

They may explode if handled carelessly or the valves may be damaged. They can also lead to uncontrolled propulsion of their own body to harm people, equipment and other uncontrolled events that are particularly dangerous in a laboratory (chemicals, etc…).

Preventive measures

Gas tubes must be tied securely to prevent them from falling over with the help and approval of the floor technician. Gas tubes must also be kept away from any heat sources as they must not be heated. You must put a sign on the door when gas tubes are in use/stored in the lab (seek advice from the safety officer).

They should never be stored with the pressure reduction valve installed.

Transportation of Cylinders: the cover cap should be screwed on hand tight to protect the valve, until the cylinder is in place and ready for actual use. Cylinders should never be rolled

or dragged. They should never be transported with pressure reduction valve installed. Large cylinders should be strapped to the wall at all times regardless of their use status. If you plan to move a gas cylinder, plan with the floor technician the new location before you move it.

Actions in case of accident

Refer to the relevant sections in this document depending on the nature of the accident.

Biological substances

Description

The biological laboratory and all of the substances therein is regulated by Biosafety Level 2 (BSL-2) restrictions. BSL-2 is suitable for work involving microbiological agents that pose moderate hazards to personnel and the environment. The laboratory personnel have specific training in handling pathogenic agents and are supervised by fellow scientists competent in handling infectious agents and associated procedures. The access to the laboratory and the biological substances is restricted when work is being conducted and all procedures in which infectious aerosols or splashes may be created are conducted in Biological Safety Cabinets (BSC) or other physical containment equipment.

Main Risk

Infectious aerosols and splashes of biological processes and samples can cause on personnel and lead to contamination of the environment.

Preventive measures

Persons must wash their hands after working with potentially hazardous materials and before leaving the laboratory. All procedures have to be performed in a way so that it minimizes the creation of splashes and/or aerosols. All cultures, stocks, and other potentially infectious materials have to be decontaminated before disposal using appropriate and effective method. Depending on where the decontamination will be performed, the following methods should be used prior to transport:

1. Materials to be decontaminated outside of the immediate laboratory must be placed in a durable, leak proof container and secured for transport.
2. Materials to be removed from the facility for decontamination must be packed in accordance with applicable local, state, and federal regulations.

Actions in case of accident

The work surfaces have to be decontaminated after any spill or splash of potentially infectious material with appropriate disinfectant.

Experimental techniques

Ventilated areas

Description

Fume hoods are extensively used in laboratory experimentation and should be operated appropriately to obtain their protection.

Main Risk

Unawareness of low ventilation flow and inefficient protection.

Preventive measures

The ventilation and alarms for the fume hood are regulated via a small digital display on the outside of the fume hood beside the sash.

Check that the fume hood is activated – the light beside the text ”normal” shall be lit.

Check the flow meter which is situated on the display box to ensure that the air flow in the fume hood is sufficient. Normal flow when in use is 0.5-0.6 m/s. If the display shows the text

”setback”, and the air flow is around 0.3 m/s, press the ***setback*** button; this activates the fume hood.
An alarm will sound if the air flow becomes too high or too low in the fume hood. *This means that the fume hood is not working properly.* If the fume hood sash is closed the air flow goes back to normal and the alarm signal is turned off. If the fume hood must be left open (e.g. during equipment assembly), the alarm can be turned off by pressing the ***mute*** button. *This means that the alarm will not sound despite the unsatisfactory ventilation in the fume hood.* The alarm function can be reactivated by pressing the mute button again. In case of emergency it is possible to increase the ventilation in the fume hood by pressing the red ***emergency*** button. This will increase the air flow to maximum and the alarm will sound. Press the red ***emergency*** button again to return to the normal state.
Routines:

- Always work inside the fume hood with the front hatch pulled down as far as possible. It will prevent splashes on you as well as improve the ventilation.
- NEVER put your head in the fume hood over a reaction set-up with chemicals in it!
- In the reaction set-up the stirrer/heater has to be placed on an adjustable table
- Keep your fume hood as clean as possible and wash up dirty glass as soon as possible after use.

Actions in case of accident
Refer to the appropriate section in this document depending on the nature of the accident.

