General laboratory safety regulations

Institute of Chemistry

University of Rostock

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Universität Rostock Traditio et Innovatio

Operating Instructions
According to § 14 of the "Ordinance on Hazardous Materials"

These general laboratory regulations lay down basic behaviour in the lab, point out specific dangers, and state how to deal with hazardous materials, equipment and apparatuses. They are obligatory and must be known by and easily accessible to Employees and students. Employees and students should strictly follow and adhere to each of these regulations.

Specifically the following texts concerning laboratory work are also binding and have to be followed:

- Ordinance on Hazardous Materials (Gefahrstoffverordnung)
- Regulation (EC) 1272/2008 on classification, labelling and packaging of substances and mixtures
- Directive 67/548/EEC Dangerous Substances
- Directive 1999/45/EC Dangerous Preparations
- BGI/GUV-I 850e "Working Safely in Laboratories"
- Technical Rule for Hazardous Substances (TRGS)
- Safety data sheets
- Lists of hazard pictograms, H- and P-phrases
- Individual operating instructions
- Group operating instructions
- Specific operating instructions for equipment and procedures

Operating instructions and relevant safety data sheets are accessible online – see: Homepage of the Institute of Chemistry → Service → Arbeitssicherheit. After clicking on "Arbeitssicherheit" further information, e.g. the brochure of the Legal Accident Insurance "Working Safely in Laboratories", can be found.

Hazards in chemical laboratories

Various hazards may occur in chemical laboratories:

- fire and explosion hazards resulting from flammable solids, liquids and gases
- risk of solids, liquids or gases causing damage to health (inhalation, skin contact, swallowing)
- risk of unknown or violent reactions or reactions out of control
- risk resulting from containers at an overpressure or reduced pressure
- risk resulting from hot or cold surfaces and media
- mechanical hazards of equipment and installations
- risk resulting from radiation (UV-, laser-, IR-radiation)
- risk resulting from magnetic fields
- risk resulting from electricity

All activities have to be carried out in such way that the risks mentioned are always minimised.

Start working in a laboratory is allowed only after a hazard assessment has been performed according to the "Ordinance on Hazardous Materials". The hazard assessment must be updated if significant changes make it necessary.

Safety and emergency equipment

Safety and emergency equipment consist of ventilation systems, emergency showers, emergency eye-wash units, eye-wash bottles, fire extinguishers, master switches for electricity, emergency cut-off switches, cut-off switches for gases and water, first aid boxes, respirator masks and alarm buttons to activate the house alarm system.

All safety and emergency equipment must be clearly visible, recognizable, and easily accessible. It may not be covered or removed. In case of faulty or missing safety and emergency equipment working has to be stopped immediately.

Everyone working in a laboratory must know the location and the function of the safety and emergency devices and also the emergency exits, the fire alarm boxes and emergency plans.

Emergency showers and eye-wash units are to be checked at least once a month. The inspections should be documented. The locations of emergency showers and eye-wash units have to be labelled with the permitted sign.

Two types of hand fire extinguishers are present in the area of the laboratories:

- carbon dioxide fire extinguisher inside the laboratories
- powder extinguishers on the floors

Fire extinguishers which have been used or damaged (even if the seal is damaged) must be exchanged immediately.

First aid boxes are to be installed in a sufficient number at suitable places. They have to be refilled regularly.

For emergency situations and special activities (e.g. working with toxic substances) respirator masks with right filters must be available. It is not allowed to work with a respirator mask over longer periods. Respirator masks reduce the oxygen intake for a person.

Access paths for emergency vehicles (fire brigade, ambulance, police) have always to be kept free.

Basic rules

Access to the laboratories is only granted to authorized persons.

Performing laboratory work is only allowed if at least two persons are present in the laboratory. In case only one person is present in a laboratory, working is permitted if a second person is in hearing distance. They have to check in regular intervals if their counterpart is well.

Eating and drinking is not allowed in laboratories. Never keep food and drinks in laboratories.

Smoking and open flames with the exception of gas burners, are prohibited. Existence of ignition sources and of electrostatic charging has to be excluded.

Persons must promptly rectify defects, damage, hazardous conditions and other hazards that occur in laboratories. If this is not part of their remit or if they do not have the necessary capabilities, they must immediately report the defects to their superior.

Before starting hazardous activities all other persons working in the immediate vicinity have to be informed about the specific hazards and the necessarily protective measures.

For pipetting operations mechanical devices have to be used. It is absolutely forbidden to pipette with the mouth.

Pregnant women and breastfeeding mothers are under special protection. Only in exceptional cases are they allowed to work in a laboratory (see the directive “Unterrichtung gebärfähiger Arbeitnehmerinnen über Beschäftigungsbeschränkungen des Instituts für Chemie”; “Instruction of employes capable of bearing children of the Institute of Chemistry”).

Youth under 18 years are allowed to work with hazardous chemicals only in case of permanent supervision.

Persons working in a laboratory must not, by consuming alcohol, drugs, other intoxicating substances or substances changes their state of mind put themselves in a state in which they might pose a risk to themselves or others.

At the end of the laboratory day all facilities and experiments have to be stopped. Water, gas and protective gas waves, must be closed, master switches are to be turned off, shut-off cocks have to be closed. Furthermore, power plugs of devices which can cause a fire must be plugged off. After leaving the laboratories laboratory doors must be locked.

Work clothes and shoes

Appropriate work clothes and protective clothing are to be worn when working in laboratories. This normally consists of a long lab coat with a cotton content of at least 35 %. The fabric of this work and protective clothing should not pose an increased risk because of its dangerous burning and melting properties. Clothes (also undergarments) having a high ratio of synthetic material are not suitable for laboratory work. The clothing should cover the body, arms and legs. The lab coat acts as first barrier against the effects of hazardous substances. Work clothes that may be contaminated with hazardous materials may only be worn in work rooms and not in clean areas such as offices, break rooms or seminar rooms. Protective gloves have to be taken of before leaving the laboratory.

Only sturdy, closed and slip-proof footwear may be worn in laboratories.

If work involves a risk of contamination, separate storage facilities for work clothes/ protective clothing and street clothes are to be provided.

Protective glasses

Protective glasses with adequate side panels must always be worn in the laboratory. People wearing glasses for their vision should have optically corrective protective glasses or protective glasses to wear over their own.

During work with special hazards to the eyes further means of protection may be necessary e.g. a visor.

Protective gloves

When working with certain dangerous materials (corrosive, skin irritating, sensitize etc.) protective gloves resistant to chemicals must be worn. Disposable gloves made of latex or nitrile are very thin and only suitable as a protection against splashes. Latex protective gloves can cause allergies. Damaged gloves or gloves that have become unusable in another way are to be replaced immediately.

Respiratory devices

If hazardous materials can occur in dangerous concentrations, appropriate respiratory devices (respirator masks) must be provided. If there is a possibility that workplace limits for hazardous materials may be exceeded, respiratory devices must be used. Wearing respiratory devices must not be a permanent measure and must not be allowed to replace technical and organizational protective measures.

Order at work

Each person must keep his or her work place clean and orderly. Appliances which are contaminated with hazardous substances must immediately be cleaned. Do not keep objects on the floor.

At least once a year the chemicals in the laboratory must be checked if they are needed any longer. Otherwise they must be given away (for someone else to use) or disposed of.

Carrying out experiments

In a laboratory all experiments must permanently be supervised. Supervision may be given to other persons with the necessary knowledge and capabilities. Is a permanent supervision not possible, it has to be ensured by technical facilities that the occurrence of dangerous situations can reliably be eliminated (night working room, automatic emergency cut-off of all media pathways and electricity supply to reliably prevent the occurrence of hazardous situations, automatic extinguishing system, double securing supply of water, electricity, protecting gas etc., double number of all control devices, electrical warning and alarm systems).

All experiments have to be done in compliance with the following conditions:

- Building and equipment are in correct state.
- All employees and students have the necessary expertise.
- Work is in accordance with the relevant rules of engineering and the state of the art.
- All operations are performed in a laboratory scale.
- Work is in compliance with these laboratory safety regulations and the BGI/GUV-I 850-0e.

Handling hazardous substances

In laboratories, work involving hazardous materials and equipment may be performed only if this is necessary to realize working tasks.

When working with gaseous, liquid and solid hazardous substances as well as hazardous substances which exist as dust, special rules of conduct and precautionary measures are to be taken.

Substances and mixtures (preparations) having at least one of the following properties are characterized as hazardous.

