Laboratory and workshop

HANDBOOK

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As the executive manager at NTNU, it is my responsibility to ensure that all personnel who work at the organisation enjoy a safe and healthy working environment.

HSE issues entail leadership and personal responsibility – a commitment to ensuring the personal safety and health of ourselves and our colleagues, and to the external environment.

I encourage you to make yourself familiar with the contents of this handbook, and to make an active contribution towards creating safe workplaces at NTNU.

Good luck and thank you for your help!

Trondheim, 1 August 2018

Gunnar Bovim
Rector
NTNU

HSE-related activities in laboratories and workshops

The Laboratory and Workshop Handbook is a guide to where you can find information about how to work safely in our laboratories and workshops.

Innsida:
NTNU operates with a set of HSE guidelines that apply to all personnel at the university. More specific work procedures are available at the individual departments in question. These regulations must be adhered to.

NTNU's HSE guidelines can be found by here at Health, safety and the environment on Innsida.

Contents

1
HSE – RESPONSIBILITIES AND TASKS

1.1 Line managers

A line manager has responsibility for HSE matters at his or her own division, and this responsibility cannot be delegated.

This entails responsibility for ensuring that:

- HSE coordination procedures are adhered to
- HSE regulations are made known to, and adhered to by all employees, contracted personnel, visitors and students.
- local provisions are prepared as and when necessary
- essential training is carried out and documented
- all personnel are made familiar with notification procedures and emergency response plans
- unwanted incidents such as accidents, near misses and hazardous situations are dealt with and followed up
- persons are appointed who are responsible for laboratories/workshops and fire prevention zones
- protective equipment is accessible and used
- dangerous work equipment is fitted with the necessary safety devices
- risk assessments are carried out
- Safety Data Sheets are readily available and updated
- work carried out alone outside normal working hours is only permitted after a risk assessment has shown that this is justified
- targeted health checks are carried out in collaboration with the HSE section in question.
- all personnel are made aware of first aid and fire regulations

1.2 Employees with management or supervisory responsibilities

Employees whose task it is to lead or supervise other employees are responsible for HSE matters during the planning and implementation of work tasks. Such employees include tutors, laboratory managers, workshop managers, project managers, fieldwork leaders, student assistants, scientific assistants and suchlike. Note that in some cases, students will be regarded as employees.

Personnel with technical responsibility and/or subject tutors involved in Ph.D. or other student projects are responsible for risk assessments, tailored training programmes, safety equipment and emergency response procedures, among others.

1.3 Employees and students

Employees and students must make themselves familiar with, and adhere to, all HSE regulations.

This entails responsibility for ensuring that they:

- plan and carry out their work in such a manner as to avoid risks to health and the environment.
- use mandatory and essential protective equipment
- keep the workplace in good order
- participate in mandatory training
- report all non-conformances and unwanted incidents

Employee health and safety representatives are responsible for safeguarding employees' interests. More detailed information about this role can be found at:

- **Innsida:** Employee health and safety representative(s)

The students' faculty representatives are responsible for safeguarding students' interests.

The employee health and safety and student representatives have no formal responsibility for HSE issues, but have a supervisory role ensuring that HSE issues related to employees and students are safeguarded.

The HSE Section can provide assistance to the divisions in connection with HSE-related work.

1.4 Employees in the Campus Services Department

The line manager responsible for the Campus Services Department shall ensure that all employees in the department receive training in HSE guidelines and the use of dangerous equipment, and that they complete an e-learning course in HSE. Work in laboratories and workshops at NTNU is incorporated in the e-learning course. Moreover, employees in the department receive HSE training from users in situations where this is mandatory.

Cleaners' tasks:
Fixtures and fittings

- the cleaning of hand basins and mirrors, but not benches, laboratory basins or equipment
- the replacement of soap and paper, and cleaning of dispensers as required

Waste

- the removal of household waste, but not hazardous, infectious, or radioactive waste
- cleaners must not move laboratory equipment in order to facilitate cleaning.

Floors

- the cleaning and maintenance of floors

Cleaning must not be carried out in locations where cleaners find:

- sharp objects, such as syringe needles
- liquids, including pure water
- chemicals
- infectious materials
- inadequate cleaning by employees/students

2
GENERAL REMARKS REGARDING SAFETY IN LABORATORIES AND WORKSHOPS

2.1 General HSE provisions

All personnel have a duty to make themselves familiar with HSE regulations, room safety information cards and general safety information cards, evacuation routes, and the location and use of alarms, fire extinguishers and first aid equipment.

- Risk assessments of work tasks, laboratories, workshops and equipment must be carried out
- Training must be provided prior to the commencement of work
- Mandatory protective equipment and devices must be used
- Safety Data Sheets must be readily available
- Always respond to alarms
- On hearing the fire alarm, leave the building. Follow instructions relayed over the public address system, where applicable
- It is prohibited to eat and drink in laboratories and workshops
- Adherence to safety regulations is of particular importance during demonstrations or experiments for special groups of visitors such as children. The person(s) responsible for demonstrations and experiments must ensure that all those present have understood the potential hazards, and that they are using the necessary protective equipment. The need for the demonstration or experiment in question must be assessed

2.2 Complex and/or dangerous equipment

The use of complex and/or dangerous equipment must be risk assessed, and followed by the preparation of detailed instructions for use. Written mandatory training requirements for the use of such equipment shall be stipulated prior to use.

The term equipment is understood to mean apparatus, machines, installations/devices, test rigs, etc.

2.3 Field work

NTNU operates with separate regulations governing employees and students in connection with field work (work in the field, scientific cruises, inspections, excursions, etc.) Field work is not covered by this handbook.

Innsida:

- Field work – HSE instructions for field work leaders
- Field work – HSE instructions for field work participants

2.4 Exposure register

In accordance with Chap. 31 of the statutory regulations governing the performance of work, a register must be kept of employees and students who may be exposed to the following substances/agents as part of their work:

- Carcinogenic or mutagenic chemicals
- Lead and lead compounds
- Materials containing asbestos fibre
- Biological agents
- Ionising radiation
- Substances generated by rock materials that may be harmful to health

NTNU uses the Eco Exposure system as its exposure register. Eco Exposure is a separate module incorporated into NTNU's chemical substance index, ECO Archive (EcoOnline).

NTNU's general recommendation is that all personnel, including students, shall register themselves. For students,

academic mentors (tutors) are responsible for providing information and training.

Employees and students who intend to record an incidence of exposure (on behalf of themselves or others) must be granted personal access to the Eco Exposure system. If you require access, contact the person responsible for the chemical substance index.

Innsida:
- Exposure register
- Chemical Substance Index
- Chemical Substance Index – contact persons

2.5 Training

Training shall be given to employees and students to enable them to work in laboratories and workshops. The minimum requirements are:

- familiarity with HSE regulations
- safe use of work equipment (apparatus, machines and tools)
- use of protective equipment, protective devices, alarms and emergency switches
- fire extinguishing
- first aid
- use of the chemical substances index and Safety Data Sheets
- entry of non-conformances in the non-conformance system

The employer has a duty to organise first aid courses and fire drills. Here you will find information about courses and training: **Innsida:** Health, Safety and Environment

3 RISK ASSESSMENT

3.1 General remarks regarding risk assessment

Risk assessment is one of several tools that we use for the systematic identification of issues linked to HSE that may arise in connection with our projects. A risk assessment must be carried out prior to the commencement of a specific task or process, and again when the task in question is modified. This is done so that measures designed to remove or control risk factors can be implemented prior to commencement of the work. A risk assessment must be documented in writing.

During a risk assessment, the following must be taken into consideration:

- What can go wrong?
- How high is the probability that something can go wrong?
- What are the consequences if something goes wrong?
- What measures must we take in order to reduce the probability of occurrence and/or mitigate the consequences and thus minimise risk?

The line manager and the employee health and safety representative involved in the area/activity that is the subject of the risk assessment must be informed of the risk assessment process. Participation in risk assessments will depend on an employee's level of responsibility and relevant competence Potential participants will include:

- A line manager
- Room supervisor
- The person with technical responsibility (Project Manager, supervisor)
- Employee health and safety representative(s)
- HSE Coordinator
- Student representative
- The workshop overseer, Principal Research/Departmental Engineers
- Coordinator with local responsibility for radiation protection
- Personnel from the relevant HSE Section – to provide technical assistance
- Personnel from the Campus Services Department with responsibility for facilities within the building in question (WHS, buildings, etc.)
- Representatives from other parties occupying the same premises such as NTNU/SINTEF/St. Olav's Hospital
- Other personnel whom the division considers appropriate.

As an aid to the completion of a risk assessment, examples of hazards, unwanted incidents, consequences and preventive measures are given in the table below:

1. Risk factors	
	All personnel must make an assessment of the hazards linked to their own activities. The following list may be of assistance in the assessment of potential hazards. NB! This list is not exhaustive
Chemicals and gases	• Explosive, flammable, caustic and corrosive substances, or those difficult to dispose of • Substances constituting a particular health hazard – carcinogenic, allergenic, mutagenic, or those which can cause reproductive damage • Harmful to the environment • Substances which react unfavourably with each other, or react explosively on contact with air or moisture • Substances which have special storage requirements, and in situations where data may be lacking regarding a chemical's health risk and reactivity
Electricity	• High voltages, high-potential electric fields, high current intensity, current leakage or earthing faults, short circuits, sparks (which cause ignition, ozone formation) and static electricity (synthetic materials in clothes and equipment)
Radiation	• Ionising radiation, X-rays, lasers, strong visible light, ultra-violet and infra-red radiation and ultrasound

Human pathogens (micro-organisms)	• Clarification of type of micro-organism and risk classification • Virulence, infectiousness • Work involving animals
Others	Powerful magnetic fields, open flames, temperature, pressure, vacuum, centrifuges, hoisting cranes, vibrations, physical stresses on personnel, apparatus, objects which may fall or overturn, fragile/exposed/rotating apparatus components, dust (causing soiling, respiratory problems, explosions), noise, splashing, spillage, overheating, immersion boilers, heavy weights, hazardous transport, obstruction of gangways and evacuation routes, difficulties for maintenance and cleaning personnel, non-Norwegian speakers, work after normal working hours, apparatus which is required to operate without supervision, and hazards caused by experiments in the near vicinity Water (cooling)
2. Unwanted incidents	
Examples	• Failure of water coolant system • Rupture in water hoses • Heating elements boil dry • Failure in electricity supply • Pipe blockage, or fracture in pipes/rupture in hoses • Valves opened too quickly/too far, or failure to open • All kinds of leakages • Wear and tear or accidents at other locations on the premises

3. Consequences	
Examples	In addition, an assessment must be made of what can happen if an accident occurs, irrespective of the cause. • What is the maximum force of a potential explosion (in kJ or MJ)? • What is the maximum amount of substance that can be ignited? • Can a fire spread? If so, how? • Are there other objects in the vicinity which may catch fire? • Will a fire generate large volumes of smoke or toxic gases? • Will an explosion generate a secondary hazard in the form of splinters? (Glass from doors and windows is particularly dangerous) • Will an explosion result in leakages of hazardous substances? • Will falling objects cause fire, corrosion or such like? • Will harmful splashing of liquids result from an accident or from the loosening of a spring washer or safety valve? • Will any form of accident result in the obstruction of evacuation routes? • How extensive can a spillage become? What are the consequences? • Will a given accident lead to accidents involving other apparatus?