Vacuum equipment

Description
Vacuum equipment and particularly the one made with glass is particularly fragile. However it is often used in our manifolds, distillation equipment, mass spectrometers, etc…
Main Risk
Glassware under vacuum is particularly fragile and may implode. Water pumps/suction devices must be operated in a proper way to avoid back suction.
Preventive measures
Before using any vacuum equipment, ensure that all glass equipment is undamaged and that all connectors are clean. Use grease if appropriate (NOT in the rotary evaporators).
Actions in case of accident

Cryogenics

Description
Liquid nitrogen and dry ice are used to achieve low temperatures needed to run special instruments (react-IR, NMR) and perform experiments. These substances are transported in special containers, among which cold traps present their own risks. These vessels are equipped with a double wall glass vessel that is evacuated (high-vacuum) between the glass layers. If impacted the glass will implode, resulting in the projection of sharp glass pieces that may injure any person close to it.
Main Risk
Implosion of cold traps and skin cold burns
Preventive measures
The handling of cold traps must be conducted safely. Any liquid nitrogen cooling must be handled carefully to avoid cold burns. Special cryogenic gloves are available next to the liquid nitrogen tanks and dry ice stations.
When the cold traps are used, make sure you operate them in a safe way to prevent liquid oxygen to condense. Further instructions can be found in the appendixes

Actions in case of accident

Depending of the type of accident/injury, seek medical advice, consult the relevant section in this document (including appendixes) and report the accident to your supervisor and the safety officer.

Extraction

Description

During extraction using volatile solvents (e.g. diethyl ether) in a separation funnel, the pressure can easily build up as the funnel is shaken.

Main Risk

Splash of toxic and/or corrosive solutions containing flammable organic solvents.

Preventive measures

The pressure can be equalized by turning the funnel upside down while holding the thumb against the stopper and then ***carefully*** opening the stopcock. Repeat this at regular intervals until the extraction is completed. This is particularly important during neutralization of acids with a carbonate base; this generates carbon dioxide. Extraction must ***always*** be undertaken in the fume hood, with the outlet pointing into the hood when the separation funnel is handled.

Actions in case of accident

Refer to the relevant sections in this document depending on the nature of the accident.

Electrical equipment

Description

In a chemistry laboratory there is plenty of electrical equipment that needs to be handled and maintained safely to prevent electrical accidents.

Main Risk

Electrical shock.

Preventive measures

Check that all the equipment is undamaged including the insulation on electric leads and plugs. Remember that moisture may cause normally inert objects to transmit electricity. All electrical equipment must be properly grounded. *Make sure that the electricity is turned off when assembling, connecting and disassembling electrical equipment. There must be no leads that are connected to an electricity source at one end while the other end is free and accessible.*

Actions in case of accident

If required ask for assistance from the co-worker that is within earshot from your workplace and seek medical advice if necessary. A defibrillator device is available by the main entrance of the Arrhenius building.

Ovens

Description

Ovens are used to dry glass-ware, molecular sieves etc. Ovens are usually run 24/7 at elevated heat.

Main Risk

Burns, cuts because hot glassware is dropped, explosions because glassware containing solvents are misplaced in the ovens.

Preventive measures

Always use proper insulated gloves when putting/taking out glassware to/from oven. Never put glassware or other material into the oven that has not properly been dried. Never ever put any chemicals into the ovens.

Actions in case of accident

Refer to the section Emergency handling depending on the type of accident.

Hot-plates

Description

Hot plates are used for heating and stirring oil/water baths inside hoods in the laboratory.

Main Risk

Fires and smoke.

Preventive measures

Make sure that the electrical cord is not touching the heat plate. Make sure that the oil bath is not too full (remember that oil expands when heating). Use mineral oil instead of PEG. Always use a boy for heating plate so that you can withdraw heating from your reaction. Never heat or stir a chemical reaction outside the hood.

Actions in case of accident

Refer to the section Emergency handling depending on the type of accident.

Bunsen burner

Description

Bunsen burners are used for heating, sterilization, and combustion. The main use in our department is activation of molecular sieves at high temperature under vacuum by removal of water and humidity. Bunsen burners produce an open flame with two regions: The primary flame, seen as a small inner cone, is a pale blue flame; and the secondary flame, almost colorless flame, seen as a larger, outer cone. The hottest part of the Bunsen flame, which is found just above the tip of the primary, inner, flame, reaches about **1500 °C**. Therefore, extreme safety measures are needed when handling a Bunsen burner.

