Health - Security - Environment (HSE) in the laboratory

Lecture in laboratory focused HSE for master's students at the Faculty of Natural Sciences and Technology

Lecturer: Turid Rustad, professor at The Department of Biotechnology

The presentation will be made available here:
http://www.ntnu.edu/nt/nt/hse-course

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HSE in the lab– course objective

The course shall contribute to ensure that you have the necessary **knowledge** and **awareness** of HSE and safety in laboratory work.

HSE training by NT faculty will provide a common platform for students at NT. Specific training targeted towards various types of laboratory work is done by Departments.

Good knowledge and awareness of HSE is an important learning objective because you will need it in your future work when you have finished your studies.

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HSE in the lab– course objective

In the master's study you will work more independently in the laboratory. It is very important that you have:

- Good knowledge of HSE and guidelines for lab work.
- Good attitudes and consciousness of responsibility in relation to HSE in the laboratory.
- Good understanding of the risks connected to lab work.

Both knowledge and attitudes is essential in order to fulfill **the responsibility YOU have for your own safety and the safety of others** in the lab.

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HSE in the lab – content

- Working attitudes and conditions in the laboratory
- HSE issues associated with:
  - Chemicals, radiation sources and biological factors
  - Pregnancy and lab work
  - Mechanical work, and working with high temperatures
  - Gas and electricity
  - Fieldwork and excursions
- Personal protective equipment
- Risk Assessment
- Technical protection measures: fume cupboards, biosafety cabinets, security alarms, etc.
- Administrative protective measures: Laws, regulations & guidelines

The laboratory is not a lunch room

- Never eat or drink in the lab
  - chemicals, infectious materials, etc, might be consumed together with food/beverages
  - Also avoid using chewing gums, «snus»/tobaccos, applying cosmetics, etc
- Never taste chemicals
  - even if it «only» contains NaCl (table salt) or «pure» water
- Never use your mouth for pipetting or other operations in the lab
- Wash your hands befor leaving the lab

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Documenting lab activity

- Keep good records of your work in the lab
- Some instruments and processes require additional documenting in special log books
- Use of carcinogenic materials, lead, some radiation sources, etc, may require additional logging in personal records (still under construction at NTNU)

Make a good plan for the work

- Do a proper risk assessment of all activity
- Plan the use of instruments, methods and chemicals, including waste handling
- Read safety data sheets, operating instructions, guidelines, etc, relevant to your tasks
- Assess your need for additional training in any aspects of your work. Some equipment requires special training.

Good behaviour and tidiness in the lab

- Experience has shown that order in the lab significantly reduces the risk of accidents
- Only bring what you need for your work into the lab
- Make your contribution to a tidy lab
- No «practical jokes» or «stunts» in the lab
  - Due to numerous potential hazards present in a lab environment, consequences of practical jokes or stunts can be disastrous

Comply with regulations and local rules

- Follow regulations and local guidelines related to the lab activity
- Always use personal protection equipment where required or needed
- HSE nonconformities shall be reported:

https://avvik.ntnu.no

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Things you should know prior to working in the laboratory

- Type of activity?:
  - Chemical? Biological? Mechanical? Radiation sources? etc.
- Any significant risks with your activity?
- Is it likely that your work could interfere with other's?
- Is the lab properly designed and equipped for your purpose?

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Fire regulations

Rev. okt. 2010

BRANN-INSTRUKS

Gjør deg kjent med:

- Rømningsveiene
- Nærmeste brannmelder
- Slokkeutstyrets plassering og virkemåte

Hvis brann oppstår:

- Prøv å slokke 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

Fire alarm

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Fire extinguisher equipment

Extinguisher (shown: CO_2)

Fire hose

Fire blanket

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First aid kit

- Cabinets with equipment for basic first aid is available in most laboratories

Eye-wash stations

- Cabinet with eye-wash bottles
  - *pH Neutral* for neutralizing acids/bases (small bottle)
  - Sterile salt water (large bottle)

- Eye-wash shower
  - Different types and looks

Emergency shower

Handling of chemical spill

- Various types of equipment exist for handling chemical spills
  - Personal protection equipment, absorbents, etc

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Laboratory documents

Room card	Bills outside entrances to laboratories showing vital information on safety issues to fire fighters and others
Apparatus card	Bills situated by the instruments telling who the owner is, what to do in emergency situations, etc.
Operating instructions	How to perform a working task or using an instrument. May also include user manuals, etc. Copies available in the lab.
Risk assessments	Documentation of risks. Copies available in the lab.
Safety data sheets	Safety information on dangerous substances. Copies available in the lab.