4. Actions	
Examples	The following preventive measures must be evaluated based on risk and impact analyses: • Use of instrumentation during inspections and notification/raising alarms • Choice of materials • Use and location of alarms • Use and location of spring washers, safety and reduction valves • Labelling of switches and valves • Partition walls and such like to provide protection from fire/explosions • Manual monitoring requirements • Requirements regarding the amounts of chemicals, and their safekeeping • Flushing with inert gases or liquids prior to commencement, during, and after completion of the work • Protection from spillage and splashing • Maintenance requirements • Conduct experiments under fume extraction/ separate fume suction facility • Containers in which to collect leaked substances • Make sure that absorbent materials are available to clear spillages • Requirement for a drain in the floor • Working hours' restrictions • Use of protective equipment • Appropriate gas masks must be accessible outside the laboratory/workshop • Plan for analysis of the laboratory/workshop atmosphere after a gas emission in order to establish a basis on which to grant re-entry to the room and building • Regular blood and/or urine analyses • Plan for alarm in the event of the need for evacuation

Innsida:

- Risk assessment
- Carrying out a risk assessment

3.2 Construction and operation of research and teaching equipment

Apparatus can be of different types and is constantly changing. For each set of apparatus, a person will be appointed with responsibility for the apparatus in question. He or she must ensure that:

- assembly and work are carried out in compliance with current legislation and statutory regulations
- hazards are assessed and preventive measures put in place. If necessary, technical assistance must be called upon.
- risk assessments of complex apparatus or experiments which constitute a significant hazard must be documented in writing. If in doubt, consult the person responsible for the laboratory/workshop or the HSE Coordinator. The results of the risk assessment shall be appended to the apparatus, and the person responsible for the room/laboratory must keep a separate copy outside the lab/room in question.
- all documentation concerning apparatus and equipment must be kept together in safekeeping in a separate folder which must be made readily accessible to all users of the equipment in question. For further information about apparatus safety cards, we refer to the chapter dealing with protective equipment and hazard signage.

4
PROTECTIVE EQUIPMENT AND HAZARD SIGNAGE

4.1 General regulations governing protective equipment and hazard signage

- Employees, students, contracted personnel and visitors must use mandatory protective equipment at all times, in compliance with the Norwegian Working Environment Act (*arbeidsmiljøloven*), statutory regulations pertaining to the Act, and local regulations
- Prior to the commencement of a new activity, personnel must ensure that the correct protective equipment is being used. This shall be based on a completed risk assessment
- Information regarding mandatory protective equipment will be found on signs located outside laboratories and workshops, on the relevant Safety Data Sheets and on apparatus and other safety cards. If you are in doubt as to the correct protective equipment, contact the supplier or the person responsible for the laboratory/workshop in question.
- Mandatory protective equipment shall be readily accessible, and its location and usage explained by means of posted signs
- Rooms and equipment shall be signed in such a way that makes it easy for others to raise the alarm in the event of danger/incidents of non-conformance, extinguish fires, or shut down an experiment
- Protective equipment must be inspected and maintained on a regular basis
- Deficiencies or defects must be reported immediately as non-conformances and repaired

4.2 Personal protective equipment

Symbol	Description
 **Protective eyewear**	Must be worn in situations where there is a danger of splashing, during work with liquid nitrogen, high-pressure work, work involving the production of chips or shavings, a danger of explosion, or work involving cutting machines and saws, etc. In the event of the need to fit protective eyewear for a user, contact your immediate supervisor. **Example:** • Protective glasses • Visor
 **Work clothing**	Must be easy to remove. Should be made of cotton in order to prevent them catching fire as a result of sparks generated by static electricity. **Example:** • Laboratory coat • Boiler suit • Protective suit
 **Hand protection – gloves**	Gloves should be worn when working with hazardous and corrosive substances, laboratory animals, and with sharp and piercing instruments For further information, we refer to the chapter on gloves. Wear gloves that are made of the proper materials and labelled correctly (refer to the Safety Data Sheet).

Symbol	Description
 **Breathing apparatus**	**Ensure that breathing apparatus:** • is readily accessible at locations where there is/may be a need for such equipment (refer to the HSE product data sheet and apparatus safety card) • is fitted with the correct filter for the chemicals, hazardous substances or dust exposure in question • is well maintained • is stored in such a way that it does not become contaminated – preferably in a sealed plastic bag and kept inside a cabinet. • has not exceeded its shelf-life. Filters etc. have limited shelf-lives. Check the expiry date. • is designed so that is doesn't draw in unfiltered air **3 categories:** 1. Full and half masks with replaceable filters 2. Filtering half masks 3. Fresh air masks
 **Protective footwear**	**There are several types.** Must be fitted with steel toecaps to provide protection from pressure, impacts and heavy weights. Spiked soles are appropriate in certain situations.

Symbol	Description
 **Hearing protection**	There are several types. Special ear defenders with a built-in radio, communications functions, and active noise reduction are also available. Examples: • Ear plugs • Ear defenders
 **Safety helmet**	It is important to check the helmet's quality and condition. Helmets must not be kept in locations where they are subject to prolonged exposure to sunlight, because UV radiation degrades the plastic
 **Other forms of protective equipment**	Procured and made available as required. Examples: • Hairnet • Surgical mask • Shoe coverings • Safety harness and fall protection equipment

4.3 Room safety information card

- A room safety information card must be posted on all doors providing access to rooms/laboratories where a hazardous situation can arise, including rooms/laboratories where there is uncertainty linked to the level of risk.

- NTNU operates with a digital room safety information card system that provides information regarding particular hazards, amounts of flammable materials, and contact information for key personnel. The room safety information card system is accessible only to employees.
- A room safety information card shall provide information regarding hazards to personnel working in the laboratory/workshop in question, and the identity of the person responsible for said laboratory/workshop

Innsida: Room safety information card

4.4 Apparatus safety card

- Is intended to provide information regarding hazards, mandatory protective equipment and protective measures, a method for effecting an emergency shutdown, together with the name and telephone number of the person responsible for the apparatus
- Shall be prepared in compliance with guidelines for all forms of apparatus which may constitute a major hazard. Also applies to larger analytical apparatus used by several persons
- The need for an apparatus safety card must be evaluated before new equipment is put to use
- Must be completed and signed by the person responsible for the apparatus
- The card shall be placed so that it is easily visible

Equipment may have a restricted lifetime. The apparatus safety card must be updated/renewed in the event of modifications

4.5 Safety information card

A safety information card is intended to provide information for all personnel as to the identity of the manager, health and safety representative, deputy health and safety representative and, if necessary, the HSE Coordinator and faculty student representative for the safety area in question. All personnel in the safety area shall be made aware of the existence of any coordination agreements.

4.6 Experiment in progress

When an experiment which may constitute a hazard is in progress, information shall be provided in the form of a warning sign. The sign must include information regarding the identity of person(s) who are permitted to enter the room while the experiment is in progress (such as cleaners, facilities operations personnel, the Fire Department, etc.).

5
USE OF GLOVES

5.1 Work during which the hands must be protected

Gloves are used either to protect personnel or the materials with which personnel are working.

A risk assessment must be carried out prior to each task in order to identify any need for protective measures. Examples of types of work for which protection of the hands may be particularly important are:

- Work with hazardous chemicals/substances
- Work with biological agents.
- Work with laboratory animals
- Work involving thermal risk factors (heat/cold)
- Work involving a risk of intense contact heat
- Work with cutting tools/instruments
- Work involving the handling of sharp-edged objects
- Work involving sources of radiation

5.2 Labelling of gloves

Medical gloves are categorised as *medical equipment*, whereas protective gloves are categorised as *personal protective equipment.* Each is thus governed by its own set of regulations. Both types must be CE-labelled. The labelling must be affixed to the glove itself and/or its packaging.

CE -labelling

CE-labelling (where CE stands for Communautè Europèenne = French for EU) is intended to ensure that the product meets specific requirements in respect of health, safety and environmental considerations. Several products require CE-labelling in order to be traded within the EU and EEA. This applies also to personal protective equipment such as protective gloves.

Medical gloves
Standard EN 455 for disposable gloves used for medical applications consists of a set of standards that stipulate requirements related to verification of the gloves' physical properties. No standard exists that stipulates requirements in relation to the penetrability of medical gloves, but some medical gloves have been tested against standard EN 374 which applies to the properties of protective gloves in relation to chemicals and micro-organisms.

Protective gloves
Protective gloves are sorted into three categories depending on the type of risk or hazard against which they provide protection:

Category 1, Low risk: Basic gloves which only provide protection against very low risk factors. This category of gloves may only be used in situations where the risk is not serious and where the user has adequate time to recognise hazardous circumstances should they arise. These gloves can be tested and approved by the manufacturer.
CE-labelled.

Category 2, Moderate risk: These gloves provide good protection against the risk of cuts, puncturing and general wear and tear. These must be tested and certified individually by a testing institute. The institute in question must be identified clearly with its name and address printed in the instructions for use that come with the gloves. CE-labelled with a pictogram.

Category 3, High risk: These gloves are designed to provide protection against serious risk factors or permanent injury. They must be certified by an approved institute. Moreover, the manufacturer's production processes must be subject to quality assurance. CE-labelled with the ID number of the test institute and a pictogram.

A pictogram is a simple pictorial symbol that illustrates the standard for which the protective gloves in question are classified, e.g., protection against radio-active contamination (see the pictogram tables). An *i*-label appended to the pictogram indicates that further information is available as to how the gloves should be used.

Protective glove pictograms

PICTOGRAM	DESCRIPTION	LEVEL OF PROTECTION	STANDARD
	**Micro-organisms**	1-3	EN374
 abc	**Chemicals** Penetration time of minimum 30 minutes in relation to three chemicals (abc) taken from a list of 12 pre-defined standard chemicals.	1-6*)	EN374
	**Low resistance to chemicals/waterproof** Used for gloves which do not achieve the minimum 30 minutes penetration time in relation to the three chemicals taken from a list of 12 standard chemicals, but which have been shown to be air- and waterproof during standard tests.		

PICTOGRAM	DESCRIPTION	LEVEL OF PROTECTION	STANDARD
 abcd	**Physical and mechanical** a) Resistance to wear and tear b) Resistance to cutting c) Resistance to tearing d) Resistance to puncturing	1-4 1-5 1-4 1-4 0 = the glove is tested but does not meet with protection levels 1-4/5 X = not tested	EN388
	**Cuts**	Approved	EN1082
	**Static electricity**	Approved	EN60903
 abcdef	**Heat and fire** a) Combustibility b) Contact heat c) Convectional heat d) Radiative heat e) Floating particles of molten metal f) Minor droplets of molten metal	1-4 1-4 1-4 1-4 1-4 1-4 X = not tested	EN407

PICTOGRAM	DESCRIPTION	LEVEL OF PROTECTION	STANDARD
	Cold a) Convectional cold temperatures b) Contact cold temperatures c) Resistance to water n)	 1-4 1-4 0-1	EN511
	Ionising radiation Lead equivalency is stated on the label(s).		EN421

*) Level of protection given in penetration time (minutes)

(EN374: the time it takes before 1µg /cm^2 penetrates the glove material)

1	2	3	4	5	6
10-30	30-60	60-120	120-240	240-480	>480

Even if the gloves display the symbol for 'gloves protected against chemicals' and belong to a 'high class', it is important that you check that the gloves are made of a material that provides adequate protection from the specific chemical that you intend to work with (refer to the Safety Data Sheet or the guidelines provided by the supplier).

5.3 Selection of gloves

In order to select the correct gloves best suited to the work to be carried out, personnel must evaluate the risk to which they are subjected during the work in question. The user must define the requirements that the gloves must meet in order to provide the necessary protection;

- What kind of work will the gloves be used to carry out?
- What must they provide protection against?
- For how long must they provide protection?
- What level of exposure is considered to be hazardous?
- Will the hands be in contact with harmful substances throughout the work, or is there simply a risk of occasional contact?

Special considerations regarding chemicals

- The Safety Data Sheet (see item 8) is intended to provide information about the correct glove material required for the chemical in question.
- Note that different brands of gloves made of the same materials may have different properties.
- Accurate information as to how effective a glove is in terms of providing protection against a specific chemical can be obtained from the glove supplier.
  The various brands of glove are listed in a table in which their resistance to different chemicals is given. The suppliers often publish such information on their websites. The resistance to chemicals should also be stated together with a pictogram, either on the gloves themselves or on their packaging (see labelling of gloves).
- Remember that no glove is entirely impenetrable!
  It is simply a matter of time!

Materials

The gloves' barrier properties depend on the materials they are made of.

Material	Suitable for	Unsuitable for
Latex	A natural raw material derived from rubber trees. Elastic – excellent resistance to cutting/wear and tear. Good protection against bases, alcohols and dilute aqueous solutions of many chemicals. May cause allergies. Personnel must therefore select gloves made of other materials if they do not have a particular need for this type of protection. Provides better protection from infection than vinyl or polyethene gloves.	So-called 'latex hydration' may negatively affect the gloves' properties. When the gloves become wet, water is drawn into the pores between the rubber particles. This increases penetrability in relation to chemical substances and viruses, and affects other properties such as finger sensitivity and strength under stretching. Latex gloves must not be exposed to sunlight during storage. This degrades the glove material.