As a complementary tool, vacuum pumps and cold traps are used. The user should therefore be familiar with the manipulation of these elements as well.

There is a user guide at the wall next to the Bunsen station and as a appendix, with detail guidelines of how to start and finish the manipulation of the gas keys.

Every time the station is used, write down the details in a notebook placed by the wall next to the bench (user name, date, time, and any event to be reported). Never leave the notebook on the bench since it can burn with the flame! Sign out when you have finished using the burner.

Main Risk

Gas explosion. Starting a fire at the department. Burns by open flame. Burns by touching hot materials. Burns by liquid nitrogen. Cuts by shattered glassware. Oxygen condensation in the cold trap.

Preventive measures

- Always remember to tie-back long hair, loose clothing (e.g., shirt sleeves hanging down), or dangling accessories before lighting the Bunsen burner. Always wear a cotton laboratory coat. Keep your hair, clothing, and hands at a safe distance from the gas burner. Always have the proper safety equipment, like a fire extinguisher and a fire blanket, on hand. Know where the safety equipment is located and how to use it.
- Remove all combustible materials (e.g., notebooks) from the bench. Check the gas hose for cracks, and notify if cracks are found.

- Do not use cracked or chipped glassware.
- Only use the sparker to ignite the Bunsen burner, and have it available and ready before turning on the gas.
- Always add liquid nitrogen in the Dewar vase. Turn on the vacuum pump before introducing the cold trap into the vessel. Follow the “Cryogenics” guidelines.
- Do NOT leave the open flame unattended and never leave the room while the burner is on. Turn of the burner off immediately when not in use.
- If the flame goes out or if you smell gas, turn the gas off. If you continue to smell gas, notify it immediately, the hose or burner might be leaking.
- Shut off the gas keys after use.
- Heated metals (e.g., glass burner and tongs) and glassware stay hot for a long time. Allow plenty of time to cool before touching it. Place the hot glass vessel at the metal frame and lay the “hot” sign plate visible and obvious for the next person to come.
- Ensure that the cold trap is outside the Dewar vase and clean of condensed solvents, as well as that the vacuum pump is off before leaving the room.
- Ensure that the gas valves are off before leaving the room.

Actions in case of accident

- There is a fire extinguisher just outside the room, near the door.
- There is a fire blanket and a burn treatment kit in the room.
- In case of gas alarm: Investigate the alarm, close the gas valve, and open the window. The alarm should react well below the dangerous limits if the installation is done in the right way, (for example normally 25% of explosion limit).
- In case of fire while operating the burner: Make use of the fire extinguisher and/or fire blanket (see Fire and extinguishers section). If the fire is too big, start the fire alarm.
- In case of flame or heat materials burns see the Fire and extinguishers section guideline above stated.
- In case of liquid nitrogen burns see the Cryogenics section.
- In case of cuts by shattered glassware, treat you wounds if they are small in the nearest first aid station and report it. In case of large damage, seek medical assistance immediately.
- Look for help immediately. Do not try to hide the incident or the burns, and treat them as soon as possible.

Water hoses

Description Any equipment requiring water cooling must be used with care. Make sure that the tubing is safely attached in order to prevent flooding and potential risk of water in the oil bath.

Main Risk

Flooding oil bath/hood/laboratory

Preventive measures

Make sure that the tubing is fixed to the glass in- and outlets. Only minor flow of water is required for cooling. A major water flow is also a risk considering flooding and must be avoided.

Actions in case of accident

Refer to the section Emergency handling depending on the type of accident.

Rotary evaporators

Description

Rotary evaporators are fundamental equipment for our research with high-throughput of samples and different solvents that are normally toxic and flammable. Thus, the risk of contamination between samples and to the researchers and the environment, special policies has to be implemented. These evaporators operate usually under vacuum with water cooling and thus the risks associated with vacuum and water hoses need to be considered as well (see sections Vacuum equipment and Water hoses).

Main Risk

Cross-contamination, water cooling and vacuum.

Preventive measures

- Splash heads must always be cleaned and immediately put back after use.
- Solvent containers on the rotavaps should always be emptied and the heating always be turned off directly after use.
- When evaporating high-boiling solvents (toluene, DMF etc.)/water or acid, clean the rotavap afterwards with acetone.
- When evaporating something toxic or smelly use a rotavap in the hood. For solvents that can damage the pump (for example acids) the water suction should be used instead (switch adapter).