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Categories of signs

Mandatory	
Prohibitory	
Danger/warning	
Fire fighting	
Evacuation	

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Personal protective equipment (PPE)

- Choice of PPE should be based on the risk assessments

Eye protection	Splash of chemicals? Corrosive materials? Aerosols in the air? Need to use prescription glasses? Face shield?
Hearing protection	Type of earmuffs? Risk of «shot noise», or just continuously irritating noise?
Gloves	Glove material must endure the chemicals involved. Special types of gloves for heat, cold, cutting operations, etc
Lab coat	Lab coat made of cotton should be used i chemistry labs, due to flammability concerns. Other types of working clothes?
Footwear	Tight shoes shall be used in chemistry labs. Other types of footwear?
Respiratory protection	Hazardous gases/dust/aerosols? Filter masks? Fresh air supply system?

Facilities in the lab?

It is important that you are aware of the local conditions in the lab you will be working in:

- Access to working place in a fume hood?
- Storage space for equipment and chemicals?
- Access to the right type of instruments? Are the instruments working properly?
- How should hazardous waste be treated?
- Procedures for use of personal protection equipment, lab coats, etc

Ergonomics in the lab

– your health is important

- Plan your tasks in the lab carefully
- Find natural and suitable working position
- Avoid long-lasting, repeating task - take a break frequently
- Adjust your chair, and if possible the bench, to your needs
- Work in sufficient lighting conditions
- Try to find protection equipment that fits you, e.g. safety glasses that is pleasant to use

Further information: *www.ntnu.no/hms/ergoilab/*

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Ergonomics - Special needs?

There might be personal health issues (disabilities, diseases, allergies, etc) that requires special arrangements of the workplace.

Do you have such needs? Or just want to discuss the issue? Contact your supervisor, or others that you think can help you.

Permits and responsibility

- Roles and responsibilities:
  - Safety delegate (employees), student's representative (students)
  - Supervisor
  - Person responsible for the room? For instruments?
  - HSE-coordinator, purchaser, laboratory technicians
- Is it allowed to work alone? Special permit?
- Any instrument requiring special training?
- Admission to the lab – shall the doors be kept closed, etc?

Working with chemicals

- Be well prepared before you start
  - Use EcoOnline, NTNU's database of Chemical substances
    - English: http://www.ntnu.edu/hse/substances
    - Norwegian: https://innsida.ntnu.no/web/guest/wiki/-/wiki/Norsk/Stoffkartotek
  - Every Department has its own contact person that can help you
  - All chemicals, dangerous substances and gases shall be registered and risk assessment performed in EcoOnline before you can use it
  - Always consider substitution of substances that represent serious health risks
  - Always read the safety data sheet
    - Contains vital information you need to know for safe handling
  - Copy of the safety data sheet shall be in binder on the lab
  - Important to be aware of risks and safety precautions before work starts. This includes how to handle waste.

Safety data Sheet

Safety Data Sheets	
Contents	1. Name of the chemical and its supplier. 2. Hazard identification 3. Composition/Information regarding constituents 4. First aid measures 5. Fire extinguishing measures 6. Measures in the event of unintended discharge/emission to the environment 7. Handling and storage 8. Exposure control and personal protective equipment 9. Physical and chemical properties 10. Stability and reactivity 11. Toxicological information 12. Ecological information 13. Instructions for disposal 14. Information regarding transportation 15. Regulatory information 16. Other information

- Primary risks
- Spills on your skin? Inhalation?
- Avoid water?
- Cleaning up spills?
- Handling. What should be avoided?
- Required safety equipment?
- Highly reactive? Potentially explosive?
- Important for disposal
- Hazard symbols, R-and S-phrases

- **Many points on the data sheet may be important**
- It is not enough to check the primary risks

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Hazard symbols

Old symbols	Current symbols	Old symbols	Current symbols
 VERY FLAMMABLE  EXTREMELY FLAMMABLE		 CORROSIVE	
 OXIDISING  EXPLOSIVE	 		 Gas under pressure
 VERY TOXIC  TOXIC	 	 HARMFUL TO THE ENVIRONMENT	
 HARMFUL  IRRITANT			