Polyisoprene (synthetic natural rubber)	Same as for latex. Does not cause latex allergies.	Same as for latex.
Polyvinyl-chloride (Vinyl)	Skin-friendly. Not as strong or as elastic as latex. Suitable for both wet and dry grip. Good protection against most aqueous solutions, cleaning agents, cutting fluids, oils, dilute acids and bases.	Poorer barrier properties in relation to infection and chemical substances. Provides no protection against organic solvents.
Polyvinyl-alcohol	Good protection against most organic solvents.	Intolerant of contact with water or aqueous products.
Nitril	A synthetic butadiene-acrylnitril composite. Very resistant to wear and tear. High resistance to cutting and puncturing.	Does not fully protect against aromatic solvents (for example, latex is better suited for handling acetone, or neoprene if the wearer is allergic to latex).

	Provides good protection against bases, oils, many solvents, esters, fats and animal fats.	
Neoprene	Synthetic rubber. Maintains elasticity under extremely low temperatures. Provides protection against many acids, alcohols, fats, oils, animal fats and ketones. Has similar mechanical protective properties to latex.	Not recommended for use with organic solvents.
Butyl rubber	Gas and liquid proof. Good protection against ketones, ethers, and highly corrosive acids.	Not recommended for use with aromatic, aliphatic and chlorinated compounds.
Fluor rubber (Viton)	Provides particularly good protection against halogens and aromatic compounds. Can also be used in aqueous solutions.	

Polyethene	Protects against soiling of the hands by relatively harmless chemical substances. Only minor allergen effect, and can be used as inner gloves. Protection is dependant on the strength of the seams.	Affords no protection against infection and harmful chemicals.
Five-layer PE and EVOH laminate	(SilverShield/4H). Good protection against most organic compounds. Specially manufactured for handling highly toxic chemicals and epoxy resin. Limited resistance to mechanical wear and tear.	

Hide/leather	Both comfortable and breathable. Goatskin is frequently used for assembly gloves and provides optimal protection against moisture. Cowhide and pigskin are thicker and more robust. These are best suited to dry work. Leather gloves made from the inner layer of the animal's skin (split leather) affords good protection against heat and cuts.	
Textiles	The most frequently used are cotton and polyester. Can afford a certain level of protection against heat and cuts. Can be used as an inner glove to prevent hand sweating.	

5.4 Use and maintenance of gloves

General remarks

- Gloves can never afford complete protection. Consider using other protective measures as well!

- The use of gloves entails reduced sensitivity to the extent that you are not always certain as to whether you have infectious materials/chemicals on the gloves. For this reason, after completing a work operation, change your gloves and wash your hands so that you do not transfer spilled matter (blood or other biological material, radioactive material, toxic substances), and thus make yourself and others vulnerable to unnecessary risk, or contaminate other materials.
- Remove your gloves when you answer the telephone, work on your computer, or leave the laboratory. Always wash your hands before you leave the laboratory.
- Disposable gloves must not be re-used!
- A poor quality glove is worse than no glove at all!

Prior to use

- Wash your hands before putting on your gloves.
- It is important that your skin is dry and that your gloves are dry inside when you put them on. Damp skin absorbs substances faster than dry skin.
- Always have an extra pair of gloves ready in case you discover a puncture, or if the gloves are insufficiently clean.
- Make sure that the gloves you purchase are fit for purpose.
- Make sure that the chemicals are not about to penetrate the glove material.
- If you intend to use latex-free gloves in a situation where there is a risk of infection, the barrier properties should be at least as good as those for latex gloves. Alternatively, use latex as an outer glove covering latex-free inner gloves.
- Cotton gloves worn inside vinyl gloves will afford excellent grip. Similarly, vinyl gloves worn outside polythene gloves afford good gripping properties and better protection than vinyl gloves alone.

- Make sure that the gloves cover the cuff and lower part of the sleeve when working with highly toxic substances and other agents such as radiation, laboratory animals (risk of scratching) and cryogenic gases that can injure the hands or damage the sleeves. If necessary, use gloves with long cuffs or disposable sleeve protectors.

When in use

- During prolonged use, and especially when working with substances that are known to penetrate the gloves after a certain time, you must change your gloves on a regular basis.
- Remember to remove your gloves when you answer the telephone, work on your computer or leave the laboratory! If a spillage has occurred onto your gloves, remove them without delay.

After use

- Clean the outside of non-disposable gloves before you take them off!
  In this way you will avoid the usual mistake of touching a dirty glove with your bare hands. Disposable gloves must be pulled inside out so that the inside faces outwards when you throw them away.
- It is important to make sure that non-disposable gloves are clean and inspected. With time, chemicals will penetrate the gloves. At the end of the working day, wash the gloves thoroughly inside and out and hang them up to dry.
- You must replace your gloves in situations where they are coming apart or where you can see that chemicals are about to penetrate the material.

- All gloves that have become contaminated with chemicals on the inside must be disposed of immediately. Gloves used for handling solvents must be replaced at frequent intervals, normally several times a week, even if they have not become contaminated on the inside. Solvents, and chemicals in solution with solvents, will easily penetrate the material. A substance may continue to penetrate the material even though the substance itself is not being worked with, e.g. during the night.
- After using gloves, your skin may be more vulnerable to penetration by chemicals and other hazardous substances than normal due to the presence of heat and moisture.
- Hands should be washed after the gloves have been used in order to remove micro-organisms or any latex allergens, powder or substances that may have penetrated the gloves. Use a mild form of soap. Rinse and dry the hands thoroughly and carefully. Wash with alcohol, as appropriate. Use a fatty skin cream with a low water content.

5.5 Side-effects of using of gloves

Typical examples of the side-effects of using gloves include itching, eczema, rashes and hand sweating.

The causes of such complaints may include:

- Chemical penetration through the glove material
- Allergenic substances in the glove material
- Rubber chemicals and substances in the latex material
- Anti-bacterial agents in the glove lining
- Chromium in chrome-tanned gloves
- Irritation due to glove powder
- Irritation due to the lining material
- Increased hand sweating as a result of tight glove fit. The use of tight plastic gloves for more than two hours per day is defined as "wet work"
- The worsening of a pre-existing hand eczema condition.
- Bacterial growth on the inside of a glove as a result of the skin not being clean when the glove was put on.

Rash – Contact urticaria (CU) is an itching skin rash that expresses itself as pale, irregular weals surrounded by reddened skin. The rash develops rapidly and then fades gradually. It often appears as a single diagnostic entity, but may also constitute part of a series of general reactions (anaphylactic shock). It is caused by direct contact with the allergen. The treatment of CU consists first and foremost of avoiding contact.

Contact eczema – Allergic Contact Dermatitis (ACD) is a delayed allergic skin reaction that appears initially 24 hours after contact of the allergen with the skin, and which expresses itself as an itching eczema. It is not caused by the rubber material (latex) itself, but by chemical additives incorporated during manufacture of the gloves.

Irritiative contact eczema – A non-allergic eczema of this type may be the result of hands sweating inside the gloves that in turn make the hands more sensitive to agents causing irritation. Glove powder normally consists of starch and may contain minor amounts of anti-coagulant additives. These in turn may produce a weakly alkaline environment on the inside of a damp glove and thus promote irritation of the skin. The glove powder itself is seldom the cause of allergic reactions, but may be the carrier of allergic substances.

Latex allergy is caused by allergens (substances that cause allergies) such as the proteins within the latex (natural rubber). Proteins may also be used as additives during the manufacturing process. Common reactions to latex are Contact urticaria and/or hay fever resulting from the powder in the gloves. The powder (which is commonly maize starch) is itself a relatively weak allergen, but bonds itself to other allergens derived from the latex. The powder is wafted into the air making the allergens airborne. This can result in symptoms varying from eye and respiratory complaints in those who are already allergic, and may also give rise to an allergic reaction among those who are not in the first instance allergic. The powder also acts to dehydrate and irritate the skin, which in turn increases the risk of developing eczema and allergies.

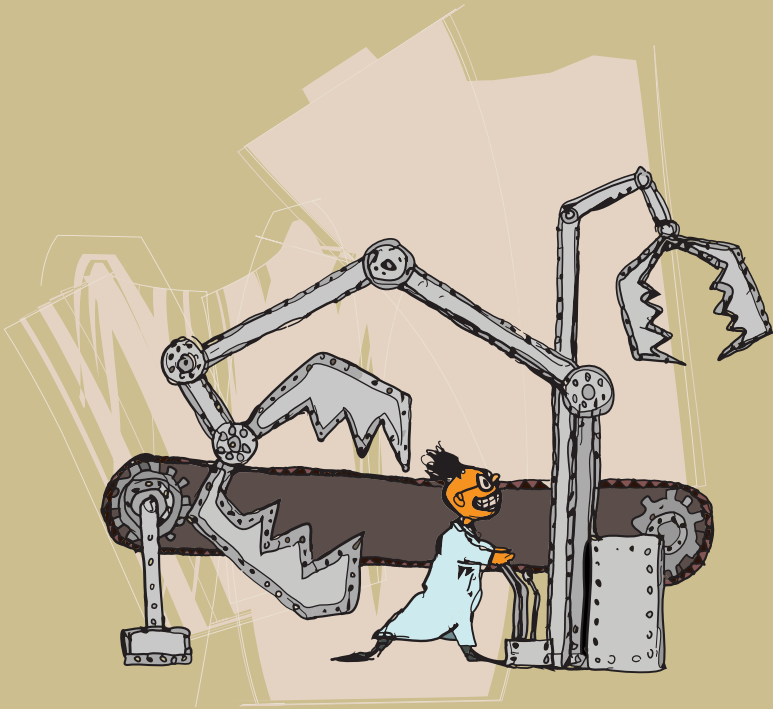
How to avoid allergies?

If you are already allergic, the symptoms can be treated but the allergy cannot be cured. The best approach is therefore to prevent an allergic reaction occurring in the first place. If wearing gloves is in itself irritating to your skin, you must only wear them as and when necessary, and then only for as short a time as possible. In order to reinforce prevention of the development and provocation of allergic symptoms, the following measures can be considered:

- Wear inner cotton gloves between the skin and the protective outer gloves in order to reduce irritation to the skin.
- Replace latex gloves with alternative materials, but remember to make sure that the replacement material provides sufficient protection against the substances you are working with.
- Wear powder-free gloves.
- Your gloves must be regarded as personal property, and should not be worn by others.
- Disposable gloves must not be re-used!
- Gloves designed for repeated use must be cleaned thoroughly after use.
- Vary your work patterns so that the skin has glove-free periods.

6

EQUIPMENT AND TECHNICAL AIDS



6.1 General safety regulations for work equipment

- All personnel must make themselves familiar with local safety regulations as they apply to work equipment.
- A risk assessment must be carried out prior to the use of equipment and apparatus or of new configurations/settings.
- Training must include the safe use of particularly dangerous work equipment.
- Equipment which may constitute a health hazard shall be used only under the supervision of qualified personnel. A minimum of 2 persons must be in attendance under such circumstances.
- Appropriate work clothes and mandatory protective equipment and protective devices must be made available and utilised. Personal protective equipment must be used if other measures cannot provide satisfactory protection.
  - Eye protection shall be worn during work involving the production of chips or shavings, and during work involving cutting machines, saws and such like.
  - Hearing protection must be worn during work involving noise This applies also to personnel working within range of the noise in question.
  - Breathing apparatus must be worn during work involving the formation of toxic gases and dust.
  - Protective footwear must be worn in situations appropriate to the work in question.
- Work equipment must be registered in accordance with the division in question's procedures, and a complete set of documentation for the equipment must be archived.
- A person shall be appointed responsible for each item of work equipment. All mechanical equipment must be inspected and maintained on a regular basis.
- Damage to work equipment must be reported without delay as an HSE non-conformance, and any faults or defects repaired.
- Work areas must be kept tidy, and all equipment and machinery stored in its correct location after use.

6.2 General remarks on the use of fume cupboards, safety benches and sterile benches

- All users must receive training in the practical use of these items of equipment.
- All users must adhere to the guidelines for safe use, including the use of personal protective equipment.
- Make sure that you have your materials and the necessary equipment, such as glass flasks, reagents, pipettes, tippers, etc., ready before work commences.
- Make sure that you have a container for hazardous biological waste and a waste bucket close at hand.
- In order to facilitate airflow, do not store superfluous equipment in fume cupboards or on sterile and safety benches.