- explosive
- oxidizing
- extremely flammable
- highly flammable
- flammable
- carcinogenic or suspected
- reprotoxic or suspected
- mutagenic or suspected
- very toxic
- toxic
- harmful
- corrosive
- irritating
- sensitizing
- dangerous for the environment

Substances or preparations whose use could lead to the production of dangerous or explosive substances are also to be classified as hazardous materials. Dangerous biological material from biological and genetic engineering as well as pathogenic material belongs to the hazardous materials. Even if the course of the reaction is as expected, by-products are created in addition to the main product and may also be hazardous materials.

The intake of substances in the human body can occur by inhalation into the lungs, by absorption through the skin, the mucous membrane and the digestive tract. Avoid the inhalation of vapours and dusts as well as the contact of hazardous substances with skin and eyes.

The hazardous potential has to be assessed before using hazardous materials or starting work which results in the production of dangerous substances. Information sources are the labelling of materials, operating instructions, material safety data sheets, specialist literature, catalogues of producer and trader, databases with valid data such as the GESTIS substance database of the BGIA (Institute for Occupational Safety and Health of the German Social Health Insurance).

Hazard statements (H-phrases) and precautionary statements (P-phrases) for hazardous substances are strictly to be observed. Materials for body protection (protective glasses, facial protection and appropriate protective gloves) which are stipulated in the P-phrases and operating instructions should be used.

Before working with hazardous substances and before implementing any activity that could lead to hazardous substances or liberate them, the risk potential must be investigated and slipped in into hazard assessments.

Work with certain hazardous substances have to be done always in a fume hood (see also directive of the Institute of Chemistry “Arbeitsmedizinische Vorsorge” - “Occupational health care service”):

- potential hazardous, until now not classified substances without any information about its hazardous nature (no safety data sheets available)
- new synthesized compounds
- potential hazardous substances without workplace limits
- carcinogenic, mutagenic and reprotoxic substances

- toxic, corrosive and chronic toxic substances
- substances absorbed through the skin, substances causes eye or skin damages
- airway sensitizing and skin sensitizing substances
- spontaneously flammable substances
- explosive substances
- lead and inorganic lead compounds
- *n*-hexane, *n*-heptane, butanone, pentan-2-one, methanol, ethanol, 2-methoxyethanol, benzene, toluene, xylene, styrene, dichloromethane, 1,1,1-trichloroethane, trichloroethylene, tetrachloroethylene
- compounds mentioned in appendix II

Foregoing mentioned substances, with which operations have to be performed in the fume hood, are to be considered as hazardous. Protective measures have to be chosen like for toxic, corrosive and chronic toxic substances. Great care must be taken to avoid contact with the skin, inhalation and any other form of incorporation. These materials have to be treated at least according to the P-phrases 261 and 262. These materials can also be flammable or even spontaneously flammable and form explosive mixtures.

Working with the above mentioned compounds outside the fume hood is permitted only if there are no risks existing for the employees and students.

Before using especially hazardous materials (very toxic, carcinogenic, mutagenic, reprotoxic, explosive substances) a check must be conducted to determine whether substituting hazardous materials or procedures will reduce the hazards.

While working with hazardous substances workplace limits must be observed. Otherwise all activities have to be stopped and may be continued only if additional precautionary measures ensure compliance of the limits.

In case of working with flammable liquids, gases or dusts, formation of hazardous explosive atmospheres have to be prevented. Ignition sources and electrostatic charging must be avoided. Open evaporation of flammable liquids is not acceptable.

Work during which gases, vapours or suspended matter may be generated in hazardous concentrations or quantities may only be performed in fume hoods. Front panels are to be kept closed during such work. Work during which gases, vapours or suspended matter may be generated in hazardous concentrations or quantities may only be performed outside fume hoods if it is ensured by means of appropriate measures or by the type of work that persons are not endangered by these materials.

Work with toxic and highly toxic materials should be carried out in closed laboratory apparatuses in the fume hood or comparable facilities.

Closed apparatuses in this sense are:
- apparatuses which are not operated open standing in a closed fume hood
- vacuum apparatuses
- glove boxes
- apparatuses with sealed connections where all openings are connected to an effective extraction system

If substances escape in unexpected and possibly hazardous concentrations or quantities, the area at risk must be evacuated and everyone in the vicinity must be alerted. The power supply should be switched off from a safe location. In a similar manner should be acted if there are initial signs of decomposition during the course of a chemical reaction or distillation process. The hazardous situation may only be rectified if the persons taking action not to put

themselves in danger and if appropriate measures are applied (personal protective gear, respiratory devices, chemical binder).

In case of common laboratory conditions, hazardous materials may be worked with up to the following amounts:

- 2.5 l of liquids
- 1.0 kg of solids
- 0.5 l / 0.5 kg of carcinogenic, mutagenic and reprotoxic compounds
- 0.1 l / 0.1 kg of very toxic compounds

Activities involving bigger amounts or particularly dangerous hazardous materials (e.g. explosive materials) even if the limits on quantities specified above comply with, require additional measures. Such operations have to be separately considered in hazard assessments. Storage of chemicals must be realised in a tidy and clear way.

It is necessary to compile a comprehensive directory of hazardous materials and keep it always up to date.

Working with carcinogenic, mutagenic and reprotoxic materials

For working with carcinogenic, mutagenic and reprotoxic materials, there are special regulations and have ever to be observed:

- Before starting work with carcinogenic, mutagenic and reprotoxic materials, it is important to check whether they can be replaced with less hazardous ones.
- Separate operating instructions are to be prepared for carcinogenic, mutagenic or reprotoxic materials.
- Danger areas are to be cordoned off and marked with warning and safety signs.
- Working with carcinogenic, mutagenic and reprotoxic materials has to be carried out in closed laboratory apparatuses in the fume hood (see above and below).
- During weighing processes scales are to be operated in a fume hood, a glove box or an effective enclosure with an appropriate extraction system.
- Quantities of materials are to be kept to the minimum required for the relevant activities.
- Compressed gases must be used in a fume hood in the smallest possible quantities. If compressed-gas cylinders are placed in a safety cabinet (“storage cabinet showing fire resistance”), at least a 120-fold exchange of air per hour is required in the cabinet. Permanently sealed lines are to be used to supply these gases to apparatus and equipment.
- Inside laboratories storage of carcinogenic, mutagenic and reprotoxic materials are to be realised in containers which are really tighten, at locations with extraction systems in continuous operation. The storage amounts have to be reduced to a minimum.
- In the fume hood, residual materials and waste are to be converted into a less hazardous form by means of a chemical reaction or, in the case of emptied containers, taken directly for disposal without this posing a hazard.
- Contaminated apparatus components are to be cleaned so that they no longer represent a hazard.
- Contaminated personal protective equipment, including lab coats, is to be decontaminated or disposed of directly without this posing a hazard.

Working with spontaneously flammable substances

Work involving spontaneously flammable materials (e.g. metal alkyls, metal hydrides, silanes, white phosphorus) must be done in a fume hood. All flammable materials that are not needed immediately for work to continue uninterruptedly must be removed from the fume

hood. Suitable extinguishing agents should be kept available. Spontaneously flammable substances are to be stored in safety cupboards separated from other inflammable substances.

Working with explosive materials

Some types of reactions or special substances show an increased risk of releasing of chemicals or of exploding. Examples are nitration, oxidation, synthesis of unstable or metastable compounds, polymerization, diazotization and exothermic reactions in general. Such risks have to be considered when planning a reaction.

Before using explosive materials, it is important to check whether they can be replaced with less hazardous ones. If replacement is not possible explosive materials and mixtures may only be handled in the smallest possible quantities and only in adequately protected workplaces (e.g. fume hood with closed front panel). The number of people in the area at risk should be limited to the bare minimum.

Visors that also protect the sensitive neck and chest areas have proven to be effective personal protective equipment, as have thick leather aprons and thick, long leather gloves.

Overheating, proximity to flames, sparking, impacts, friction, hazardous enclosure (damming) and metal spatula are to be avoided.

Storage is to be realised protected from the influence of flames and heat and kept under lock and key away from workplaces in safety cupboards. Stocks of explosive materials and mixtures must be kept to a minimum. They may not be stored with flammable hazardous materials or compressed gases, even in safety cabinets.

Explosive materials include numerous organic nitroso and nitro compounds, nitric acid ester, diazo compounds, radicals, hydrazoic acid, their salts and esters, salts of fulminic acid (formation of silver fulminate e.g. in ammoniacal solutions containing silver salts), salts of acetylene and its derivatives, heavy metal perchlorates, nitrogen iodide, organic peroxides, peroxy acids and chalcogen-nitrogen compounds. These materials may be subject to explosives legislation.