Chemicals and eye protection

Always use eye protection when working with chemicals and hazardous substances

- Contact lenses are not recommended to use when working with chemicals
  - contact lens can be "burned" into the eyeball
- NT-faculty has its own eye protection instruction (in Norwegian) http://www.nt.ntnu.no/innsida-dokumentlager/HMS/oyeverninstruks-12-08.pdf

Chemicals, gloves & hand hygiene



- Wear gloves of appropriate type in relation to the chemicals you work with
  - The gloves have different properties.
- NTNU's lab and workshop handbook is a good guide for you – see separate chapter on gloves
- After finishing work with chemicals, you shall always wash your hands, even if you have used gloves
  - Good hand hygiene is important!

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Chemicals and ventilation

- Much of the work with chemicals must be done under ventilation, preferably in fume cupboards
- Check out the safety data sheets for the chemicals you will work with

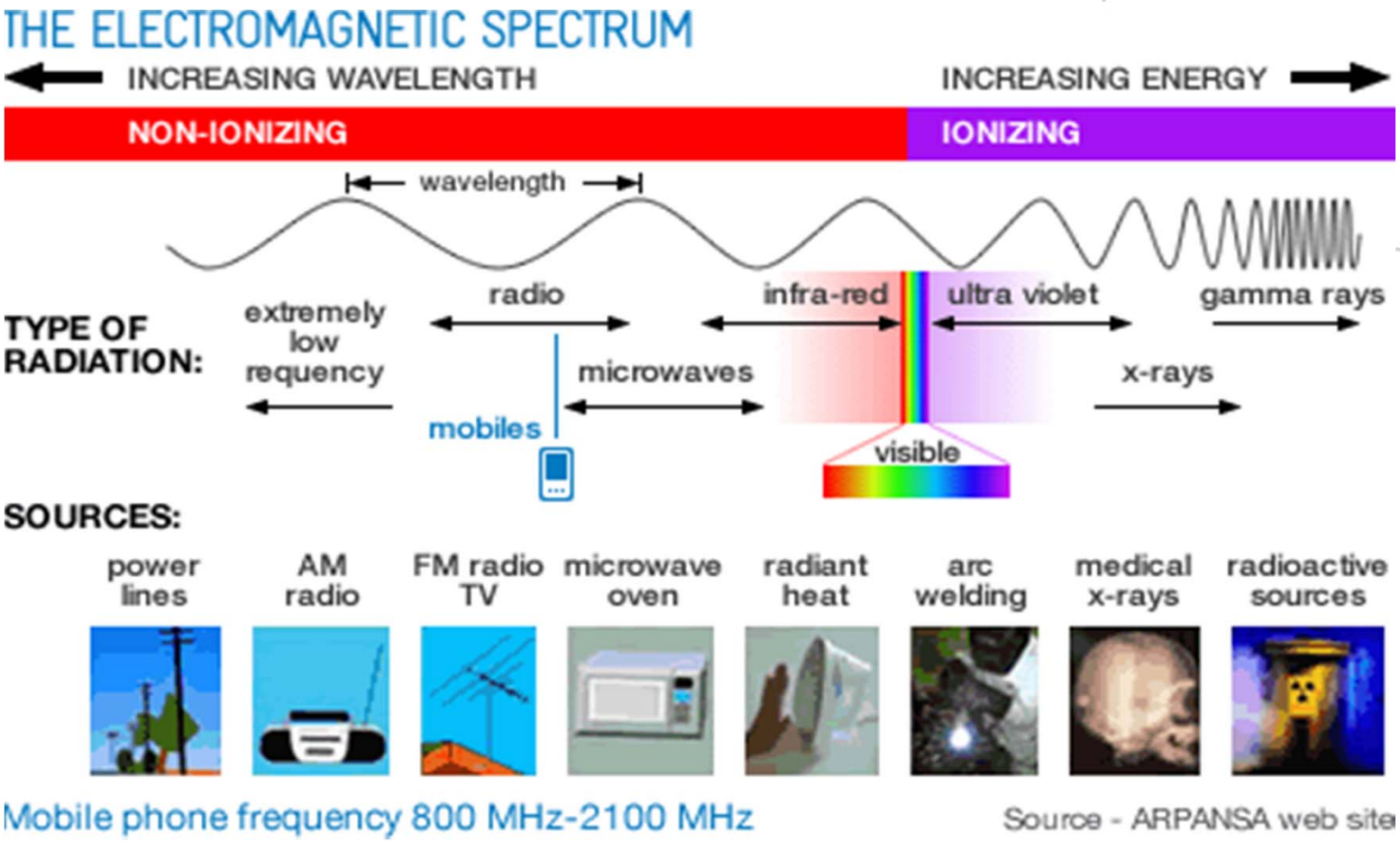
Transportation of chemicals

- Use suitable transport containers or trolley table with frame for safe transportation of chemicals