6.3 Fume cupboards

Principle: Fume cupboards transport chemical fumes out of the building. Its purpose is to protect the operator.

Fume cupboards are used during the handling of chemicals and materials where the following may be generated:

- fumes or gases which represent a risk to health, or a fire or explosion hazard
- dust
- unpleasant odours

Be aware that the properties of a chemical, and in particular the specific gravity of its fumes, will influence how the fumes disperse within the fume cupboard. When working with highly toxic and dense fumes, you must find out which safety requirements have been stipulated for fume extraction. This must be done by means of a risk assessment. We refer to the requirements set

out for the use of fume cupboards under items 7 and 8 in the Safety Data Sheets/Information Sheets. The working area within a fume cupboard must not be used for storing chemicals. Store volatile chemicals in a separate fume cupboard.

Safety requirements:

- The maximum permitted working opening is 30 cm. This must be indicated on the cupboard itself.
- The air velocity in the cupboard must be fixed at 0.50 m/s (+/- 0.05 m/s).
- The minimum air velocity requirement is 0.40 m/s. Where a cupboard is fitted with an alarm, the alarm should be activated when air velocities below 0.40 m/s are detected. If the air velocity falls below 0.40 m/s, the cupboard must be closed and a warning sign posted. Fume cupboard air velocities must be checked either by users or as part of a technical inspection.
- The alarm must be inspected both by users and as part of an annual technical inspection.
- Free airflow must not be obstructed by the presence of superfluous equipment stored in the cupboard.

Use of fume cupboards:

- For older fume cupboards not fitted with alarms: Check the air flow by hanging a piece of weighing paper onto the base of the sash so that the paper hangs free and you can observe its movements.
- Fume cupboards with control panels: For cupboards with a 'maximum air velocity (emergency)' function, these must be reset to normal operation as soon as it is no longer necessary to increase the fume extraction velocity.
- For fume cupboards with a 'reduced extraction velocity (min.)' function: This function must never be activated when the cupboard is in use.

- For fume cupboards with a ‹reduced extraction velocity (min.)› function: This function must never be activated when the cupboard is in use.
- Pull the sash as far down as possible, and never higher than the maximum work opening (30 cm).
- Raise the sash slowly so that the air volume achieves regulation.
- Remove as much equipment, bottles and other items as possible from the cupboard while you are working. If your use of the cupboard requires a large amount of equipment, you must consider the justification for this in advance.
- Try to work as much as possible in the centre of the cupboard, and at no less than 20 centimetres from the opening.
- Work using calm and deliberate hand movements.
- Never put your head inside a fume cupboard.
- Prevent other people from moving about close to the cupboard while you are working.
- Always close the doors and windows in the vicinity of the cupboard while you are working.
- Tidy and clean the fume cupboard after use.
- Always pull the cupboard's sash down after use.
- Monotonous and repetitive movements may overstress the body. This applies in particular to the neck, shoulders and arms, which are vulnerable when working in a fume cupboard. Be aware of your working posture and the duration of the work you are carrying out. Read more about this on Innsida: Ergonomics in laboratories. Contact the occupational health service provider if you need advice on ergonomics in connection with work using fume cupboards.

Innsida: Fume cupboards in laboratories and workshops.

6.4 Safety benches

	Safety benches
	Principle: Safety benches are designed to generate air inflow that protects the operator. Air is removed from the bench via a HEPA filter. Its purpose is to protect the operator. Safety bench Classes II and III also provide product protection. Factors that should be considered prior to the purchase of a safety bench: the size and design of the work surface, lighting, the presence of vertical or sloping walls, the height of the bench (working posture), noise, etc. The unobstructed air flow velocity, measured inside the cabinet, must be greater than 0.4 m/s. **Safety bench Class I: Protects the operator and surroundings.** Inflow is directed away from the operator, and HEPA-filtered air is expelled to the surroundings. **Safety bench Class II: Protects the operator, product and surroundings.** Inflow is directed away from the operator, HEPA-filtered air is expelled to the surroundings, and HEPA-filtered laminar downflow is provided. When working with volatile and toxic chemicals in cell cultures, the bench must be connected to a ventilation system. There are different types of Class II benches. One type (A2) recirculates 70% of the air, allowing 30% to be released via the HEPA-filter. Another type (B2) involves no recirculation of air. This type should be used for work involving large volumes of volatile and toxic substances.

Safety bench Class II: Protects the operator, product and surroundings. Inflow is directed away from the operator, HEPA-filtered air is expelled to the surroundings, and HEPA-filtered laminar downflow is provided. When working with volatile and toxic chemicals in cell cultures, the bench must be connected to a ventilation system. There are different types of Class II benches. One type (A2) recirculates 70% of the air, allowing 30% to be released via the HEPA-filter. Another type (B2) involves no recirculation of air. This type should be used for work involving large volumes of volatile and toxic substances.

Safety bench Class III: Protects the operator, product and surroundings.
Work using a "glove box".

- This type of safety bench may be connected to a fume extraction device or equipped with a filter which removes harmful substances prior to releasing outflow into the room. Safety benches which release outflow directly into their immediate surroundings must not be used for work in which fume extraction is necessary in order to guarantee safe working conditions.
- The purpose of a safety bench is to act as a barrier between the material being worked on and the person using the bench.

	Safety benches – Preparatory work
Prepara-tory work	• Work involving chemicals etc., is not suited to the use of safety benches (with the exception of those in Class II type B2). Such work must be carried out in a fume cupboard • It is important to ensure that you have adequate space on the bench/trolley table, and that your chair is properly adjusted • Wear cotton laboratory coats with long sleeves and a surgical mask when working with human pathogenic micro-organisms • Disposable gloves must be worn, and be changed or disposed of when you leave the cupboard. The gloves must be pulled over the sleeves of your coat in order to avoid exposure to the skin. Under special circumstances a plastic apron is worn, together with plastic arm protectors • Good sterile techniques are prerequisite • When work has been completed, remove all waste, equipment and materials. Wash, using water if necessary, before disinfecting the bench using a 70% ethanol solution (provided that there have been no spillages which require disinfection prior to cleaning using water). Use ultra-violet light if this has been fitted. You will find more details about the uses of UV light at page 122.

	Safety benches – Maintenance
Main-tenance	• Cleaning: Wash the base, hobs and walls. (NB! Remove the baseplate in the working space/chamber) • An agreement should be entered into regarding safety bench servicing and maintenance. As a minimum requirement, the airflow and filter should be inspected once a year.
Disin-fection of benches NB! Applies only to benches connected to a fume extraction device	For servicing operations that entail the replacement of filters, the cupboard must be disinfected beforehand. In the case of benches connected to a fume cupboard, disinfection can be carried out as follows: • Make sure that the cupboard is clean and that all equipment has been removed. • Prepare formalin (using 40 ml formalin, 37% + 40 ml water in a glass beaker), and ammonia (using 27 ml 25% ammonia + 40 ml water in another glass beaker). This must be carried out using fume extraction. • Put the hob and the beakers containing formalin and ammonia inside the cupboard. • Close the bench and put tape along all the gaps around the sash and air vents. • Switch on the fan and commence boiling of the formalin (10 min.). • When all the formalin has evaporated, keep the fan running for a further 20 min. • Turn the fan off and leave the cupboard undisturbed for at least 5 hours.

	Safety benches – Maintenance
	• Switch the fan on and commence boiling of the ammonia (10 min.). • Keep the fan running for 20 min. after the ammonia has evaporated. • Remove all sealing tape. **Different procedures apply to benches which are not connected to a fume extraction device.**

6.5 Sterile benches

Principle: The purpose of these benches is to sterilise air by means of filters and then blow it across the work surface as particle-free laminar airflow (LAF). The purpose is to protect the product. **NB! Does NOT protect the operator.**

6.6 Hot work

Hot work is defined as all construction, installation, assembly, disassembly, repair, maintenance and similar work involving the use of an open flame, and work involving equipment for heating, welding, cutting, soldering and/or grinding.

Prior to the commencement of hot work:

- Make sure that hot work is carried out in a proper manner such that hazards to human health, fire risk, and the risk of explosions are reduced to a minimum

- Make sure that external contractors have been issued with a Work Permit before they carry out hot work
- Ensure that follow-up work is carried out

Innsida: Hot work

6.7 High-pressure apparatus

All user-assembled apparatus subject to high pressures must be assessed for strength by qualified personnel

- Prior to use, the apparatus must be pressure-tested at values in excess of working pressures. Testing must be carried out with water (if possible), or an inert gas (entails a risk of explosion during testing)
- Test results must be documented either on the apparatus itself or otherwise in writing. If such documentation is lacking, the apparatus must be re-tested before it can be used to carry out a new experiment
- The apparatus must, in so far as possible, be assembled using approved components (tubing, connectors, valves and suchlike)
- A certified workshop must be employed for welding components onto high-pressure apparatus
- Metal containers can be guaranteed to tolerate specified pressures. Pressure containers made of glass, sapphire, etc., are designed according to the same computational methods, but may fail unpredictably after short- or long-term use. This must be taken into account during the assembly and location of the apparatus in question
- High-pressure apparatus must be procured, constructed, tested and used in compliance with the directive governing pressurised equipment, as described in the NS-EN13445 standard. More information can be obtained from the Norwegian Directorate for Civil Protection and Emergency Planning (DSB)

6.8 Glass apparatus subjected to high pressures or a vacuum

Face and eye protection must be worn in connection with all work involving glass apparatus used at high pressures or involving a vacuum, or when using rotating/cutting tools

- Glass apparatus used for high-pressure or vacuum experiments, or which are to contain liquid air, liquid oxygen or liquid nitrogen, must be of the appropriate strength. Do not use thin-walled or flat-bottomed flasks for such purposes
- Use special safety screens to protect apparatus such as suction flasks, vacuum excitation, and vacuum distillation apparatus
- The danger of splinters can be reduced somewhat by winding self-adhesive cloth tape around vulnerable apparatus components
- Prior to the opening or disconnection of such apparatus, it must be cooled to room temperature, and air permitted gradually to permeate inside

6.9 Laboratory experiments involving electricity

Safety linked to electrical devices is governed by a separate set of statutory regulations which apply to all electrical devices with voltages of 0 V or greater.

Exceptions:

- Electrical apparatus designed for use by non-experts
- Devices with outputs so low that they do not constitute a hazard

The regulations also apply to laboratory activities carried out for the purposes of research and teaching. Under normal circumstances, an experiment in which the voltages used do not exceed 50 V will constitute a *"device with an output so low that it does not constitute a hazard"*, and is thus not governed by the regulations. The regulations specify roles and responsibilities in connection with work involving, and the operation of, electrical devices. These include the following functions: A person responsible for the facilities, a person responsible for the work being carried out, an expert facilities operations manager, and a safety manager.

When using Variac as a voltage source, personnel must be aware of the following:

- In so far as the nature of the experiment allows, DC-decoupling must be employed.
- If this is not possible, it is important to be aware that even if the voltage in its secondary coils is set at 0 V, there will be a voltage to earth of 110 V (IT-system) or 230 V (TN-system). The experiment is governed by the provisions set out in the statutory regulations
- If DC-decoupling is not employed, the circuit must be protected, and personnel must use caution even when the Variac voltage is reduced to 0.
- The use of Variac (voltage regulator without DC-decoupling) in a building equipped with a TN power supply system is prohibited because the Variac output voltage in the TN system will depend on the way in which the plug is inserted into the wall socket.

During experiments in which apparatus carrying voltage is left unattended, a risk assessment must be carried out in order to evaluate the risk of overheating and fire.

It is recommended that smoke alarms be connected to detectors which automatically disconnect the device if said alarms are activated.

Experiments involving voltages between 50 and 1,000 V

The following requirements must be met:

- The device must be protected when it is carrying voltage.
- Fuses of appropriate size and type must be used to provide protection from overload current.
- A research/teaching group carrying out an experiment involving voltages in excess of 50 V must appoint a person responsible for the facilities in compliance with the regulations. The role and duties of the person responsible for the facilities are described in the regulations.
- A person responsible for the work being carried out must be appointed for each individual experiment. He or she is responsible for safety in connection with the experiment.
- The person responsible for facilities must make a judgement as to who is qualified to take responsibility for the work being carried out.
- Access to laboratories where experiments are being carried out must be restricted.