Mixtures of oxidizing compounds such as nitrates, chromates, chlorates, perchlorates, fuming nitric acid, concentrated perchloric acid and hydrogen peroxide solutions (in particular concentrations exceeding 30 %) with flammable or reducing materials may have the properties of explosive materials. For example, fuming nitric acid reacts explosively with acetone, ethers, alcohol and oil of turpentine.

Metal powders that contain hydrogen as a result of the reduction, hydrogen peroxide with H_2O_2 contents above 30 %, heavy metal ions contained therein and halogenated hydrocarbons in contact with alkali metals can also result in explosion hazards.

Alkali metals and their amides must be stored so as to prevent admission of components in the air. Alkali metals and their amides form highly reactive compounds when combined with components in the air. This also occurs slowly in tightly sealed vessels and under protective liquids. It may no longer be possible to destroy such contaminated materials without risk.

Work involving peroxide-forming liquids

Liquids that tend to form organic peroxides (e.g. diethyl ether, dioxane, tetrahydrofuran, tetralin, aldehydes, ketones) and solutions of these materials must be examined for the presence of peroxides prior to their use (peroxide test papers).

Present peroxides are to be destroyed by suitable methods. Especially during distillations peroxides may be enriched in the distillation boiler.

Liquids that tend to form organic peroxides have to be stored protected from the light – in particular UV radiation (storage in the dark, utilization of dark bottles). However, peroxide formation cannot be prevented with absolute certainty by protecting liquids from the light during storage. Formation of peroxides can be prevented effectively by consequent storage under exclusion of oxygen (protective gas).

Drying of solvents

Pre-drying with less reactive drying agents should be used before resorting to chemically highly reactive drying agents.

If it is necessary to use alkali metals or alkali metal alloys as drying agents, special safety measures must be taken. Possible hazardous reactions between solvents and drying agents must be taken into account. For example, halogenated hydrocarbons may never be dried by means of alkali metals (explosion hazard).

Labelling

Every container for the storage of chemicals is to be clearly marked for its contents. In case of hazardous substances labelling must include as minimum the name of the substance and if existing the hazard symbols, the signal word and the wording of H- and P-phrases. For minor quantities a simplified labelling is permissible. Thereby, established regulations must be followed strictly and have to be applied individual on every hazardous substance.

Containers of waste substances must also be marked for their potential hazards.

Storage of hazardous substances in the laboratory

Only the amount of hazardous substances needed may be present in the laboratory. Hazardous materials that are no longer required or have become unusable must be disposed of appropriately. Hazardous materials are to be kept/stored so that they do not pose a risk to human health or the environment (tightly sealed vessels). Thus it is forbidden to set down flasks and cans on the floor. Bigger amounts of flammable liquids have to be stored in safety cabinets.

Caps and closures are always to be closed after taking hazardous materials from a vessel.

Storing chemicals together may not result in any additional hazards. For this reason, it is forbidden to storage spontaneously flammable substances like elemental sodium, metal hydrides, butyllithium, white phosphorus together with explosive, flammable or oxidizing materials.

Storage of spontaneously flammable substances is to be realised safe from the possible transmission of fire (safety cabinets).

Highly toxic materials, toxic materials and substances subject to the Narcotics Act must be kept under lock (lockable cabinets).

No containers that are normally intended for food or beverages should be used for chemicals and vice versa.

The material of the vessels is to be made from materials that can withstand the stresses to be expected.

Containers with hazardous materials may only be stored up to a height at which they can be set down and removed safely.

Hazardous materials in containers which give off vapours that are corrosive or harmful to health must be kept at locations with extraction systems in continuous operation.

Highly toxic, carcinogenic, mutagenic or reprotoxic gases should be stored in lecture bottles or small steel cylinders. Compressed-gas cylinders used for storage of such materials must not be larger than 10 l.

In the laboratory, the total amount of flammable liquids has to be reduced to a minimum which is necessary for continuous work. At workplaces amounts of flammable liquids have to be reduced as much as possible. Flammable liquids with a flashpoint below 55 °C (e.g. heptane, ethyl acetate, acetone, ethanol, methanol, isopropanol, diethyl ether, acetonitrile) that are kept at the workplace may only be stored in vessels with a nominal volume not exceeding 1 l.

Storage of flammable liquids in amounts bigger than the quantities needed for daily use are to be done at protected places, such as safety cabinets (fire resistance storage cabinets).

Overnight all vessels with flammable liquids with a volume bigger than 1 l have to be stored in safety cabinets.

Plastic containers with a nominal volume exceeding 5 l are only suitable for flammable liquids with a flashpoint of up to 35 °C if they have sufficient electrostatic discharge capability.

All substances and preparations with the following hazardous properties are to be kept under lock and key:

H300 fatal if swallowed
H301 toxic if swallowed
H304 may be fatal if swallowed and enters airways
H310 fatal in contact with skin
H311 toxic in contact with skin
H330 fatal if inhaled
H331 toxic if inhaled
H340 may cause genetic defects
H350 may cause cancer
H350i may cause cancer if inhaled
H360 may damage fertility or the unborn child
H360d may damage the unborn child
H362 may cause harm to breast-fed children
H370 causes damage to organs (affected organs are to be indicated)
H372 causes damage to organs (affected organs are to be indicated) through prolonged or repeated exposure

Combinations of the mentioned H-phrases

Transferring and transporting

Suitable devices like funnels, spatulas, pumps are to be used when transferring hazardous materials from barrels, carboys, canisters or other containers. Breakable containers must be supported at the base when they are being carried. Such containers may only be transported into other rooms using aids that ensure safe holding and carrying (e.g. buckets).

Setting up and operation of apparatus

All equipment made from glass is to be checked visually before using it.

Apparatuses must be set up in an uncomplicated arrangement, free from mechanical stresses and fixed sufficiently (valuable aids in case of more complex apparatus: screw-cap connections or PTFE expansion). Essential stands are to be fixed or to be ballasted. Permanently installed lattice bar grids are preferable to stands as they offer greater stability.

It must be possible to remove heating baths, other external sources of heat and possibly also cooling baths safely and without changing the apparatus (lifting platform).

Ladders or steps are to be used when working with tall apparatus.

When working with glass apparatus, the permissible temperatures and temperature differences are to be observed. Changes of temperature and pressure have to be done slowly. In the case of apparatus made of borosilicate glass 3.3 temperature differences between vapour and cooling water must not exceed 140 °C.

Tight-fitting connectors must be used for work with hazardous materials. Connectors such as conical ground joints, spherical ground joints, flanged connections and screw-cap connections offer better sealing than rubber or cork stoppers and are resistant to virtually all chemicals. To ensure that ground joints do not come open unintentionally, they are to be secured with ground-joint clamps, springs or other appropriate devices. Ground joints that have become stuck are only to be loosened very careful with protection of the hands. If loosening of ground joints may not performed independent, help of a glassblower is recommended.

Hoses and fittings must be selected so as to withstand the stresses that are to be expected. They must be checked for visible defects prior to use. Defective hoses and fittings must be removed.

The use of glass apparatus with fragile hose connections (glass olives) and hose connectors made of glass is to be avoided wherever possible (danger of injury by sharp-edged fragments after breakage of glass). Plug-in or screw-joint couplings should be preferred as connecting elements for hoses.

Hoses must be secured against slipping. They are to be protected from the effects of excessive heat and other forms of damage.

If there is a risk of a material explosion or a heat explosion or of bursting due to an unintentional rise in pressure when operating glass apparatus, measures must be taken to protect oneself against flying pieces of broken glass, splashes and materials that may escape (working in the fume hood or using an explosion screen).

An apparatus for procedures where a power cut may result in increased hazards must be connected to its own power circuit.

The size of a distillation apparatus must be matched to the quantity and type of material to be distilled:

- avoidance of blockage of vapour or condensation
- usage of a sufficient effective condenser
- monitoring of coolant flow (flow indicator)
- distillation apparatus is to be secured firmly in place with support, if necessary
- avoidance of superheating (boiling stone, boiling capillary, stirring)
- make full distillation flasks never more than ¾
- risk of blockage in case of distillate that solidifies easily – attention! after blockage risk of dangerous increase in pressure
- no usage of product condenser for reflux apparatuses
- usage of leak-free condensers (metal condensing coils or metal condensers) when working with highly reactive drying agents (such as alkali metals)

Care should be taken that drying tube and absorption vessels are not blocked and cannot become blocked during operation. It is also important to ensure that no liquid can drip from the absorption vessel into the reaction vessel.

No easily inflammable materials (polystyrene, cotton cloth) and no materials containing asbestos may be used for the thermal insulation of hot parts on apparatus. Aluminium foil is a suitable simple isolation material.