Chemicals and waste handling

- Chemical waste must in general be handled as hazardous waste
- You shall know how to handle the waste before work starts
- All departments at NT have their own contact person that are responsible for the disposal of hazardous waste
- NT-faculty have their own guideline for disposal of hazardous waste (in Norwegian)
  - http://www.nt.ntnu.no/innsida-dokumentlager/HMS/Avhendig-farligavfall

Radiation sources and protection

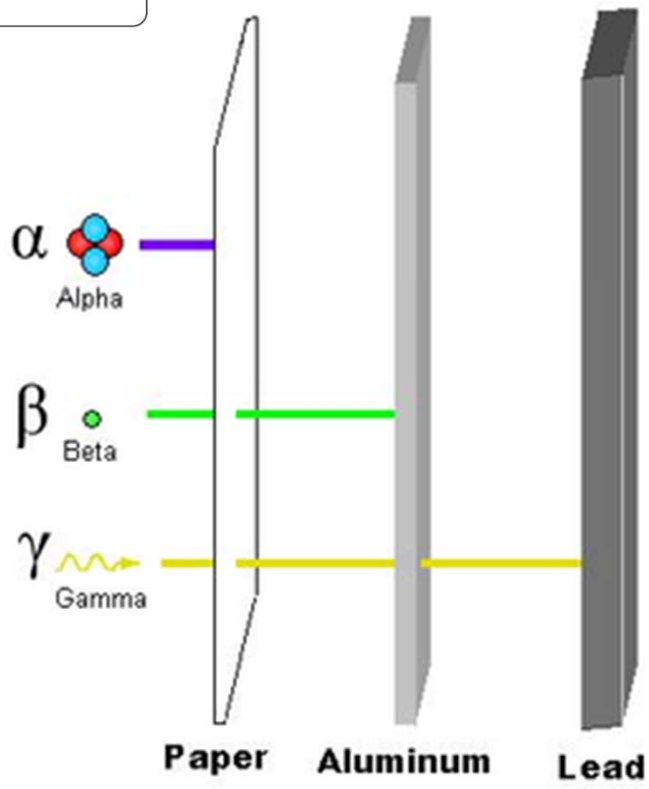


Radiation protection at NTNU

- NTNU has got specific approvals from the Norwegian Radiation Protection Agency (NRPA) for using our radiation sources.
- Radiation protection coordinators:
  - Main coordinator at the HSE dept
  - Local coordinators at each department
- Matters concerning radiation sources and protection shall be addressed to our local coordinators.

Radioactivity

- *Alpha particles* (*He*-nuclei)
- *Beta particles* (e+, e-)
- *Gamma* (electromagnetic)
- Radioactivity easy to measure/monitor
- Ionizing and damaging DNA



Penetration properties

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Encapsulated radioactive sources

- «Hermetically» sealed
- Even very strong sources can be quite small (physical dimensions)
- Main risk is external radiation to the body
- Use of strong sources are restricted
- **Requires special training**

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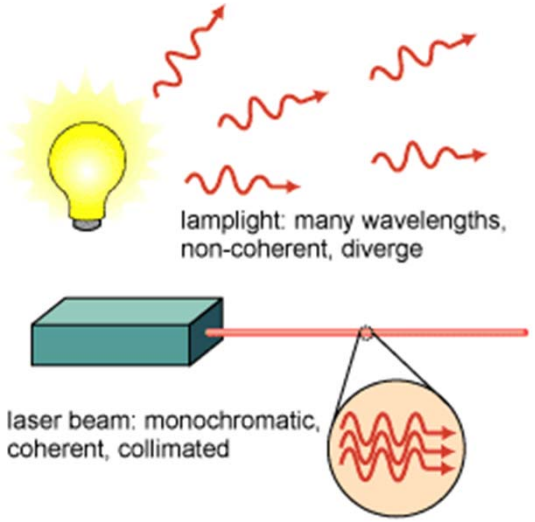
Open radioactive sources