Actions in case of accident

Refer to the section Emergency handling depending on the type of accident.

Analytical techniques

NMR

Description

NMR spectroscopy is used to determine molecular structure based on magnetic interactions at radiofrequency.

Main Risk

Dewar quench of liquid gases (helium and nitrogen) with rapid gas evolution in the room (suffocation).

Magnetic objects in close vicinity of strong NMR magnet.

People with pace-maker may be severely damaged.

Preventive measures

No large magnetic (e.g. iron-containing) objects and tools in the room.

Warning signs about strong magnetic fields and no entrance for pace-maker carrying persons and general cleaning personnel.

Oxygen meter to detect and alarm for low concentration of oxygen.

Actions in case of accident

In case in quench leave room and close doors.

MS

Description

Mass spectrometry is used to measure molecular mass or to determine molecular composition.

Main Risk

Leakage of nitrogen gas from nitrogen generators (suffocation).

Preventive measures

Oxygen meter to detect and alarm for low concentration of oxygen.

Actions in case of accident

Opening of windows, turning of generator, evacuation of room and thereafter closing of doors.

GC

Description

Gas chromatography is used to separate molecules using gas as the mobile phase.

Main Risk

Carrier gas used is hydrogen. FID detector uses hydrogen gas and air.

Preventive measures

Manually check that the FID is on (burning).
In case of reduced air pressure the FID needs to be checked frequently.
Check for leaking of gases when connections are changed.

Actions in case of accident

Turn gas off, close valves, open windows, leave room and close doors.

HPLC

Description

High-performance liquid chromatography is used to separate molecules using liquids as the mobile phase.

Main Risk

Solvent leakage.

Preventive measures

Check tubing and connections.

Actions in case of accident

Turn off instrument and tighten connections.

Cleaning equipment

Each researcher is responsible for cleaning their equipment and cleaning in a professional way to leave it ready for the next researcher:

- All glass has to be rinsed with acetone in the fume hood before it is brought to the sink. After the glass is washed with water and detergent in the sink, it should be rinsed first with deionized water and then with acetone. The acetone will make it dry faster. Don't rinse acetone down the sink; it should be collected in a beaker Before washing dirty glass in the sink, first rinse it with acetone in the fume hood. Switch on the ventilation when doing dishes, collect the acetone and throw it in the organic waste.
- Glass equipment that is not clean after washing should be put in the basic or acidic wash bath and not in the drawers.

Waste handling

Plan ahead – how will you dispose the waste generated in your experiment from your lab?

Solvents

- All solvent wastes should be in the 25L containers for Acetone or the 25L containers bought from the SU-shop specifically for this purpose. These are to be kept in the cupboard in specific cupboards (the locations of these might vary from lab to lab – know where yours is located!).

- All solvent waste should be disposed of inside the fume hood in a small waste container – never in the container for acetone used for washing which is located in the sink. Before being poured into the large containers.
- Separate chlorinated-containing solvents from non-chlorinated ones at all stages and keep your waste containers inside a ventilated cupboard.
- Separate aqueous waste that contains chemicals not suitable for the sink/normal wastewater into a 25-L container in the waste-cupboard.
- Solvent waste containing heavy metals (e.g. Pd, Pt, Co) should be disposed of individually. See below.

Glass

- Pipettes and used vials should be temporarily disposed of in a container inside the fume hood until they are odor-free.
- Odor-free glass waste and broken glass items are disposed of in the yellow containers. New can be brought from the solvent storage room and the SU-shop. When full, make sure to shake them thoroughly to make place for more. When really full, put it with the solvent- and solid wastes for Martin to remove on Wednesdays/Fridays.
- Glass sent for repair needs to be completely clean from chemicals and grease, and also dry.
- Empty solvent (or chemical-) bottles should be completely clean and odor free before disposed of in the recycling, air them out for a few days in one of the fume hoods. These cannot contain any chemical residues.