When setting up apparatus, adequately dimensioned barrier vessels must be installed between vessels containing materials that may become hazardous when mixed (correct direction of flow must be ensured). In addition, it may also prove useful to add upstream non-return valves. In case of pressure gradients inside of apparatuses, feeding back of liquids is possible which can cause dangerous mixtures.

Working with cylindrical glass parts

Cylindrical glass parts like thermometers and glass tubes or rods may not be inserted into or extracted from stoppers or hoses with bare hands. Sufficiently resistant gloves or thick cloths are examples of suitable items to protect the hands. Cover the glass parts with suitable lubricants e.g. silicone oil. Insertion should never be done in direction of the body.

Fume hoods

Fume hoods should prevent the inhalation of hazardous substances while working. Furthermore they should provide protection from splashing hazardous substances or flying pieces of broken glass.

Fume hoods can only function properly if the front panel is closed. When working in the fume hood, the front panel should not be kept open more than necessary. Containment capacity may be reduced significantly by leaving the front panel open. It must always be kept down enough to protect the head of the user. After completion of direct operations in the fume hood the front panel should be closed.

When setting up apparatus, care is to be taken that the flow conditions are influenced as little as possible.

There should be no more chemicals in the fume hood than necessary for the actual work.

Harmful substances should only be released, even in the fume hoods, only in case of an accident or while filling an apparatus. Excess reaction gases, vapours, aerosols, or dust, which occur during normal work, should be contained by special measures (e.g. by appropriate arrangements of gas-washing bottles or specific filters).

If the air flow of the fume hood is not operates properly, stop working and turn off the apparatus (coolants should be allowed to continue). Inform your superiors.

Mobile electrical equipment

Electrical cables are to be laid in a way that they cannot cause any hazard (trip hazard).

It is not permitted to connect movable multiple socket outlets in series. If movable multiple sockets cannot be avoided, they should be provided with built-in safety devices (master switch, pre-fuse, residual current device, overvoltage protector, splashguard).

A visual check of the mobile electrical equipment (also of mobile electric cables) for damage should be carried out before work starts. Defective or damaged appliances (e.g. appliances with bar live electrical leads) may not be used anymore.

Operating instructions for the used appliance should be present.

Every other year a regular insulation test on mobile electrical equipment is to be performed by an electrician. Hazards resulting from poor contacts (corrosion) or mechanical overloading have to be excluded (hazards by creep currents, fusing together of detachable electrical connections, temperature increases up to ignition, loss of contact protection).

Electrical cables, in particular plug-in connectors, must not be wetted by water. Appliances affected by a fire event or damaged in any other way (e.g. influence caused by liquids) have to be checked for their operational safety by an authorized person before using them again.

Heating baths and heating

Only electrical heating devices may be used to heat liquid heating baths and other laboratory apparatus.

Gas burners should only be used in exceptional cases e.g. for warming small amounts of substances in a test tube.

Heat carriers have to be selected so that they are appropriate for the task in hand. Only heat carriers (e.g. silicon oils) whose safe maximum operating temperature is known may be used for liquid heating baths and liquid thermostats. The maximum operating temperature must lie at least 20 °C below the flashpoint of the heat carrier (hazard of fire and explosions). Metal baths should preferably be used for higher temperatures. Sand baths may only be used if the uneven temperature distribution occurring in them can cause no hazard. The sand used as heat carrier must not have sharp edges.

Effective measures must be taken against hazards which result from an increase in volume of heat carriers during heating, and from contamination and dripping water.

Heat carriers that are miscible with water are preferable for heating baths. Heat carriers that are not miscible with water must be replaced after contamination with water or the water must be extracted by boiling (hazard of splashing and heat explosions). Water miscible and not water miscible heat carriers should not be put together.

Heating sources and liquid heating baths must be set up in such a way that they stand firmly. Their working height has to be adjustable safely to enable removal of heating sources from apparatuses without any risk (laboratory lifting platforms). Support rings are not suitable.

Gas burners

Gas burners should be used only in exceptional cases e.g. for warming small amounts of substances in a test tube. Closable adjustment devices for the fuel gas are not permitted on Bunsen burners and related gas burners. Gas burners may only be connected using special hoses. They must be sufficiently stable.

Cartridge burners must be completely closable. Safety burners with safety pilot and automatic gas shut-off have proved effective. At the workplace as few cartridges as possible are to be kept. It is a good idea to keep cartridges in a separate storage room.

Rotary evaporators

When operating rotary evaporators, the underpressure stipulated for the relevant solvent must be complied with and the water bath temperature must not be too high. Solvents with a particularly low boiling point may only be drawn off under normal pressure (e.g. diethyl ether).

Solvents that tend to form peroxides must always be checked for any peroxides that may be present before being distilled off until dry and these peroxides should be removed.

In order to reduce the rotary evaporator's implosion/explosion hazard, suitable measures are to be taken (explosion screen, covering of glass components with plastic, wire netting).

To avoid superheating the flask should rotate fast.

Water jet pumps should no longer be used to generate underpressure because they allow solvent vapours to get into the waste water. Instead, diaphragm pumps should be used. The exhaust air from these diaphragm pumps must be discharged into a fume hood.

Each time the type of solvent to be distilled off is changed, the collection flask must be emptied. Otherwise, the solvent that already has condensed may re-evaporate.

Drying ovens

The safety thermostats on drying ovens must always be used. They must be checked regularly for function ability.

Substances or devices may be dried in drying ovens if inside no explosible or ignitable atmosphere can be formed (e.g. ignitable solvent air mixtures).

Drying of explosible substances in drying ovens is prohibited. In case of thermal instable substances decomposition has to be prevented in a reliable way.

If thermally unstable materials are dried, the temperature set on the temperature safety device must be at least 20 % below the decomposition temperature and, in the case of easily inflammable materials, at least 20 % below the ignition temperature.

The materials to be dried should not have contact with the walls (walls are at temperatures above the set oven temperatures).

Hot-air guns

Hot-air guns reach temperatures of up to 600 °C.

It is strictly prohibited to utilize hot-air guns (hot-air blowers) in a close distance of flammable liquids, gases, dusts or spontaneously flammable substances. Do never heat round-bottomed flasks or something like that with flammable solvents. Do not place hot-air guns near flammable materials.

To reduce a high fire hazard, hot-air guns should be kept outside of fume hoods.

Heating of closed flaks or vessels with hot-air guns is not allowed.

Refrigerators and freezers

Only closed vessels with proper labelling may be stored in refrigerators and freezers.

The interior of refrigerators and freezers in which hazardous explosive atmospheres can develop must not contain any ignition sources. Appropriate refrigerators are available on the market. Refrigerators and freezers which fulfil the stated requirements have to be indicated by an outside fixed well visible sign labelled with the following text: „Nur Innenraum frei von Zündquellen“ (“Only interior free from ignition sources”). Standard refrigerators and freezers may be modified in this way (see BGI/GUV-I 850-0e, chapter 5.2.9.1).

Refrigerators and freezers for the storage of toxic substances need a lock and must be kept locked.

Storage of food and drinks together with chemicals in refrigerators and freezers is absolutely forbidden.

Working under vacuum conditions

Thin-walled glass vessels may only be evacuated if they are of a suitable shape for this purpose. Unsuitable vessels are, e.g. thin-walled glass vessels like Erlenmeyer and flat-bottomed flasks.

Before evacuating any of glass vessels, they must be checked visually for any damage that may affect their strength (cracks, scratches).

Evacuated glass vessels should not be heated on one side or dot-shaped.

To protect oneself against pieces of flying broken glass caused by implosions, suitable measures have to be taken (working in a fume hood, safety screens, safety nets, covering of glass components with plastic).

It must be ensured that there is no superheating during vacuum distillation (boiling capillary, distillation with stirring).

The apparatus must be evacuated before heating starts and may not be vented until it has cooled down.

Vacuum pumps and compressors

Instead of water jet pumps diaphragm pumps should be used.

Compressors and vacuum pumps have to be installed so as to ensure safe operation. In working rooms compressors and vacuum pumps, together with their equipment, may only be installed if they do not represent a noise hazard for persons working there. Any escaping gases, mists or vapours with hazardous properties must be removed safely. Oil mist from rotary vane pumps (oil pumps) should be precipitated (oil filters).

Centrifuges

Centrifuges may only be used by authorized persons, who have undergone an instruction.

These persons have to be familiarized with the operating instructions and the directions for usage.

Centrifuges must be positioned in a stable way (no movement of the centrifuge during operating). A free area of at least 30 cm around the centrifuge is to be realized.

The rotor has to be loaded symmetrically according to the weight. Any contact with rotating parts is to be excluded. Attention must be paid to the specific hazards encountered when

working with easily and highly inflammable materials (explosion hazard). Instruments with internal chambers that are insufficiently protected against explosive atmospheres must be inerted.