- Radioactive liquids, powders, gases which are not encapsulated
- Examples: I-125, H-3, C-14
- Typical use at NT:
  Tracing in biological materials.
- Greatest danger inside or on the surface of the body
- Designated laboratories
  («B-lab», «C-lab»)
- **Use requires special training**

Lasers

- Highly concentrated beam
- Potensially dangerous to eyes
- You can not determine the danger only by observing the beam
- Lasers should be classified and marked
- An internasjonal standard (EN 60825) exists



Laser classification

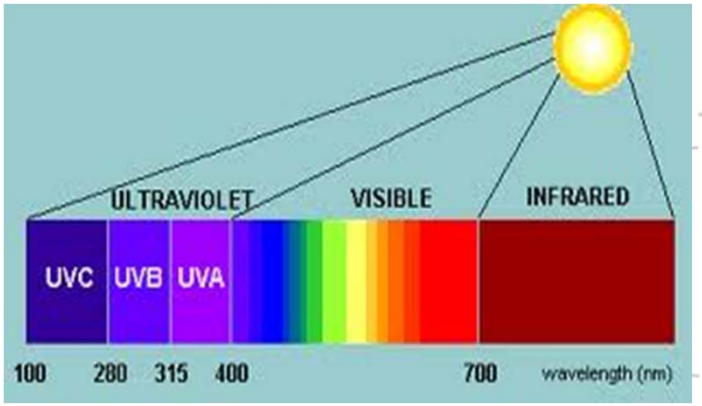
Laser class	Risk	Typical use
1 (1M)	Always considered safe	Non-restricted use; strong but safely encapsulated lasers, CD-player
2 (2M)	Regarded safe if not stirring into the beam	Non-restricted use; laser pointers, laser carpenter level
3R	Safe for short duration blinks, but with reduced safety margin	Use in laboratories
3B	Direct beam viewing potensially dangerous for eyes, diffuse reflexes considered safe	Only restricted use in special labs. Requires proper training
4	Always potensially dangerous to eyes, even short blinks of diffuse scattered radiation. May also ignite fires and cause skin burns	Only restricted use in special labs. Requires proper training

Laser pointers

- Lasers used in «public places», in lectures, demonstrations, etc
- In Norway maximum allowed power is **1 mW (class 2)**
- Be aware of strong and dangerous laser pointers available in the market (illegally)
- Green colour has much higher visibility than red, at the same optical power and risk level
  - ➢ Use green laser pointers

Ultraviolet radiation (UV)

- UVA (315-400 nm)
  - mostly skin tanning
- UVB (280-315 nm)
  - skin tanning and sun-burns
- UVC (100-280 nm)
  - skin and eye damage, snow-blindness
  - UVC not present in the solar radiation at earth's surface
  - only technical use (not in solariums)



UVC sources

- Typical source consists of a light tube without fluorescent coating
  - Radiating at 254 nm, Hg-line emission
- Typical use:
  - Sterilisation (air, water, surfaces)
  - Polymerisations, curing
- Requires protective measures
  - Protection of eyes and skin
  - Restricted use

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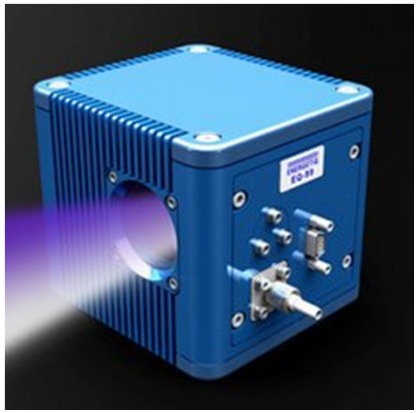
Other strong light sources

- Recently some new and very intense light sources have become available.
- Use with caution, eye protection might be required

Examples:

Strong light emitting diodes (LED)

Laser-driven optical light source (LDLS)



X-rays

- X-rays in material sciences: concentrated beam onto samples
- Even short exposures may cause severe burns
- Beam paths at most of the x-ray machines at NT-faculty are safely encapsulated
- Special laboratories and routines
- **Special training required**