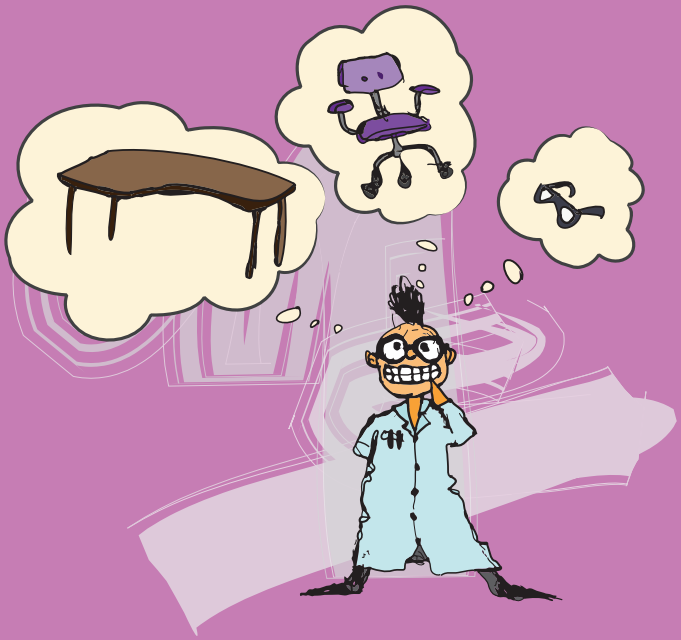
Experiments involving voltages in excess of 1,000 V

The following requirements must be met:

- A qualified expert operational manager must be appointed from the Technical Division (Electronics Group), or from a local grid supplier. The expert facilities manager shall prepare instructions for experiments involving voltages in excess of 1,000 volts carried out in the laboratories in question.

- Devices carrying voltage must be screened/enclosed so that it is impossible unintentionally to come into contact with live components (these must be connected via an interlocking circuit so that the voltage is disconnected if a door/port in the protective screen is opened).
- Fuses of appropriate size and type must be used to provide protection from overload current.
- A Safety Manager must be appointed for each individual experiment. The Safety Manager is responsible for safety in connection with the experiment
- Only personnel who have been granted specific permission will be allowed access to laboratories where experiments involving high voltages are being carried out. Access permission may include permission to accompany visitors. A list must be drawn up of personnel who are granted such access, and of who is granted permission to accompany visitors

7
ORGANISATION OF THE WORKPLACE



7.1 Ergonomics

NTNU shall organise work in such a way as to prevent the occurrence of muscle and skeletal disorders. Such disorders are commonly a response to excessive workloads. Work may be too strenuous, monotonous or prolonged, or carried out using incorrect working postures.

The following measures may be taken to prevent muscle and skeletal disorders:

- Plan your working day and use the appropriate equipment for the task at hand!
- Adopt natural and appropriate working postures
- Introduce variation into your day-to-day tasks
- Make sure that you take regular breaks (some need rest, others exercise)
- Use aids when making lifting heavy loads (greater that 25 kg)
- Adjust the height of your table or workbench according to the nature of the task at hand
- Wear appropriate footwear
- Use a stress relief mat when carrying out
- prolonged tasks in a standing posture
- It is important that you have sufficient light to illuminate your task
- Reduce the time you spend sitting still!
- Keep moving about!

Avoid:

- Over-stretching your joints
- Tasks that involve working above shoulder height or below knee height
- Static muscle work
- Work involving long levers (arms)

- Tasks that involve locked, static, bending or twisted working postures.

Innsida: How to prevent occupational muscle and skeletal disorders

7.2 Work arrangements for pregnant and breast-feeding women

- A risk assessment of the workplace shall be carried out and arrangements made to ensure that no employee is exposed to substances which can damage reproductive capacity, or cause injury to a foetus or breast-feeding women.
- In some laboratories and workshops, conditions in the working environment may constitute a hazard to the foetus and pregnant women
- Certain aspects of the working environment may have a negative influence on both male and female reproductive capacity
- Employees and students shall notify their supervisors of their pregnancy as soon as possible so that any requirements for workplace adaptations can be planned and implemented.

Breast-feeding

- Workplaces which are inappropriate during pregnancy due to potential contact with chemical substances, will often also be unsuitable during the breast-feeding period
- Chemical substances absorbed into the mother's bloodstream may be transmitted to breast milk.

Factors within the working environment which may be harmful either to the foetus or reproductive capacity:

Chemical agents	• Lead • CO_2 • Organic mercury • Specific solvents • Synthetic oestrogens • Pesticides Refer to the relevant Safety Data Sheets
Biological agents	• Rubella • Toxoplasmosis • Hepatitis B, HIV
Physical factors	• Physical stress (work in a standing position, strenuous work, static stress) • Ionising radiation • Heat • Noise
Organisation of work	• Psychosocial working environment • Night work, shift work and rotas.

Innsida: Pregnant employees at NTNU

8
CHEMICALS AND GASES

8.1 General safety regulations for chemicals and gases

- All chemicals and gases must be stored, labelled, handled, and disposed of in compliance with statutory regulations
- Prior to the commencement of work, employees and students must make themselves familiar with the Safety Data Sheet and the results of the relevant risk assessment.
- Mandatory protective equipment must be readily accessible and must be worn
- Work with harmful chemicals and gases must be carried out in fume cupboards or under spot extraction (see chap. 8.3)
- The standard clothing appropriate for work in laboratories or workshops comprises a laboratory coat and long trousers, or boiler suit/work clothes, and full-coverage footwear (not everyday shoes) Standard clothing regulations can be waived if the relevant risk assessment shows that they are not necessary.

8.2 Storage requirements

Storage requirements (cupboards, shelving, rooms/storerooms)	
General remarks	• Mandatory protective equipment must be worn. Erect a warning sign • Chemicals and gases must be stored and handled in compliance with statutory regulations. Narcotic substances and highly *toxic* chemicals and gases must be stored in a locked cabinet • Chemicals and/or gases which can react with each other must be stored separately • Obtain information from the relevant Safety Data Sheet and risk assessment • The room safety information card must state the type and volumes of gases and inflammable liquids in storage • Heavy containers, large glass flasks or very hazardous chemicals must not be stored above head height. • When moved, chemical bottles must be carried in approved containers or transported on a trolley with a protective frame • Use the utmost caution when emptying large containers. Open bottles with caution • All packaging lacking its original labelling must be affixed with a label stating its contents, the user's identity, the relevant H and P sentences, and labels bearing hazard symbols, as appropriate • If the chemical/medicine, or its packaging, has passed its expiry date, with the possibility that its quality has deteriorated, it must be disposed of

Cupboards and shelving	• Must be labelled clearly and in compliance with hazard signage standards • Shelving must be stable and adequately spaced • Floors must not be used for the storage of chemicals • Gas cylinders must be stored on the lowermost shelves
Rooms and storerooms	• A risk assessment must be carried out • Essential protective equipment and safety equipment must be easily accessible • The room must be secured against unauthorised entry, with a notice posted on the entrance door • Local inspection procedures must be prepared • The amounts of chemicals stored in a room must be kept to a minimum. Old stock and chemicals that have passed their expiry date must be disposed of

8.3 Handling of corrosive, flammable, explosive chemicals and gases

Strong acids and bases Corrosive Caustic	• Always wear protective glasses/goggles/a visor, appropriate gloves, and a laboratory coat when working with these substances. • Never add water to dilute an acid - always add the acid to the water. Pour the acid into the water slowly! • Keep acid bottles away from heat and sunlight • When opening bottles containing acids, take care to avoid splashing • Do not lift bottles by the neck • Use graduated cylinders or burettes for measuring out strong acids and other hazardous liquids • Keep these in chemical cabinets with fume extractor devices. The bottles should be placed in plastic trays • Bottles containing chemicals/gases that can react with each other must be stored separately. • Bottles that contain substances which have high vapour pressures at room temperature, such as diethyl ether, acetone, alcohol, petroleum ether, benzene, bromine, nitric and hydrochloric acids, must never be filled to the brim

Flammable and explosive chemicals	These are subdivided into the following hazard classes:	
	Flammable liquids	**Definition**
	Category 1	**Flashpoint <23°C and boiling point <35°C, equivalent to GHS category 1**
	Category 2	**Flashpoint <23°C and boiling point >35°C, equivalent to GHS category 2**
	Category 3	**Flashpoint ≥23°C and boiling point ≤60°C, equivalent to GHS category 3**
Flammable and explosive chemicals	• Never work with flammable liquids close to an open flame. Use a fume cupboard when working with low-flashpoint liquids • Never distil flammable liquids over an open flame. Use a steam bath, water bath, electric hob or special electric heating jacket • Carry out a trial experiment using small amounts of the substance beforehand • Many organic chemicals, of which diethyl ether is the best known, can form explosive peroxides in varying degrees. A complete record of the use and storage of such substances must be kept. Peroxide-forming chemicals which are more than 1 year old or with unknown histories must be handled with great care. If in doubt, do not open the container, but send it directly for disposal. • You can read more about the disposal of chemicals, including peroxides, in the NTNU guidelines: Disposing of chemical waste.	

Flammable and explosive chemicals	• Strong sunlight can refract within bottle glass and start a fire – screen it out! • Distillation bottles should not be filled to more than 1/3 full and must be re-filled at room temperature. Anti-bumping granules should be added to the liquid prior to heating. Alternatively, mix the liquid using a magnetic stirrer. Do not heat too rapidly, and avoid local overheating
Flammable gases	• Hydrogen, propane, acetylene, methane, propylene, ammonia and butane may form explosive mixtures with air. Require special vigilance • Use permitted only in laboratories with adequate ventilation • If a gas alarm has been activated, the person responsible for the room in question must be contacted at once. Follow local procedures posted in the vicinity • Laboratory gas detectors must be calibrated in compliance with regulations. Information can be obtained from your division's Gas Coordinator
Liquids and gases in pressurised containers	• Must be stored and handled in compliance with legislation and accompanying regulations • Warning signs must be posted on doors leading to laboratories where compressed gas is in use. • The room safety information card must state the volume and type of gas • Gas containers must be properly secured to

a bench or wall. The containers must not be exposed to temperatures in excess of 45°C

- Bottles containing different gases must be stored separately. In storage, bottles containing oxidising gases, including oxygen, and those containing flammable gases, must be separated by a minimum of 5 metres. It is very important that oxygen gas is not stored together with flammable gases.
- Use the correct reduction valves with screw threads that are compatible with the container in question. The gases and the valves have specific colour codes
- Oils or grease must not come into contact with valves or connections regulating oxygen
- Handle gas bottles with care. A cylinder trolley with safety chains must be used to transport gas bottles. The cylinder valve must be closed, the regulator/reduction valve disconnected, and a protective cap fitted, if available.
- Containers that are not in use must be closed using a loose cover or cap which prevents the development of overpressure
- On replacing gas cylinders, connectors and valves must be inspected for leakages using a leak search spray
- All gas-related equipment such as connectors, valves and gas appliances must be inspected on a regular basis by competent personnel.

Liquids and gases in pressurised containers	• Inspection requirements are described in Section 9 of the statutory regulations governing the handling of hazardous substances (Forskrift om håndtering av farlig stoff), and in the accompanying guidelines. The person or persons carrying out such inspections must be qualified pursuant to Section 7 of the same regulations, and must have knowledge and experience of the relevant inspection methods. • The Faculty's HSE Coordinator must ensure that an inspection is carried out approximately every 5 years **Cryogenic gases and liquids** • Avoid contact with the skin. This is due to the extremely low temperatures. Nor must the skin come into contact with objects which have been cooled using cryogenic gases or liquids. • During the handling of cryogenic gases and liquids: It is important to wear full body coverage protective equipment, including gloves, eye protection, overalls and footwear • Containers to be filled with liquid air, nitrogen or oxygen, must be dry and free of organic substances • When transporting cryogenic gases or liquids in a lift, persons must not travel in the same lift as the gas bottles unless a risk assessment has shown that this is justified. The bottles must carry a label stating their contents, and a notice prohibiting entry to the lift. • Cryogenic gases or liquids must not be stored in sealed containers due to the risk of explosion if pressure increases.