When operating ultra-centrifuges, it should be ensured that parts flying off are caught safely (covering, catching protective device, special room). A logbook must be kept for ultra-centrifuges and the names of persons using ultra-centrifuges must be recorded.

Deep Cooling

Skin contact (low temperature gloves) and eye contact (protective glasses, face protection shield if necessary) have to be avoided while working at lower temperatures (dry ice: -78 °C, liquid nitrogen: -196 °C).

After skin contact injuries comparable to a hard burn can be the result. Never touch pipe lines flowing through from deep-cooling media (risk of freeze hard). Strong enrichment of nitrogen in breathing air can give unconsciousness up to death by asphyxiation (1 l liquid nitrogen produces about 750 l gaseous nitrogen).

Only dry and clean dewar vessels may be filled with cooling agent. The glass surface of a glass dewar vessel must be free from scratches.

Dewar flasks made from glass must have a protective covering or another kind of protection against implosion.

Make sure that by using a dry ice cooling bath no dangerous reaction can occur between the content of the cooled reaction flask and the cooling medium, after a possible break of the reaction flask.

Give dry ice or liquid nitrogen in a cooling bath only at such a rate that no bubble over or spouting takes place. As solvent for such purposes isopropanol is suggested.

Limit the dwelling time of liquid nitrogen in an open dewar vessel. Such dewar vessels must be completely emptied in regular intervals. Liquid oxygen (b.p. -183 °C) can condense into the liquid nitrogen and concentrate there (light blue colour). Liquid nitrogen enriched with liquid oxygen can form explosive mixtures in contact with organic substances.

Cooling baths and dewar vessels are to be covered to reduce the rate of evaporating of organic solvents or the speed of enrichment of liquid oxygen into liquid nitrogen.

Since argon (b.p -186 °C, m.p. -189 °C) exists as a solid at the temperature of the liquid nitrogen it can block apparatuses.

Do not cool solvent cooling bathes lower than 10-15 degrees above the melting point of the used solvent (isopropanol m.p. -90 °C).

Liquid oxygen or liquid air as cooling media are forbidden.

In elevators transportation of containers with liquid nitrogen is allowed only if there are no persons in the elevator.

Usage of liquid nitrogen is only valid in open vessels or in excess-pressure containers equipped with a pressure relief valve.

Work involving liquefied gases

When working with liquefied gases, measures must be taken to prevent hazards due to quickly evaporating liquefied gas. Particular hazards include fire, explosion, frostbite, as well as hazards from asphyxiation and hazards resulting from toxic properties.

No adequate warning signs are perceptible when these gases are inhaled.

Apparatus leaks can lead to the freezing of cables and safety devices, and to the rupture of apparatus components.

Personal protective equipment is to be used (protective glasses, gloves providing protection against the cold and if necessary visors and aprons).

Chromatography

With flash chromatography in particular, the tightness and pressure stability of the connections must be ensured. Supply vessels that are under pressure have to be protected. If they burst, the escaping solvent must be captured and the surrounding area protected against flying fragments.

If the apparatus cannot be operated in a fume hood, the solvent vapours escaping must be removed safely.

Compressed-gas cylinders and fittings

For fire protection purposes compressed-gas cylinders should be installed securely outside of laboratories. Installing compressed-gas cylinders in laboratories creates hazards due, for example, to items leaking or falling down, cylinders being transported and fires resulting from cylinders bursting. Storage of compressed-gas cylinders inside laboratories is permissible only in permanently ventilated gas cylinder safety cabinets. Gases must be supplied to the workplaces in permanently fixed, sealed pipelines. If such protective measures are not possible or practicable, compressed-gas cylinders have to be taken to a safe location once work has been completed.

Laboratories in which compressed-gas cylinders are installed must be marked with the warning sign “Warnung vor Gasflaschen“ (“Warning: Bottled gas”).

Compressed-gas cylinders are to be protected against warming and mechanical effects, especially against falling down (chains, pipe clamps or adjustment devices).

Compressed-gas cylinders which contain toxic, highly toxic, carcinogenic, mutagenic or reprotoxic gases must be installed in fume hoods or ventilated gas cylinder cabinets for work in laboratories. The smallest possible compressed-gas cylinders have to be used for these gases (e.g. lecture bottles).

All compressed-gas cylinders must have the standardized European colour coding.

Gases may be fed into apparatus only if it is ensured that no impermissible overpressure can build up in the apparatus (safety immersion, overpressure valves, pressure compensation at designated openings). When feeding gases into liquids, equipment must be used that can reliably prevent liquids from flowing back into the line or into the removal vessel (empty safety bottles).

Compressed-gas cylinders must be operated with suitable pressure reducers. No torque-increasing tools may be used to open and close valves.

Fittings, pressure gages, seals and other parts for intensely oxidizing compressed gases (e.g. oxygen, laughing gas) must be kept free from oil, grease and glycerine (fire hazard). Only pressure gages and valves may be used which are approved for the content.

When transferring gases in liquid form into smaller compressed-gas cylinders, overfilling must be avoided.

Valves of compressed-gas cylinders are to be closed after use and also after emptying.

Gas-tightness has to be realised for all compressed-gas cylinders, pipelines and as sealed constructed apparatuses.

Compressed-gas cylinders may only be transported with suitable aids and only with a safety cap on. Compressed-gas cylinders should not be transported in elevators along with people.

If the inspection date has passed compressed-gas cylinders may continue to be used only in order to empty them and only if the gas cylinders appear to be without any complaints.

Autoclaves, sealed tubes, pressure tubes

Apparatuses for performing reactions under increased pressure must be designed in a way that they reliably withstand the mechanical, chemical and thermal stresses and remain tight.

Pressure must be discharged so as not to put people at risk. A safe discharge of possibly large amounts of escaping gases is to be ensured. A fume hood can fulfil this requirement only in case of pressure devices with a very small volume.

Experimental autoclaves for experiments where it is not known how the reaction, pressure or temperature will develop must be installed in special chambers or behind protective walls. These must be designed in such a way that persons are protected against broken glass, other flying fragments, leaking contents and the effects of possible subsequent explosions should the autoclave fail. It must be possible to monitor and operate safety devices and measuring devices from a safe location.

Experimental autoclaves with flammable or toxic contents must be operated in ventilated chambers that are designed to withstand possible pressure surges and the momentum of flying fragments. Toxic or explosive mixtures of air, gas, vapour or dust ejected from an autoclave in the form of clouds are not restrained by protective walls.

Using sealed tubes is only allowed if they cannot be replaced by other less hazardous apparatus. Appropriate protective measures must be taken when such tubes are being sealed. Sealed tubes should be placed in a steel shell immediately after closing. After the experiment, they may not be removed from the carius oven until they are completely cool and then only in the protective shell. They may not be removed from their protective shells until they have been depressurized.

If pressure tubes made of glass without safety-valve or comparable construction unit (e.g. bursting diaphragm) are used, the development of an inadmissible overpressure has definitely to be excluded. Such overpressure may be avoided in case the boiling temperature of the applied solvent will not be exceeded. For realizing exceeding temperatures a higher boiling solvent should be utilized.

Ultrasound

Ultrasonic baths must be operated closed if the formation of an aerosol can cause a hazard.

If chemical reactions are performed in ultrasonic baths, it must be taken into account that these reactions may be accelerated (overheating, fire hazards).

Microwaves

Substances in microwave ovens heat very quickly if they have a correspondingly high absorption capacity for microwave radiation. Solvents can reach their boiling point in a matter of seconds. Solids may be heated to very high temperatures, for example carbon quickly up to red heat. Carbon can be formed from overheated organic material.

Possible fire and explosion hazards must be taken into account when heating is done with microwave equipment. Superheating has to be prevented when heating liquids (rupture hazards, hazards of flying splitter).

It is advisable to use laboratory microwave equipment (mechanically stable housing, controllability of the microwave power).

Reactions in microwave equipment

The equipment manufacturer's operating instructions must be followed, in particular the details on the average service life of pressure reaction vessels. A sufficiently stable design and sensors to monitor pressure and temperature are necessary.

If flammable liquids are being heated, equipment must have additional safety devices (e.g. mechanical ventilation and an explosion sensor).

If apparatus is installed that protrudes from the oven chamber, equipment must have appropriate through-holes with radiation damping.

Reaction mixtures in microwave ovens with field inhomogeneities that cause uneven heating must be stirred particularly vigorously.

Many reactions take place unexpectedly quickly (hazard that reactions get out of control, formation of hazardous reaction products, overpressure as a result of gas formation).

In case of reaction mixtures without solvents or in such ones metallic films can separate out a risk is given of a strong heating of the walls of the reaction vessels up to its melting or rupture.