Special and old chemicals

- Heavy metals are to be collected separately in separate wastes (must be plastic containers). Let the solvents evaporate in the fumehood before sending this to recycling or destruction.
- Pd-C waste should be put in a plastic waste container filled with water (the Pd-C has to be in the water). The container should be taken for destruction when full.
- Azides are never to be thrown in a common solvent wastes. Read how to specifically destroy your azide before you use it.
- Hg: For old thermometers there is a mercury-shelf in the “chemicals for destruction”-cupboard in chemstore. ***CLOSED and whole*** bottles of mercury-compounds can be put here as well for destruction. Seal them one extra time with parafilm.

Solid waste

- SiO_2, Celite and contaminated gloves, drying agents, paper, filters etc. are thrown into the solid waste disposal kept in a ventilated cupboard.
- SiO_2 and Celite waste should however be emptied in a closable container (e.g. zip-lock bag) in a fume hood before being put in the solid waste bin.
- Glass-waste not suitable for the yellow containers (e.g. when highly contaminated) can also be put boxes specifically for this purpose (Carton box marked with glass waste, black plastic bag inside). These can be bought from the SU-shop (SU-butiken).

Sharp objects

- Needles should ***ALWAYS*** be disposed of in a 25 L Acetone container or a waste-container 25L (the same as for solvent wastes) or a yellow needle containers (0.5 L

or 2L) that can be acquired from the SU-shop. This is of high importance as the needles can pierce other plastic bottles, for example DCM-containers.
- Syringes and needles can does not have to be separated. However, syringes can be disposed of in the common solid waste.
- Other sharp, contaminated objects can be disposed of together with needles.

Leaving the laboratory

As a routine, when you abandon the lab you ***must***:

- Make sure that all (unnecessary) equipment in your fume hood is turned off! E.g. coolers, heaters, vacuum etc.
- Leave a card stating your name, telephone number, reaction scheme and recommended actions in case of accident on the fume hood when running over-night experiments!
- Always wash your hands with water and soap. This is to make sure that you do not bring chemicals with you outside the laboratory.
- Tell your lab colleagues that you are leaving for the day. This is important in case there would be an evacuation after you have left.
- Make sure that all (unnecessary) equipment in your fume hood is turned off! E.g. coolers, heaters, vacuum etc.
- Tidy up. It is everyone's duty to keep the lab in order, and to clean up after himself/herself. All solvents must be put away in proper cabinets with the caps firmly screwed on.
- Instruments that are not in use and are supposed to be switched off should be switched off. If you are the last one leaving, turn off the heating baths and pumps from the rotary evaporators. If you are not sure if you are the last one, turn them off anyhow, it can be easily turned on again.
- Computers should be put in resting mode in order to save energy.
- Close the door to the laboratory if you’re the last one leaving.
- Make sure the door to the department closes properly after you.

Leaving the Department

- Put reagents back in their proper permanent storage locations.
- Put your compounds in the freezer in properly-labeled vials. Structure, cross-referenced to notebook number, no flasks), in a vial box that has your name on it.
- Cleaned your glassware and stored it in drawers.
- Completely clean your hood, bench, and supplies (including manifold).
- Completely clean your desk area.
- Make sure your group tasks are completed (supplies of everything remade and restocked, etc.).
- Make sure that common equipment that you have used has been cleaned and stored.
- Make sure your pump oil has been changed.
- Cleaned at least some part of the common bench areas.
- Empty your waste containers and their caps are securely in place.
- Make sure you have updated your notebook table of contents, all notebook entries are complete, and I have left your notebook with your PI.

- Make sure that all spectra (NMR, GC, HPLC, etc) and all other electronic data has been saved onto the group server and is saved according to your initials, notebook #, and page # (with experiment descriptor if necessary).
- Make sure that all of your files related to lab-related activities (subgroup, group meeting, write- ups, grant proposals) have been saved on the group server, properly labeled.
- Leave your contact information (email, telephone, address) with PI (Jenny) and dropped off all keys and identification to the appropriate people.

Appendices

You find the this document “General Safety Framwork” and the appendices above on our website Link: http://www.organ.su.se/internal/?lang=eng#Environment_and_safety

A. Chemical Hazards in Working Environment (AFS 2014:43) – this document contains a list of regulated substances

B. (1) Hazard and (2) Precautionary statement lists

C. Instructions on the use of cold traps and liquid oxygen

D. Instructions for the glass pressurized reactor

E. Bunsen burner at flame-drying station