	• Baths and insulated containers used to store cryogenic liquids must be free of visible defects. To avoid the risk of implosion, do not empty cryogenic liquids onto the rim of the cooling bath To avoid the risk of it being thrown back, do not pour large volumes of a cryogenic liquid into a container which is inadequately cooled. • When using compressed or condensed gases and cryogenic liquids, be aware of the risk of fire and of suffocation due to oxygen displacement. • When working with dry ice and other refrigerated materials, take the same care as you would when working with cryogenic gases and liquids.
Dust explosions	• The ignition within a container of a flammable powder, existing as a dust mixed with air, has the potential to produce an explosion as powerful as that caused by a flammable gas (flammable vapour) and air mixture • Hazardous dust explosions can be caused by finely-powdered organic chemicals and certain powdered metals, such as magnesium and aluminium.
Chemicals and hazardous substances	• Material which has absorbed a liquid takes on the same hazardous properties as the liquid itself • In the event of the absorption of volatile, non-reactive liquids, used absorption agents must be packed in plastic without delay so that the liquid does not evaporate. Must be disposed of in compliance with prevailing regulations • Absorbed, reactive liquids must be handled in the same way as the liquids in their pure form, and disposed of in compliance with prevailing procedures

Chemicals and hazardous substances	• Sweeping up after the spillage of flammable and volatile liquids may constitute a risk of ignition due to static electricity. This can be avoided by moistening the absorption agent, and by sweeping with water, preferably salt water • Work involving large amounts of chemicals in situations where there is a risk of generating explosive mixtures in air, must only be carried out in suitable surroundings. Special care must be taken to avoid the risk of sparks.

8.4 Safety Data Sheet and Chemical Substances Index

A Safety Data Sheet (SDS) – provides information regarding the proper handling of chemicals (substances and preparations). A Safety Data Sheet for hazardous chemicals used by your division can be found in the substances index Eco Archive (EcoOnline). A Safety Data Sheet must be made available on-site where the chemical or substance is used. The manufacturer/supplier is obliged to send out updated Safety Data Sheets. Your division is responsible for preparing an information sheet for hazardous chemicals that are produced during processes carried out as part of its activities.

An Information Data Sheet – is mandatory for harmful biological agents and hazardous chemicals that are not provided with a Safety Data Sheet. An Information Data Sheet can be found in the substances index Eco Archive (EcoOnline). An Information Data Sheet must be made available on-site where the chemical or agent in question is being used.

Risk assessment – the substances index contains an assessment of the risk linked to each individual chemical (inherent properties, amounts/volumes, etc.). Chemicals that are identified as particularly hazardous must be afforded special consideration during the risk assessment of processes in which said chemicals are used.

Substitution – entails an obligation to assess whether a given hazardous chemical can be replaced/substituted by another, less hazardous, chemical.

Safety Data Sheets	
Contents	1. Identification of the substance/ preparation and the company/firm 2. Hazard identification 3. Composition/Information regarding constituents 4. First aid measures 5. Fire extinguishing measures 6. Measures in the event of unintended discharge/emissions 7. Handling and storage 8. Exposure control/protection of personnel 9. Physical and chemical properties 10. Stability and reactivity 11. Toxicological information 12. Ecological information 13. Disposal 14. Information regarding transportation 15. Regulatory information 16. Other information

Information Data Sheet for hazardous chemicals / [harmful biological agents]	
Contents	1. Name 2. Composition (for hazardous chemicals only) 3. Supplier information 4. Physical, chemical and potentially harmful properties/potentially harmful properties/ toxicological data 5. Toxicological data/information regarding risk of infection 6. Risk factors 7. Preventive measures 8. First aid

8.5 Exposure scenarios

- Substances or substance components that are classified as hazardous (such as chemicals with known carcinogenic or mutagenic properties, or which can cause reproductive damage), or which are assessed as bio-persistent/bio-accumulative/toxic AND are registered in the REACH index in amounts of 10 tonnes of more, must be accompanied by an expanded Safety Data Sheet, i.e. an SDS that includes exposure scenarios.
- The exposure scenarios must provide descriptions of the conditions for safe use and essential risk-mitigating measures that must be taken during use and waste disposal.
- Please refer to the information regarding exposure scenarios and what you must do when you receive an expanded Safety Data Sheet

8.6 Preparatory work and purchasing

The responsibility for the purchase, receipt and registration of substances in the chemical substances index shall be delegated to one or a restricted number of persons within the division.

Preparation and purchasing	
Chemicals and hazardous substances	• Perform a needs assessment and an evaluation of possible substitution • Obtain information from the Safety Data Sheet as to how the substance should be used, stored, and disposed of • Make sure that a risk assessment is carried out prior to use • Make an assessment as to how spillages will be removed • Obtain the mandatory protective equipment and, if necessary, safety equipment for the handling of spillages (ref. the Safety Data Sheet) • All chemicals must be registered in the electronic chemical substances index, and a paper copy of the Safety Data Sheet made available on-site where the chemical in question is to be used • Ordering must be carried out in compliance with prevailing procurement and purchasing guidelines • In the event of purchase, the supplier must supply a Safety Data Sheet. The fewer the suppliers, the easier it is to keep track of transactions, and thus ensure a safer environment. Use our frame agreement supplier.

8.7 Hazardous waste

Hazardous waste includes the following:
- Chemical waste
- Contaminated glass
- Some types of electrical (EE) waste, such as fluorescent tubes, energy efficient bulbs and mercury lamps
- Batteries

• All personnel who generate hazardous waste have a duty to assist the person or persons responsible for delivering it to the waste disposal contractor by providing the information necessary to facilitate proper handling and declaration of the waste.
• **The disposal of hazardous waste must be carried out by designated personnel who have received training in exercising the responsibilities and obligations associated with this function.**
• Waste disposal contractor: NTNU has a frame agreement in connection with the transport and delivery of hazardous waste.

NTNU; Innsida: Hazardous, infectious and radioactive waste

8.8 Chemical waste

• Explosive, self-igniting and highly reactive chemicals must not be disposed of together with other chemical waste. Contact the HSE Section if you have any questions. Radioactive waste must not be mixed with other chemical waste. If you have any questions, contact your local Radiation Protection Coordinator.

Use the Safety Data Sheets to identify chemicals which are self-igniting, explosive or highly reactive:

- Item 2: Self-igniting chemicals may be assigned a variety of hazard symbols. However, most are labelled as "flammable". Most highly reactive chemicals are labelled "oxidising"
- Item 10: Check whether there is notification of any risk of explosion, self-ignition or high reactivity.
- Item 13: Check what recommendations have been provided regarding disposal.
- Item 14: Check the transport hazard class of the chemical in question:
  - Hazard class 1 (explosives)
  - Hazard class 4.1 (easily ignitable and flammable substances): If the chemical belongs to hazard class 4.1 and carries a UN number that is listed in the HSE guidelines Disposing of chemical waste, the chemical must be regarded as explosive.
- Hazard class 4.2 (self-igniting substances)
- Hazard class 4.3 (substances which give off flammable gases on contact with water): All substances in this hazard class are highly reactive.
- Hazard classy 5.2 (organic peroxides):
  All substances in class 5.2 are highly reactive. If a chemical belongs to a subordinate category within hazard class 1, it must be regarded as explosive.
- Hazard class 8 (corrosive substances): All substances belonging to hazard class 8 and subordinate category 5.1 (oxidising) are highly reactive.

Sorting, packaging and declaration

Sorting

- Acids and bases must be packed in separate boxes.
- Chemicals in solid and liquid form must be packed in separate boxes.
- Highly reactive chemicals must be packed in separate boxes.
- If the nature of a chemical is unknown: Contact the waste disposal contractor!

Packaging

- Packaging materials, labels etc., can be ordered from the waste disposal contractor.
- Use the same packaging as the chemical was delivered in, provided that this is suitable for the type of storage and transport required.
- Pack waste in such a way as to minimise the risk of breakage. Use shock-absorbent materials.
- Any cardboard outer packaging must be UN-approved. Under normal circumstances, the original packaging can be used.
- All consignments and exterior packaging must carry labels displaying the declaration number, UN-number and transport hazard class.
- The person disposing of the waste must check that the waste containers and their exterior packaging are adequate for transport.

Declaration

- A declaration must be made via the website avfallsde-klarering.no If you require a user account, refer to the procedure Hazardous, infectious and radioactive waste.

- When the person disposing of the waste signs the declaration, he or she is confirming
  that the waste being delivered corresponds to that stated in the declaration.

Collection
The collection of hazardous waste must be ordered via the purchasing system. Your division may have entered into an agreement for the regular collection of waste.

Innsida:
- Hazardous, infectious and radioactive waste
- Disposing of chemical waste

8.9 Hazard pictograms

From 1 June 2015, the EU's CLP scheme (Classification, Labelling and Packaging) is the only official set of regulations governing the classification, labelling and packaging of substances and chemical preparations. These regulations also entail the use of some new hazard pictograms.

Chemical preparations that are currently classified, labelled and packaged according to the now redundant Norwegian statutory regulations governing classification, labelling, etc. of hazardous chemicals, and which were on the market prior to 1 June 2015, do not require to be re-labelled or re-packaged before 1 June 2017.

CLP HAZARD PICTOGRAMS	
	**FLAMMABLE** Chemicals that are flammable and which may burn violently on ignition or in response to heating. Some chemicals release flammable gases on contact with water or self-ignite in air.
	**OXIDISING** Chemicals that can cause fires or contribute towards the combustion of other materials.
	**EXPLOSIVE** Chemicals and objects which may explode if they are exposed to shock, friction, sparks or heat.
	**HIGHLY TOXIC** Chemicals that are highly toxic and can cause life-threatening injuries in the event of swallowing, skin contact and/or inhalation.
	**HEALTH HAZARD** Chemicals that are hazardous in the event of inhalation, skin contact or swallowing. This pictogram is also used for chemicals that are irritant to the skin, eyes and airways or that cause allergic skin reactions, drowsiness or fainting.

	**CHRONIC HEALTH HAZARD** Chemicals that have chronic effects on health because they are carcinogenic, mutagenic or inhibit fertility. This also includes chemicals that cause allergies if inhaled, chemical pneumonia or other serious injury.
	**ENVIRONMENTAL HAZARD** Chemicals that have short- or long-term harmful environmental impacts if released into waterways. These must be stored and handled in such a way that the chemical, either during its use or as a waste product, does not cause damage to the environment.
	**PRESSURISED GAS** Gas or other chemicals that are stored under pressure, or gas that assumes liquid form at very low temperatures. The container may explode in the presence of fire.
	**CORROSIVE** Chemicals that cause chemical burns to skin and eyes or severe eye damage. Also used for chemicals that are corrosive to metals.

Hazard and safety sentences (CLP)

- H-sentence: An H-sentence describes the nature of the hazard and, if relevant, the degree of hazard.
- P-sentence: A P-sentence provides advice as to how damaging effects can be prevented or minimised.

H- and P-sentences are standardised and are allocated a three-figure code number. The table below provides an overview of the classification of hazard and precautionary sentences as set out in the CLP:

CODE	HAZARD SENTENCES
H200-H299	Physical hazard
H300-H399	Health hazard
H400-H499	Environmental hazard

CODE	PRECAUTIONARY SENTENCES
P100	General
P200	Preventive
P300	First aid required
P400	Storage
P500	Waste

Other symbols employed to classify chemicals

SYMBOL	TEXT
H	Absorbed through the skin
K	May be carcinogenic (K1-K3, with K1 being the most harmful)
M	May be mutagenic, Mut. 1-3, Mut. 1 being the most harmful
R	May cause reproductive damage, Rep. 1-2, Rep. 1 being the most harmful
A	May be allergenic or cause other form of over-sensitivity.

9
BIOLOGICAL AGENTS

9.1 Definition of biological agents

Living and dead microorganisms, cell cultures, endoparasites and prions which can cause infections, allergies and toxic reactions in humans. Biological agents may be naturally-occurring or genetically modified.

Components of biological agents such as enzymes/proteins and fatty acids are also regarded as non-living biological agents. These can cause allergic and/or toxic reactions. Infections caused by biological agents may also be carcinogenic (e.g. the Human Papilloma Virus), or may cause foetal damage (e.g. Toxoplasma gondii).

Living biological agents are classified into four infection risk groups according to the level of infection risk they represent.