Additional safety equipment in the device may include mechanical ventilation or an explosion sensor.

Specially designed equipment with additional monitoring functions is needed for pressurized digestion.

If blowing off or bursting of a vessel can result in materials escaping from the oven chamber, these should be captured and discharged safely in order to prevent them from getting into the laboratory.

Robots and automated laboratory equipment

Hazards for persons resulting from mechanical movements, in particular those of needles and cannulae contaminated with hazardous material, must be prevented on autosamplers, handling equipment, automatic screening, pipetting machines and other automated laboratory equipment. If necessary, there must be safeguards (light barriers, light curtains, covers and doors with limit switches).

The possibility of hazardous materials escaping from damaged containers is to be taken in account.

Instruction manuals have to be known and safety instructions inside are to be followed.

Laser radiation

Before starting work with laser beams, operating instructions have to be created.

All lasers must be labelled according to their category.

Depending on the laser category necessary protective measures have to be taken, especially against the effects of direct light and the effects of stray light into the eyes and on the skin. Laser light may be a high hazard for the eyes and the skin.

Areas with lasers of category 2 and above must be marked with the warning sign “Warnung vor Laserstrahl“ (“Warning: Laser beam”).

Category 2, 2M and 3A lasers may only be operated if the path of the beam is clearly and permanently marked.

Category 3B, 3R and 4 lasers may only be operated if additional protective measures are taken. These include restricted access and laser beam shielding. It may be necessary to wear laser protection glasses. Reflective objects may not accidentally find their way into the path of the beam during work. In particular, jewellery should be removed. The responsible accident insurer and the responsible authorities must be notified when operating category 3B, 3R and 4 lasers. A laser protection officer must be appointed in writing before commissioning category 3B, 3R and 4 lasers. Laboratories in which category 3B, 3R or 4 lasers are operated may only be entered by appropriately instructed personnel. Laser radiation is to be routed in tubes or housings. Reflective surfaces should be avoided near the path of the beam.

In laboratories, laser light can trigger chemical reactions and physical processes by a high energy input and may destroy materials or represent an ignition source.

Laser protection glasses, protective clothing and protective gloves are to be provided and used in consultation with the laser protection officer.

UV radiation

Direct or indirect UV exposure can lead to inflammation and burns of the cornea and conjunctiva. On the skin, it may cause burns similar to sunburn. Repeated exposure can result in skin cancer. Ultraviolet radiation sources must be arranged and operated so as not to damage the eyes or skin (shroud, special protective glasses, protective clothing, no direct visual contact with the lamp, no ray exposure).

Ozone may be created, in particular, when using high-output lamps. Ventilation measures should be taken to ensure that ozone levels remain below the workplace limit and impairments to health can be excluded (if necessary, work in the fume hood).

It must be unambiguously apparent whether ultraviolet radiation sources are on or off.

Attention, ultraviolet radiation sources can become very hot.

Ionizing radiation

When working with open radioactive materials, special regulations are valid, see thereto "Strahlenschutzverordnung" ("Ionizing Radiation Regulations"), "Röntgenverordnung" ("X-ray Regulations") and BGI/GUV-I 850-0e.

Electromagnetic and magnetic fields

Areas with sources of electromagnetic radiation with strong electromagnets or permanent magnets (e.g. NMR-instruments) must be marked - "Warnung vor elektromagnetischem Feld" ("Warning: Electromagnetic field") or "Warnung vor magnetischem Feld" ("Warning: Magnetic field"). Access has to be regulated as appropriate.

There must be no unacceptably high field strengths in areas where there is a possibility of persons being exposed.

Access to danger areas must be restricted.

Needles and cannulae

Needle-stick injuries can occur when working with syringes and cannulae (hazard of infection, risk of incorporating hazardous materials).

Needles must be disposed of in needle containers without being touched.

Cannulae should not be returned to their protective sleeve without appropriate aids.

Cleaning

Washing with organic solvents should be avoided if possible.

Cleaning agents with a strong reaction (e.g. strong acids or bases) may only be used if other cleaning agents have proved unsuitable.

Prior to cleaning, it is to be ensured that any residue in the containers cannot lead to hazardous reactions with the cleaning agent.

In laboratories cleaning bathes with inflammable cleaning liquids are only allowed if this does not result in a higher risk especially in case of fire.

Waste disposal and conservation of resources

The amount of chemicals and solvents used in a laboratory should be kept to a bare minimum. Here it is a matter of "recycling is better than disposal".

A pollution of sewage with water contaminating substances is to avoid. For this reason waste should never be given into the sink.

After completion of laboratory work waste containers for chemicals are to be closed with a suitable screw cap.

All kinds of waste must be strictly collected in the corresponding waste containers and afterwards supplied to the "Entsorgungshof" (disposal station).

The individual types of waste should be collected separately so as to rule out hazardous reactions. Collection containers for waste of hazardous material have to be installed in a

laboratory in a way usual laboratory work will not be impaired and a hazard can be excluded. In the case of hazardous liquid waste, an adequately dimensioned collection pan must be located below the collection containers.

Waste has to be collected separately according to the following categories:

- solvent mixtures (Lösungsmittelgemische)
- washing water contaminated with organic solvents (Waschwasser verunreinigt mit organischen Lösungsmitteln)
- inorganic solids (anorganische Feststoffe)
- organic solids (organische Feststoffe)
- chemical glassware brown (Laborglas braun)
- chemical glassware white (Laborglas weiß)
- adsorbents and filter materials (Aufsaugmittel und Filtermaterialien)
- laboratory waste made from plastics or other materials (Laborabfälle aus Kunststoff oder anderen Materialien)
- packaging contaminated with dangerous substances (Verpackungen, die Rückstände gefährlicher Stoffe enthalten)
- broken glass (Glasbruch)
- pump oils - mineral oils (Pumpenöle - Mineralöle)
- silicone oils (Siliconöle)

Waste that cannot be disposed of by third parties owing to its chemical properties has to be destroyed safely in the laboratory or converted into a harmless form.

All waste containers are to be labelled and marked properly.

It is to be ensured that providing and filling waste containers give not any risk or health damages (storage at permanently ventilated places).

Containers for different kinds of waste can be received in the “Entsorgungshof” (disposal station).

Broken glass is to be disposed of by using the appropriate waste containers.

Glass-blowing work

To avoid health hazards to the glass-blowers, glassware has to be cleaned and dried before performing glass-blowing work.

Escape and rescue routes

To the escape and rescue routes belong corridors, stairs, stairwells, and exits.

Escape and rescue routes have always to be kept free! It is forbidden to put down things of any kind in the area of escape and rescue routes.

To placement of cupboards, tables, chairs, coat-stands and other things on corridors is only permitted in those areas which are not escape and rescue routes. All furniture and things put down on the floors are to be made from non-flammable or at least flame-resistant materials.

The storage and placement of chemicals, things which are combustible or consist of combustion supporting materials (paper, wood, styrofoam, pin boards, empties) is forbidden in common rooms, stairwells, passages, corridors and on attics.

Escape and rescue plans must be put up in a clearly visible way on every floor of a building. These plans have to indicate escape and rescue routes and also all locations of fire-fighting

installations (hand-held fire extinguishers, wall-mounted fire hydrants with fire hoses, fire blankets, fire detectors, appliances for heat and smoke outlets). Existing escape and rescue routes and their signposting have to be integrated in the annual instructions.

Escape and rescue routes including the exits, are to be signalized with safety signs emitting an afterglow. The signs should never be view blocked, damaged or removed.

Fire doors, smoke doors, self closing escape route doors and other self closing doors (e.g. laboratory doors, connecting doors) must never be propped open, for example by blocking the self-closing mechanism.

Automatic fire doors close self-acting. These doors are kept open by electromagnetic lock appliances.

Laboratories must be equipped with an adequate number of exits, at least two. Escape routes may only lead through an adjacent room if this room can be exited safely without outside help, even in the event of a hazard occurring.

Laboratory doors must open outwards (in the direction to the corridor) and have a window. The window is to be kept free always. Laboratory doors should be kept closed.

All employees have to report damages to fire-protection appliances, fire-detection systems and fire-warning systems.

Technical protective measures

Legal mandatory tests are to be complied for all working appliances for which such regulations exist.

Badly designed workstations in laboratories increase the risk of an accident and can contribute to the accidental release of hazardous materials.

Circulation routes and areas of movement inside laboratories have to be kept free. Floors, their coverings and cable conduits passing through them must be watertight.

It is forbidden to place flasks or containers with chemicals as well as other objects on the floor.