Exposure of 5-10 seconds
Appearance of wound after 25 days

Electron microscopes

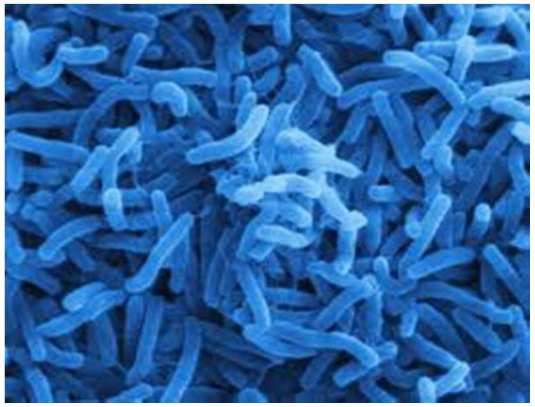
- Uses electron beams instead of light for magnification
- Might involve very high voltages (300 kV)
- Enclosed systems (vacuum)

Magnetic resonance (MR)

- Magnetical resonance effects in nuclei
- At NT: Studies of material samples (no medical use)
- Extremely powerful magnetic fields
  - Risky for users of pace makers, etc
  - Loose metal objects are dangerous
- Restricted use in specially designed labs

Biological agents

- Biological agents: living and dead microorganisms (bacteria, viruses, fungi), cell cultures, endoparasites etc. that can cause infections, allergy or toxic effects in humans. Can be naturally occurring or genetically engineered.
- Parts of biological agents such as enzymes/proteins, fatty acids, etc. are considered dead biological agents and may represent health hazards.



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Biological agents

- Living biological agents are classified into four groups of infection risks according to the level of relation to the level of infection risk they represent.
  - Group 1: Does not normally cause infectious disease in humans.
  - Group 2: may cause infectious disease in humans
  - Group 3 and 4: may cause serious infectious disease, danger of proliferation
- All biological factors need to be considered and classified regarding infection risks and other health hazards.
- List of living biological agents that are classified in hazard groups 2-4 are given in statutory regulations governing protection against exposure to biological agents. http://www.lovdata.no/cgi-wift/ldles?doc=/sf/sf/sf-19971219-1322.html
- The risks associated with organisms not found in the list of organisms pre-classified as hazard group 2-4 must be evaluated. Do not assume that they are harmless! Perform risk assessment.

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Protective measures and practices

- **Containment**: Barriers used to prevent biological agents from coming unintentionally in contact with humans or environment.
- Requirements for containment level corresponds to infection risk group. Group 3 and 4 require extensive measures, not relevant at NT.
- Containment level/ infection risk group 2:
  - Risk assessment and description of security measures must be prepared (procedures for decontamination, waste management, measures for handling accidents).
  - Laboratory shall be marked with warning sign and access should be limited. Requires notification to the labour inspection.
- Before starting to work with biological agents, you shall be given a briefing about the biological materials used, the hazards involved and the protective measures that should be used. See chap 10 handbook.

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Protective measures and practices

For all work with biological agents:

- Always use lab coat and disposable gloves. Good aseptic techniques and awareness to avoid transmission of biological agents is important.
- Biosafety cabinet can be used to protect materials against contamination and the operator against exposure. Learn how to use the safety cabinet correctly.
- Plan the work and how to handle the biological waste.
- All microorganisms in the waste shall be inactivated (by heating in autoclave or by disposing as hazardous biological waste, yellow containers).

Biosafety cabinet

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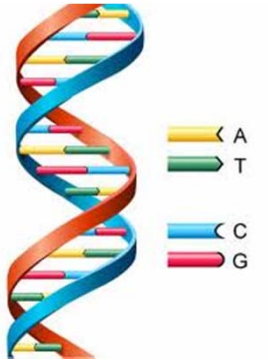
Genetically engineered organisms

- Guidelines on biological agents also apply to all genetically engineered microorganisms, but specific gene technology regulations also apply:
  - Regulation on contained use of genetically-engineered microorganisms (in Norwegian).
- For work with genetically engineered plants and animals these regulations apply:
  - Regulations on contained use of genetically engineered plants (in Norwegian).
  - Regulations on contained use of genetically-engineered animals (in Norwegian).
- The regulations specifies the requirements that the labs must satisfy for the different containment levels. Notification to the Norwegian Directorate of Health is required.



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Pregnant / breastfeeding

Laboratory work shall be safe and secure, and we must behave with responsibility to accomplish this.

If you are or intend to become pregnant, it is important to pay attention to what you're working with and the working environment. The pregnant woman is the closest to consider whether there are conditions in the working environment that may adversely affect the baby.