9.2 Infection risk groups

Gr.	Level of risk of infection
1	• Does not normally cause infectious diseases in humans
2	• Can cause infectious diseases in humans and constitutes a hazard to employees. It is unlikely that it will be transmitted into the wider community, and under normal circumstances there exist preventive measures or treatments.
3	• Can cause serious infectious diseases in humans and constitutes a serious hazard to employees. There may be a risk of transmission into the wider community, but under normal circumstances there exist preventive measures or treatments.
4	• Causes serious infectious diseases in humans and constitutes a serious hazard to employees. There may be a major risk of transmission into the wider community, and under normal circumstances no effective preventive measures or treatments exist.

A list of classified biological agents which cause infectious diseases in humans can be found in the statutory regulations governing action threshold and limiting values (*forskrift om tiltaks- og grenseverdier*), Attachment 2. Not all biological agents are listed in these statutory regulations. The division/department in question has a duty to classify those which are not included in the lists published in the statutory regulations. All use of biological agents must be subject to a risk assessment. The risk assessment must be archived in written form.

9.3 Prior to working with biological agents

- A briefing must be given as to the biological materials being used and the health risks involved. Personnel must be offered a vaccination.

- Warning signs must be posted in laboratories where work is carried out using biological agents, as well as information as to where you can find out what to do in the event of accidental inoculation.
- A substances index containing information sheets for all products involving biological agents must be kept at the division in question. Moreover, guidelines must be available for the handling of biological agents classified in infection risk groups 3 and 4.
- All personnel who work with living animals or human material will be offered vaccination against tetanus and Hepatitis B (HBV). NTNU: Contact the HSE Section
- Definition of containment: Containment constitutes barriers constructed in order to prevent biological agents from coming unintentionally into contact with humans or the environment. The statutory regulations governing protection against biological agents (*Arbeidsplassforskriften*) and the regulations governing the contained use of genetically modified micro-organisms (*Forskrift om innesluttet bruk av genmodifiserte mikroorganismer*) both set out the measures that must be implemented in order to achieve containment levels 1 (for infection risk group 1), 2, 3 or 4. They also include a review of the required protective equipment.

9.4 Personal protective equipment

- All personnel must use personal protective equipment, both for their own protection against infection, and to reduce the risk of contaminating the culture/cell line. For groups 3 and 4, full protective body coverage is mandatory.
- Mandatory protective equipment includes work clothes, gloves and a surgical mask, as appropriate (in the event of a risk of splashing), or mask with P2 (P3) filter, a cap, and protective shoe covers.

- Before leaving the laboratory, protective clothing must be removed and the hands washed thoroughly.

9.5 Handling and storage

- Micro-organisms must be handled with care because they may cause disease in humans (human pathogens)
- Sterile techniques are essential for the aseptic transfer of micro-organisms from, for example, a culture to another medium. The same applies to cell cultivation.
- Only sterilised disposable equipment or flame-sterilised reusable equipment should be used for sampling. The sterile technique will vary depending on whether personnel are working with bacterial cultures or with cell cultures on a safety bench.
- Cleanliness and meticulousness are essential and prerequisite in order to prevent contamination of the samples by their surroundings
- The workplace must be cleaned thoroughly prior to the commencement of work, and cleaned and disinfected after use.
- After any period of experimentation, all biological material must be destroyed and disposed of
- Biological material such as bacteria and cell lines must be stored clearly labelled and properly sealed in separate, purpose-built incubator cabinets.

9.6 Disinfection

- Disinfection is a process which kills most pathogenic bacteria and viruses
- In order to prevent infection to personnel or the transmission of potentially pathogenic material to the environment, disinfection must be carried out prior to manual cleaning

Disinfecting agent	Application
Chloramine	• Disinfection of glass, plastic and rubber articles. It has no significant effect on fungi and spores. Metals and textiles can be attacked. • Can be purchased as a 5% solution ready for use. Can also be obtained as a powder. Prior to use the powder must be dissolved in water to form a 5% solution: The water temperature must not exceed 30-35oC • Articles to be disinfected must be disassembled (as far as possible) and completely submerged in the disinfection solution for at least one hour. Surfaces and suchlike must be covered with absorbent paper and well-wetted with the disinfection solution. Let this process continue for one hour prior to thorough mechanical cleaning. Rinse thoroughly with water. • Unused 5% stock solution can be kept for 2 years – well-sealed at room temperature in a dark place • As a rule, used solutions cannot be re-used because chlorine-containing disinfecting agents easily become inactivated by organic material. Remember: Use gloves and a fume cupboard! Used chloramines must be collected in plastic containers and disposed of as hazardous waste.

Disinfecting agent	Application
Virkon	• An oxidative surface disinfection agent for multi-purpose use against bacteria, viruses and fungi. Gentle on humans, materials and the environment. Is not negatively affected by organic material. Works rapidly.
PeraSafe	• A supplement to Virkon in situations involving mycobacteria (TBC) and spore-forming bacteria.
Heat disinfection	• Heat disinfection is always preferable to chemical disinfection, provided that the equipment in question can tolerate heating • Autoclaving at 121°C for 20 minutes kills all micro-organisms
UV radiation	• Kills many types of micro-organisms. It is important to be aware of certain factors which may render this method unreliable: - the distance to the object subject to radiation - the entire surface of the object must be exposed to radiation - the efficacy of the UV lamp reduces with time • The highest energy frequencies in the UV spectrum may react with air to form ozone. UV radiation can also disintegrate plastics. • Restrict the use of UVC radiation to a minimum. Irradiate for approx. 1 hour • UV light reacts with air to form ozone, and it disintegrates plastics resulting in the formation of small volumes of harmful gases. If a UV light source has been operating overnight, it must be switched off for approximately half an hour before the laboratory can be used.

Alcohol (spirit)	• Ethanol or isopropanol both work rapidly, and are effective against most bacteria and some viruses Alcohols may be used: 1. when there is no suspicion of infection by HIV/HBV, 2. when disinfection must be achieved rapidly 3. when the equipment or instruments will not respond to any other form of disinfection Instructions for use of ethanol: • Make a 70% stock solution (diluted in water). 1. Visible spillages must be cleared away. Soiled articles must be cleaned prior to disinfection using ethanol (NB! Ethanol may coagulate proteins and partially infiltrate organic materials). The procedure involves a certain risk of accidental infection and gloves must be used. Use the utmost caution. 2. Allow the ethanol to take effect for at least 2 minutes. • Rapid evaporation permits a very short reaction time. When disinfecting surfaces, the ethanol must be applied either once in sufficient volumes, or repeatedly, to ensure that the minimum 2-minute disinfection time is achieved.

Innsida:

- Biological agents
- Working with biological agents
- Working with biological agents during pregnancy

9.7 Infectious waste

Hazardous waste includes the following:

- Tissue samples, cells, blood, urine and genetically-modified organisms which may represent a risk of infection or other hazards.
- Items which contain biological material and/or cytostatics, including syringes, scalpels, disposable tubing, etc.
- Human or animal pathological waste including body parts, organs or tissue.
- Waste from an airborne infection isolation room.

Organic solvents, explosive or highly reactive chemicals, toxic inorganic compounds and heavy metals such as mercury, cadmium, lead and similar, must not be mixed with infectious waste!

Packaging

- Infectious waste must always be disposed of in designated yellow boxes. When they are full, the yellow boxes must be placed in a large container specifically designated for hazardous biological waste (50/60l). This container is then delivered with the relevant label attached. Insert a cross to indicate the correct category. You may insert one or more crosses.
- Contact the waste disposal contractor if another form of packaging is required.

Please note that infectious waste must not be declared via the website avfallsdeklarering.no, because it is not formally defined as hazardous waste. However, infectious waste does represent hazardous material and must be delivered to an approved destruction facility.

Collection

- NTNU: Order infectious waste collection via the purchasing system.
- Fill in the following under the heading "Specification of goods/services" (*Spesifikasjon av vare/tjeneste*):
  - **"Infectious waste"**
  - **Number and type of containers**
  - **UN no. 3291**
  - **ADR hazard class: 6.2**
  - The EAL code **18 01 02** (waste from organisations where veterinarians or other animal health personnel provide health-related assistance to animals) or **18 01 03** (waste from primary or specialist health care services or other medical organisations).
- Fill in the following under the heading "Supplier" (*Leverandør*):
  - **Norsk Gjenvinning AS**

Used bacterial cultures, supernatants and equipment that has been in contact with biological agents

- All equipment that has been in contact with biological agents must either be autoclaved prior to washing (reusable equipment), or disposed of in boxes for hazardous biological waste and labelled as infectious waste (disposable equipment).
- Used bacterial cultures in solution and supernatants remaining after bacterial centrifugation must be autoclaved and disposed of as harmless refuse (wash in a fume cupboard). This does not apply to solutions containing organic solvents. In such cases, the bacteria must be destroyed using a caustic alkaline solution. Agar dishes containing bacterial cultures must be autoclaved in autoclave bags, after which they can be disposed of as ordinary refuse or as hazardous biological waste, labelled as infectious waste.

Special instructions for employees and students working in hospital buildings (This applies to the Faculty of Medicine and Health Sciences)

- In the hospital buildings, hazardous waste must be sorted into two categories and correctly labelled. Both must be disposed of in yellow boxes designated for hazardous biological waste:
  - Sharp or piercing instruments, cytostatics, antibiotics and medicines: Use yellow adhesive labels marked "**Hazardous waste**" (*Risikoavfall*), insert a cross indicating the relevant category, the date, and the name of the department.
  - Blood-stained waste (saturated), suction containers, drain tubing, infectious waste and pathological waste/ laboratory animals: Use blue adhesive labels marked "**Infectious waste**" (*Smitteavfall*), insert a cross indicating the relevant category, the date, and the name of the department.

Innsida: Disposing of infectious waste

9.8 Contained use of genetically modified micro-organisms

- Genetic technology involves methods for the isolation of genetic material, its characterisation, modification and insertion into living cells or viruses.
- Genetic technology is regulated by the Norwegian Genetic Technology Act (*genteknologiloven*), and the use of genetically modified microorganisms by the statutory regulations governing the contained use of genetically modified organisms (*forskrift om innesluttet bruk av genmodifiserte organismer*).

- Laboratories and other facilities which are intended to be utilised for contained use, must be approved in advance by the Norwegian Directorate for Health and Care Services, and the use of genetically modified micro-organisms must be reported to the same body.
- Definition of containment: Barriers constructed in order to prevent biological agents from coming unintentionally into contact with humans or the environment
- Laboratories and facilities are classified into containment levels 1, 2, 3 or 4, where level 1 represents the lowest level. The minimum requirements for these levels of containment are set out in the table published in the aforementioned statutory regulations governing the contained use of genetically modified micro-organisms.

9.9 Work with human material

- Work with human material such as blood, cells, tissue and autopsy material may carry a risk of diseases such as hepatitis B and C, and HIV. For infection to occur, a virus must penetrate the skin or a membrane. There is no risk of infection if the skin is unbroken.
- All personnel working with human material in circumstances involving a risk of infection must submit to a check-up with the occupational health service provider, and shall be offered a vaccination.

First aid:

- Wash wounds or the inoculation point thoroughly with soap and water. Then disinfect using an alcohol solution.
- Then try to obtain the HIV and infection status of the person from which the material was taken.

- The person vulnerable to infection must have a blood test within 48 hours in order to check that there was no infection in his/her body prior to the accident. A referral form for a blood test can be obtained from the occupational health service provider. Outside working hours, contact your general practitioner or an A&E clinic. Blood tests must be taken again after 3 and 6 months in order to monitor progress. The occupational health service provider is responsible for following up employees or students who have been subject to accidental inoculation.

Innsida: Working with human material

9.10 Work in departments involving laboratory animals

- The line manager is responsible for ensuring that employees and students are offered health checks and vaccines, if necessary, and that the premises are approved by the Norwegian Food Safety Authority's Animal Testing Committee and are fit for purpose.
- Animal health is safeguarded by means of separate regulations stipulated by the Animal Health and Welfare Inspectorate.
- Separate guidelines (see below) have been prepared to safeguard employees, students and visitors against disease which can be transmitted by animals and animal products, and to minimise the risks of the spread of allergens.
- The guidelines also ensure adequate safety provisions for personnel visiting the animal testing department.

Innsida: HSE in animal testing departments

10 RADIOACTIVE SOURCES

10.1 Radioactive sources

There are two main categories of radioactive sources:

- Ionising: Radioactive substances, X-ray apparatus, electron microscopes
- Non-ionising: Lasers, short-wave ultra-violet radiation (UVC) and sources emitting potentially harmful electro-magnetic radiation, among others.