Laboratories must be equipped with technical facilities that ensure adequate ventilation at all times (air exchange rate of 25 m^3/h per m^2; in case of a clear height of 3 m this is approximately equivalent to an eightfold hourly exchange of air). From laboratories exhausted air must not be returned. Local extraction devices are recommended in order to reduce emissions at source. Such local extraction devices are no replacement for fume hoods, but they can be useful under certain conditions.

To indicate special hazards inside a laboratory, like laser radiation, strong magnetic fields, usage of compressed gas cylinders, safety signs have to be attached at the entrance door or at the workplace.

Rules of conduct in dangerous situations, house alarm

All employees and students are obliged to prevent dangerous situations by a responsible behaviour.

House alarm

In dangerous situations a house alarm (acoustic signal) is to be triggered, if necessary.

Inside the buildings in Albert-Einstein-Straße and inside the laboratory building in Dr.-Lorenz-Weg red metal boxes are to be found at different positions on the corridors. To trigger a house alarm the glass window in the front area of the box is to be broken with a suitable object and then the alarm button has to be pressed. After pressing the button in the buildings in Albert-Einstein-Straße a fire alarm automatically will be triggered at the fire department. In case of the buildings in Dr.-Lorenz-Weg the fire department must be called via the emergency phone number 0-112.

An emergency call has to be accomplished as follows:

- Who is calling?
- What has happened?
- Where has it happened?
- How many persons are affected?
- If necessary and possible wait stay for questions!

In case of an automatically triggered alarm these questions have to be answered when the fire brigade is arriving. The action forces of the fire department are to be instructed after arriving.

The dispatcher centre of the university is to be informed by phone - phone number 1111.

If an acoustic emergency signal rings out on the corridor the following code of behaviour is valid:

- All kinds of activity have to be stopped immediately – stop the supply of current and gases to all experimental facilities, close all gate valves, press the emergency cut-off switch for current and gases and close windows if open; cooling water must be run on if necessary.
- Before leaving the room make sure that there are no persons left inside the room.
- Give help to all injured or needy persons.
- After leaving the working rooms close the door but do not lock it.
- Do inform your colleagues in the neighbouring rooms, and urge them to leave their rooms.
- The building has to be left in the shortest way following the escape routes. Do not use an elevator!
- All persons have to come together at the meeting place. There it is to be checked thoroughly if really all persons are at the meeting place.

Dangerous situations

In case of a dangerous situation like a fire, escaping of harmful gaseous substances, run out of harmful liquids and solvents or explosion hazards measures have to be taken to avert or minimize danger:

- Stay calm and avoid hasty, senseless actions.
- People should be protected before objects are.
- All apparatuses and experiments have to be switched off ore stopped; supplies of current, gases and water are to be cut off; cooling water must be run on.
- Persons in neighbouring rooms are to be warned and urged to leave their rooms.
- If a dangerous situation cannot be eliminated without self-endangerment a house alarm is to be triggered; emergency cut-off switch has to be pressed and the building must be left following the escape and rescue routes.
- Inform the head of the workgroup or the head of the practical course and the dispatcher centre of the university (phone number 1111).
- In case of a ventilation system break down stop all activities with harmful materials, leave the laboratory after switching off all apparatuses and experiments and inform the head of the workgroup.

If a house alarm was triggered the building may be re-entered only after the fire-brigade or authorized persons allowed it.

Escape of harmful gases

After an uncontrolled escape of harmful gases this gas flow is to be stopped by closing the appropriate valve if possible without self-endangerment. If necessary a respirator mask with a suitable air-filter is to be used. Afterwards a good aeration has to be realized.

If it is not possible to stop the gas escape without self-endangerment all apparatuses and experiments have to be stopped, the endangered area has to be leaved, a house alarm is to be triggered and the building must be leaved following the escape and rescue routes.

In case flammable gases are escaping ignition sources are to be prevent and electrical switches must not to be used.

The superior is to be informed.

Escape of harmful liquids

In case a liquid has run out it has to be eliminated without endangering oneself. If necessary, a respirator mask with a suitable air-filter is to be used.

Binding agents to absorb harmful liquids are to be held ready in the laboratories / on the corridors.

Code of behaviour in case flammable liquids have run out (if realizable without self-endangerment):

- Ignition sources are to be prevented.
- Electrical switches must not to be used.
- A good aeration has to be realized.
- Liquids are to be absorbed with a suitable binding agent.
- Binding agents have to be put in a collecting container which is absolutely tight.
- Liquids / adsorbed liquids are to be given to the waste disposal.
- The superior is to be informed.

In case of self-endangerment all apparatuses and experiments have to be stopped, the endangered area has to be left, the house alarm is to be triggered and the building must be left following the escape and rescue routes.

Code of behaviour in case corrosive liquids were run out (if realizable without self-endangerment):

- A good aeration has to be realized.
- Liquids are to be absorbed with a suitable binding agent.
- Binding agents have to be put in a collecting container which is absolutely tight.
- Liquids / adsorbed liquids are to be given to the waste disposal.
- The superior is to be informed.

In case of self-endangerment all apparatuses and experiments have to be stopped, the endangered area has to be left, the house alarm is to be triggered and the building must be left following the escape and rescue routes.

Fires, fire protection

All employees and students are strictly obligated to prevent a fire by their behaviour.

Extinguishing equipment

For fire-fighting carbon dioxide and powder extinguishers are available in a sufficient number. It is furthermore favourable to hold extinguishing sand ready. Carbon dioxide extinguishers are especially suitable for fighting a burning liquid. In case of a solid source of fire and also if metals, metal alkyls, lithium aluminium hydride, silanes or similar compounds are burning, powder extinguishers are the better choice.

The locations of fire extinguishers should be marked by the fire-fighting sign "Feuerlöschgerät" ("Fire extinguisher").

Fires

In rooms filled with smoke it is favourable to move in a stooping or crawling way because respirable air is mostly near the floor.

For battle against a fire the existing fire extinguishers should be used if possible without self-endangerment. Smoke can block the way back very fast. Special hazards like toxic gases, vapours and so on have to be considered.

In case a fire cannot be extinguished without self-endangerment or any other problems, a fire alarm / house alarm is to be triggered as fast as possible.

All persons not involved in the battle against a fire or in rescue measurements have to leave the hazardous area.

In general, also small fires are to be reported to the superior or the leader of the practical course as well as to the safety officer.

For the right behaviour in case of a fire the "Brandschutzordnung der Universität Rostock" ("Fire safety regulations of the University of Rostock"), the "Brandschutzordnung des Instituts für Chemie" ("Fire safety regulations of the Institute of Chemistry") and the "Allgemeingültige Grundsätze zur Brandverhütung und zum Verhalten im Brandfall" of the University of Rostock ("Common principles of fire prevention and of the behaviour in case of a fire" of the University of Rostock) have to be followed.

Burning items clothing

Persons whose clothes are burning tend to panic.

In consideration of the existing possibilities, the fighting of fires on clothing has to be performed in the following rank: emergency shower, carbon dioxide or powder fire extinguisher (health protection is to be considered), fire blanket, back and forth rolling on the floor.

Compressed-gas cylinders in the event of a fire

Fires involving liquefied and compressed gases from compressed-gas cylinders are normally extinguished by closing the cylinder valves (cutting off the gas supply). If this immediate measure cannot be implemented without risk (for example, with fires near the cylinder valves), the fire must be fought with powder or carbon dioxide fire extinguishers so that the cylinder valves can be closed as soon as the fire has been put out.

Cylinders that have been heated by a fire can be cooled with water from a protected location. With very hot cylinders (evident from vaporizing water), the area must be evacuated immediately due to the risk of explosion.

Compressed-gas cylinders that have been exposed to a fire must be taken out of service.

First aid measures

The following policies give an overview about selected first aid laboratory activities.

Personal security should be considered in all first aid services.

Persons who had an accident have to be rescued from the endangered area. Afterwards a sufficient fresh air supply is to be made sure.

After skin contact with harmful materials the wetted parts of the skin have to be flushed with much water and if necessary washed with soap for at least 5 minutes. If a large area of the skin has come in contact, an emergency shower should be used.

In case harmful materials have affected the eyes, an eye shower is to be used. Thereto the eyelids have to be spread and then washing operation is to be performed starting from outside in the direction to the base of nose for at last 10 minutes.

Items of clothing contaminated with hazardous materials, including undergarments, tights and shoes, must be removed immediately.

After accidents with soft injuries or with indisposition or dermal reactions, which are caused by chemicals, a doctor has to be consulted. The superior must be informed.

After accidents with severe injuries or when it cannot be accessed how severe an injury is, an emergency doctor is to be alarmed. Until the arrival of the accident ambulance the injured person must not be left alone. First aid is to be given. A person familiar with the local conditions should be waiting at the building entrance, pointing the way to the injured person.

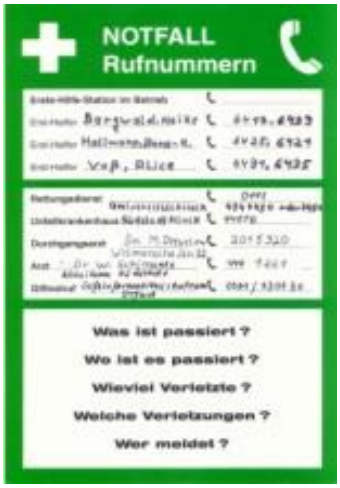
All useful and helpful information has to be given to the emergency doctor. Important sources of information (e.g. vomit and chemicals) are to be ensured and to be shown to the doctor.

All workplace accidents and all commuting accidents (also suspected cases, for example those caused by dealing with harmful materials) are obligated to register. Always, a written report must be taken down.

In case of particularly hazardous activities necessary emergency measures are to be tuned with one or several hospitals which is / are qualified.

In all departments of the Institute of Chemistry first aiders have to be named.

On the corridors announcements have to be installed to declare following information: emergency call, emergency doctor, first aider.



In the laboratories appropriate first aid equipment, e.g. comprehensively equipped first aid boxes, must be in place.

Further information is given in the brochures of the Legal Accident Insurance „Anleitung zur Ersten-Hilfe“ (“First aid instruction”) and „Informationen für die Erste-Hilfe bei Einwirken gefährlicher chemischer Stoffe“ (“Information about first aid after exposure of hazardous chemicals”).

Emergency call, Emergency phone numbers

Emergency call (in case of fire, damage, accident): 0-112

University emergency call, dispatcher: 1111

In all dangerous situations the leader of the working group has to be informed.

Make points in any emergency calls in the following order:

- WHAT happened / fire, chemical burn, fall etc.?
- WHERE did the accident occur / information about the location?
- HOW MANY injured persons / number?
- WHICH injuries / type and location on the body?
- WHO is reporting / name of the calling person?
- WAIT until the central office terminates the call, there could be important questions to be answered.

Emergency phone numbers in cases of poisoning

In cases of poisoning contact the places listed below for relevant information about the current situation:

Berliner Betrieb für zentrale gesundheitliche Aufgaben (Institute of toxicology, poison emergency call Berlin)	Phone number: 030 19240
Giftinformationszentrum-Nord (Poison Information Centre North of the provinces Bremen, Hamburg, Niedersachsen and Schleswig-Holstein)	Phone number: 0551 19240

Giftinformationszentrum Erfurt
(Poison Information Centre of the provinces
Mecklenburg-Vorpommern, Sachsen, Sachsen-Anhalt
and Thüringen)

Phone number: 0361 730730

Occupational medicine

Measures of occupational medical checkups are regulated in the directive of the Institute of Chemistry "Arbeitsmedizinische Vorsorge" ("Occupational health care service"). Appropriate medical checkups may be claimed.

Activities of outside companies

Before the beginning of third-party activities (cleaning stuff, staff of the building services, service companies) inside laboratories, concerned persons are to be informed about all potential risks. A special introduction must be given to these persons.

Rostock, 09.12.2014

Prof. Dr. A. Schulz
Executive Director
Institute of Chemistry

Dr. H. Feist
Security Officer
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Appendix I

Labeling according CLP / GHS

Hazard pictograms

 GHS 01 Potential Explosive	 GHS 02 Flammable	 GHS 03 Oxidizer
 GHS 04 Pressurized Gas	 GHS 05 Corrosive	 GHS 06 Highly Toxic
 GHS 07 Harmful / Toxic	 GHS 08 Carcinogenic / Mutagenic / Teratogenic / Toxic for Reproduction	 GHS 09 Environmentally Toxic

Signal words: -Danger
-Warning

Hazard Classification

Physical hazards

-Explosives
-Flammable gases
-Flammable aerosols
-Oxidizing gases
-Gases under pressure
-Flammable liquids
-Flammable solids
-Self-reactive substances and mixtures
-Pyrophoric liquids
-Pyrophoric solids

-Self-heating substances and mixtures
-Substances and mixtures which in contact with water emit flammable gases
-Oxidizing liquids
-Oxidizing solids
-Organic peroxides
-Corrosive to metals

Health hazards

-Acute toxicity
-Skin corrosion/irritation
-Serious eye damage/irritation
-Respiratory and skin sensitization
-Germ cell mutagenicity
-Carcinogenicity
-Reproductive toxicity
-Specific target organ systemic toxicity (TOST - from single exposure)
-Specific target organ systemic toxicity (TOST - from repeated exposure)
-Aspiration hazards

Environmental hazard

-Hazardous to the aquatic environment
  a) Acute aquatic hazard
  b) Chronic aquatic hazard
-Hazardous to the ozone layer

Hazard statements H-Phrases

-Hazard statements are coded with H and three digits
➡ thereby the first digit means:
-2: physical hazards
-3: health hazards
-4: environmental hazards
-0: physical hazards, health hazards, environmental hazards valid only in the EU

Precautionary statements P-Phrases

-Precautionary statements are coded with P and three digits
➡ thereby the first digit means:
-1: general precautionary statements
-2: prevention precautionary statements
-3: response precautionary statements
-4: storage precautionary statements
-5: Disposal precautionary statements

Carcinogenicity

-divided into 3 hazard categories: 1A, 1B, 2

- hazard pictogram 

Germ cell mutagenicity

-divided into 3 hazard categories: 1A, 1B, 2

- hazard pictogram 

Reproductive toxicity

-divided into 3 hazard categories: 1A, 1B, 2
-additional hazard classification: effect on / over lactation

- hazard pictogram 

- Hazard category 1A of the hazard classifications carcinogenicity, germ cell mutagenicity and reproductive toxicity:
  -Potential is proven by human data.

- Hazard category 1B of the hazard classifications carcinogenicity, germ cell mutagenicity and reproductive toxicity:
  -Classification was made by means of animal testings.

- Hazard category 2 of the hazard classifications carcinogenicity, germ cell mutagenicity and reproductive toxicity:
  -Effects to humans are assumed.

Specific target organ systemic toxicity (TOST - single exposure)

-divided into 3 hazard categories: 1, 2, 3

-hazard pictogram
for categories 1, 2 

-hazard pictogram
for category 3 

- Hazard category 1: Substances that have produced significant toxicity in humans, or that, on the basis of evidence from studies in experimental animals can be presumed to have the potential to produce significant toxicity in humans following single exposure.

- Hazard category 2: Substances that, on the basis of evidence from studies in experimental animals can be presumed to have the potential to be harmful to human health following single exposure.
- Hazard category 3: Substances that are showing respiratory tract irritation or narcotic effect and which adversely alter human function for a short duration after exposure without leaving significant alteration of structure or function following single exposure.

Specific target organ systemic toxicity (TOST - repeated exposure)

-divided into 2 hazard categories: 1, 2

-hazard pictogram 

- Hazard category 1: Substances that have produced significant toxicity in humans or that, on the basis of evidence from studies in experimental animals, can be presumed to have the potential to produce significant toxicity in humans following repeated exposure.
- Hazard category 2: Substances that, on the basis of evidence from studies in experimental animals can be presumed to have the potential to be harmful to human health following repeated exposure.

Acute oral toxicity, LD_{50} [mg/kg]

Lethal	Lethal	Toxic	Harmful	May be harmful
Category 1 ≤ 5	Category 2 > 5 - ≤ 50	Category 3 > 50 - ≤ 300	Category 4 > 300 - ≤ 2000	~~Category 5~~ ~~>2000 - ≤ 5000~~
				Category 5 is not valid in the EU

Appendix II

Operations in the fume hood

List of compounds

-acrylnitrile
-alkyl mercury compounds
-dust which can reach elveole
-aromatic nitro and aromatic amino compounds
-arsenic and arsenic compounds
-asbestos
-benzene
-beryllium
-tetraethyl lead and tetramethyl lead
-cadmium and cadmium compounds
-chromium (VI) compounds
-dimethylformamide
-respirable dust
-fluorine and inorganic fluorine compounds
-glyceryl nitrate and ethylene glycol dinitrate (nitroglycerine / nitroglycol)
-carbon disulfide
-carbon monoxide
-nickel and nickel compounds
-polycyclic aromatic hydrocarbons
-pyrolysis products from organic material
-white phosphorous
-platinum compounds
-mercury and inorganic mercury compounds
-hydrogen sulfide
-silica dust
-styrene
-tetrachloroethylene
-toluene
-trichloroethylene
-vinyl chloride
-xylene (all isomers)