Radioactive sources must be handled in compliance with local regulations and in such a way as to minimise the risks to your own health and safety and that of others, the working environment, and the external environment

The use and handling of radioactive sources are regulated by separate statutory regulations, standards and HSE guidelines.

Innsida: Radiation protection

10.2 Prior to the commencement of work

- The local radiation protection coordinator must be kept informed and be consulted regarding radioactive sources and their use, location, movements, procurement and disposal, etc.
- Necessary training shall have been completed
- The employee health and safety representative and relevant third parties must be notified of the activity in question, and of any precautions which must be taken
- A risk assessment of work involving the radioactive source(s) in question must be carried out
- Essential shielding, technical safety systems, personal protective equipment and appropriate measuring devices for carrying out radiation protection checks must be readily accessible
- Prior to procurement or use, personnel must be made aware of the proper storage and disposal procedures for the radioactive source(s) in question
- Emergency procedures/a contingency plan must be prepared. Accidents involving radioactive sources must be reported without delay to both the local and central radiation protection coordinators, together with standard notifications to the relevant managers
- The radiation protection coordinator must be informed of the procurement of new radioactive sources. He or she will then register the source with the Norwegian Radiation Protection Authority, or submit an application for approval for use if the source in question is not included among NTNU's general licences for use.

10.3 Sources of ionising radiation

- Service and maintenance must be carried out by qualified personnel
- Users must have training in locally prepared guidelines, handbooks and contingency plans, in the use of measuring devices and protective equipment, and in the disposal of waste

- Make an assessment of whether it is possible to employ methods which do not involve the use of ionising sources
- Access to laboratories containing sources of ionising radiation must be restricted
- Use the minimum levels of radiation possible
- A contamination check must be carried out when using open sources
- All purchases, usages and disposals must be recorded
- Signs and notices must be posted in compliance with statutory regulations on all sources and equipment, and at the workplace (parts of, or the entire laboratory)
- Radioactive sources and waste must be stored correctly
- Personnel who become pregnant must inform their technical supervisor without delay.
- If you are pregnant and intend to work with ionising radiation, the doses shall be calculated and must not exceed 1 mSv for the remainder of the pregnancy.
- The central radiation protection coordinator must be notified of all users who may be at risk of levels of exposure in excess of 1 mSv/year

Open radioactive sources

- All work carried out above the contingency thresholds described in the attachment to the statutory regulations governing radiation protection and the use of radiation (strålevernforskriften) must be carried out only in approved laboratories (Classes B or C). Applications must be made to the Norwegian Radiation Protection Authority for discharge permits for these labs.
- For more detailed information, we refer to the various types of ionising sources as described in Innsida

10.4 Non-ionising radiation

The use of sources of non-ionising radiation must be registered in a log book that accompanies the source. In compliance with local guidelines, an information folder must accompany the source.

Lasers – classes 3B and 4

- The person responsible for the equipment must make an assessment as to whether likely users are sufficiently qualified to use the lasers without supervision. In the case of class 4 lasers, the assessment must be documented in writing
- The most relevant protective equipment comprises laser goggles designed specifically for the laser radiation in use and its application. In addition, for Class 4 lasers, there may be a specially-designed visor, fire-proof clothes, gloves, etc., in order to protect the skin from exposure, fire risk, etc.
- Every effort must be made to provide maximum enclosure of the laser beams
- The procurement, movement or disposal of Class 3B and 4 lasers must be reported to both the local and central radiation protection coordinators.
- Lasers stronger than Class 2 (1mW) shall not be used as laser pointers at either NTNU or SINTEF.

10.5 UVC sources

- The division in question must ensure that UVC tubes are used correctly
- Protective equipment may include eye and face protection (goggles/visor), appropriate protective gloves, and long-sleeved work clothes
- The division must have its own equipment for, or know where to find assistance in relation to, the measurement of UVC
- All exposure must be kept to the minimum levels possible. Systems should be in place to ensure that open UVC sources are turned off automatically when a person enters an area where harmful UVC radiation is in operation
- All apparatus and laboratories where harmful UVC radiation in use must be indicated with signs and notices.

11
FIRE

11.1 General regulations in the event of fire

- Fire extinguishers designed to deal with fire hazards related to the activity in question must be located on all premises
- All alarms, fire extinguishing equipment and evacuation routes must be clearly indicated and signposted
- Fire regulations must be posted in laboratories, workshops, corridors and other communal areas so that they are easily visible
- Employees who have their place of work in the same building as St.Olav's must follow the same signs as hospital staff

Fire regulations:

BRANN-INSTRUKS

Gjør deg kjent med:

- Rømningsveiene
- Nærmeste brannmelder
- Slokkeutstyrets plassering og virkemåte

Hvis brann oppstår:

- Prøv å slukke branntilløp
- Utløs manuell brannmelder
- Ring brannvesenet på telefon 110

Ved alarm:

- Lukk dører og vinduer
- Steng gasskraner og flaskeventiler
- Forlat bygningen
- Gå til møteplass
- Meld fra dersom du vet årsak til utløst alarm

Heis skal ikke benyttes ved brannalarm!

FIRE REGULATIONS

Make yourself familiar with:

- Evacuation routes
- Nearest fire alarm
- Location of extinguishers and how they work

If a fire starts:

- Try to extinguish the fire
- Activate the manual fire alarms
- Call the Fire Department at tel. 110

If the alarm sounds:

- Shut doors and windows
- Shut off gas taps and cylinder valves
- Leave the building
- Go to the assembly point
- Please report if you know what caused the alarm

Lifts must not be used during fire alarms!

Brann 110

Politi 112

Ambulanse 113

sit SINTEF NTNU

11.2 Evacuation in response to fire alarms

- If possible, close all cylinder valves and shut-off all gas supplies prior to evacuation.
- Small fires must be extinguished, if possible. The Fire Department will take responsibility for extinguishing major fire outbreaks
- Each building must appoint a person responsible for evacuation of the building who acts as liaison with the Fire Department during emergency situations
- These persons are responsible for evacuating personnel from within their area of responsibility to a pre-determined place of safety outside the building
- The person responsible for evacuation and the Area Officer(s) are identified by means of distinctive vests.

Disabled persons
Appropriate evacuation procedures shall be drawn up based on a risk assessment. Suitable portable chairs must be made available to those employees and students with a disability.

11.3 Extinguishing fires

The divisions must carry out risk assessments to determine their needs in terms of essential fire extinguishing equipment. Equipment must be placed in easily accessible locations on the premises.

Extinguishing fires involving different materials:	
General	**Think of your own safety at all times!** • Small fires must be extinguished, if possible. The Fire Department is responsible for extinguishing larger fires • Water (if this can be used without risk) • Water in order to cool steel gas cylinders, which should be removed from the scene of the fire before the flames have had the opportunity to spread
Hair/clothes	• Use the emergency shower, a wet blanket or fire blanket • In the event of your clothes catching fire, roll around on the floor • Avoid spraying water directly onto your face, due to the dangers caused by high pressures and the effects of cold
Open receptacle	• Place something tightly over the opening (such as a saucepan lid, book or blanket).
Electrical equipment	• Primarily CO2, or a powder extinguisher/fire blanket
Organic materials on the laboratory bench or floor	• Preferably CO2 • Use a powder extinguisher only if the fire cannot be put out using CO2 • Use of fire blanket
Phosphorus fire	• Wet sand
Alkaline or rare earth metals	• Dry sand, NaCl (as part of a mixture, as appropriate), powder extinguisher with special powder

12
FIRST AID AND DEALING WITH ACCIDENTS

Important considerations in all first aid situations:

- Think of your own safety at all times
- Make sure that the scene of the accident is secured
- Make sure that the alarm is raised

Incident	Injury / what must be done
Uncon-sciousness Fall	**FIRST AID:** • Check that the person is conscious • Ensure that airways are unobstructed • Check that the person is breathing (ob-serve for at least 2 minutes) • If no breathing is detected, commence cardiopulmonary resuscitation (CPR) – 30 compressions and 2 rescue breaths. • Stop any bleeding and/or cool burns with water • Call 113 – Emergency Medical Services (AMK) • List of defibrillators: https://innsida.ntnu.no/akutt-hjelp
Cuts and stabbing injuries	**FIRST AID:** • Stop the bleeding by pressing hard on the cut, and by elevating the affected limb above the level of the heart • Remove any unattached body parts and take these to the attending doctor • Call 113 • For monitoring of possible blood-transmitted infection, see Chapter 9.9

Incident	Injury / what must be done
Electric shock	**FIRST AID:** • Disconnect the power supply (think first of your own safety) • Check that the person is conscious • Check if the person is breathing (observe for a minimum of 2 minutes) • If you have to move the person, do so by taking hold of dry clothes • Ensure that airways are unobstructed • If no breathing is detected, commence cardiopulmonary resuscitation (CPR) – 30 compressions and 2 rescue breaths • Cool burns with water • Call 113 – Emergency Medical Services (AMK) • Criteria for calling for medical assistance in the event of accidents involving electricity: - victim(s) subject to high voltages - victim(s) struck by lightning - victim(s) subject to low-voltages with high probability of passage through the body - victim(s) unconscious or drowsy following the accident - victim(s) has incurred burns - victim(s) exhibits indications of neural injury (such as paralysis) Following essential first aid, all victims who meet the criteria above must be taken to hospital immediately!

Incident	Injury / what must be done
Chemical spillages, splashing and suchlike	**FIRST AID:** **Spillages onto the skin** • Rinse the affected area with copious amounts of water • For some types of chemicals, special first aid training is required. For example: • If the spillage involves hydrofluoric acid (HF), an HF antidote gel or Calcium Zandos solution must be applied • Remove soiled clothes and shoes, and continue to rinse for 15 minutes • If a doctor is in attendance, show him/her the Safety Data Sheet
Chemical spillages/ splashing	**FIRST AID:** **Swallowing:** • A general rule of thumb is to rinse out the mouth and drink water. NB! In the event of swallowing caustic alkaline solutions or acids, vomiting must NOT be induced • Contact your nearest colleague, go to hospital or find a doctor and bring the relevant Safety Data Sheet with you • In all cases of poisoning, the Toxins Information Centre (*Giftinformasjonssentralen*) must be contacted for instructions (Tel. 22 59 13 00) **Inhalation:** • Find a source of fresh air without delay. Clear the nose thoroughly. Rinse the eyes and mouth with water. Avoid unnecessary physical exertion • Contact your nearest colleague, go to hospital or find a doctor and bring the relevant Safety Data Sheet with you

Incident	Injury / what must be done
Chemical spillages/ splashing	**Eye injuries:** • Rinse thoroughly with lukewarm water or an eye-rinsing solution. • Contact your nearest colleague, go to hospital or find a doctor and bring the relevant Safety Data Sheet with you. Continue to rinse the eye(s) during transport to the hospital or doctor **In the event of spillage onto clothes:** • Clothes must be removed and rinsed. • Make an assessment as to whether clothes should be disposed of or if they can be worn again after washing. • NB! Clothes left to dry after a spillage of oxidative compounds are very easily ignitable. **On benches, floors and suchlike:** <u>Small volumes:</u> Use an absorptive material or paper towel (provided that the substance in question is non-reactive) <u>Large volumes:</u> Hazardous water soluble substances must be collected and treated as hazardous waste. Fluids can also be absorbed using sand or absorption pads made of inert material.

Incident	Injury / what must be done
Fire **Explosion** **Gas emission**	**FIRST AID:** • Think of your own safety! • Do not enter an area before you have assessed the risk. Consider whether it is appropriate to wear a gas mask, protective clothing and/or gloves. (do not expose yourself to danger!) • Raise the alarm **Call** **113** Ambulance **110** Fire Dept. • Secure the scene of the accident. Check the room for collateral damage • Extinguish any burning clothes (use emergency shower or smother using clothes/a blanket) and other fires, if possible • Shut off any leakages • Drag any injured personnel to safety (do not lift them) **FIRST AID:** • Check that the person is conscious • Ensure that airways are unobstructed • Check that the person is breathing (observe for at least 2 minutes) • If no breathing is detected, commence cardiopulmonary resuscitation (CPR) – 30 compressions • and 2 rescue breaths • Stop any bleeding and/ or cool burns with water

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Watch the video about safety in the laboratory
Click here to start the video (http://vimeo.com/44104310)

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HAND BOOK