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Pregnant / breastfeeding

Potential risks for pregnant/breastfeeding women:

- Chemical and biological hazards
- Strong radiation sources
- Ergonomic conditions

In order to provide you with the necessary assistance in adaption of the work, advice and guidance, **you shall notify** your supervisor or lecturer about pregnancy as soon as possible.

Pregnant / breastfeeding

Risk assessment shall be carried out as soon as possible after the notification about pregnancy has been received.

There is prepared a checklist for risk assessment of pregnancy associated with laboratory work.

NT-faculty has a separate guideline for pregnant women that provides information about risk factors in the lab and responsibilities and rights.

Checklist and guideline (both in English and Norwegian) can be found on NT's HSE website
https://innsida.ntnu.no/web/guest/wiki/-/wiki/Norsk/HMS+ved+NT

Mechanical work

Mechanical work:

Grinding, drilling, sawing, cutting, mounting, carpentering.

Training shall be given before work starts.

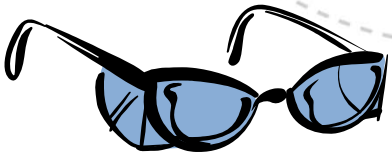
Required personal protective equipment must be used.

For mechanical equipment, operating instructions describing risks and safety precautions shall be available for the operator.

Mechanical work

Hazards:

Danger of cutting/crushing, rotating equipment, dust and exhaust from the materials.



Appropriate protective equipment:

- Hearing Protection
- Eye Protection
- Dust Mask
- Protective footwear and gloves
- Notice: gloves should not be used in rotating equipment.

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Working with high temperatures

High temperature ovens, melting furnaces and low temperature ovens in laboratories, heat treatment….

- Risk assessment must be carried out.
- The surroundings shall be protected against heat.
- Suitable fire extinguishing equipment shall be located in close proximity.
- Typical hazards: High temperature (melted metal) and pressure, toxic gases, corrosive and hazardous chemicals, high voltage, fracture mechanics.

Working with high temperatures

- Specific training shall be given on the equipment.
- Apparatus safety card shall be filled out and posted by the hot device.
- Locate the nearest fire-extinguishing equipment.

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Liquid metal

- Use appropriate protective equipment
- Facial protection, insulating gloves, light and loose clothing...
- Think of long hair, skin, eyes, glasses, shoes...
- Keep the workplace tidy
- Locate emergency showers

Liquid metal, laboratory
Fe, melting point ~ 1500 º C
- use of appropriate protective equipment

Heat treatment

Salt bath 300-600 º C

- Moisture causes splashing
- Use dry samples

Use of gases at the NT-faculty

- In most cases, use of gases requires special training

Pressurized gas containers

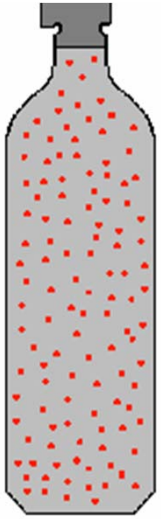
Gas outlets from distribution facility

Deep-cooled condensed gases

(Pressurized air)

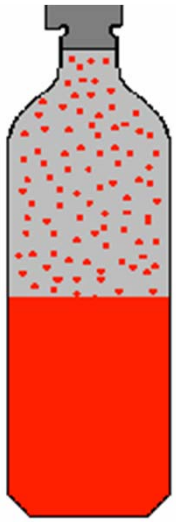
Gas in different phases

Compressed



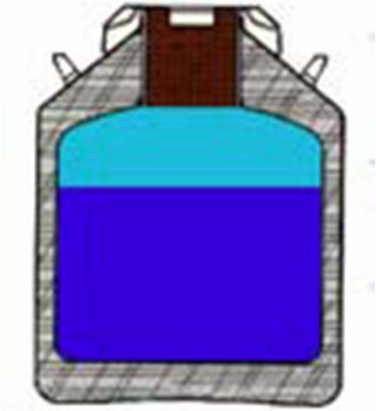
Examples:
N2, Ar, O2

Compressed and condensed



Examples:
CO2, Propan

Deep-cooled condensed



Examples:
Liquid N2, He

«Dry-ice» (CO2-sublimation)

Hazards of gas use

High pressure

Suffocation

Low temperatures
- frostbites

Fire/explosion

Poisoning

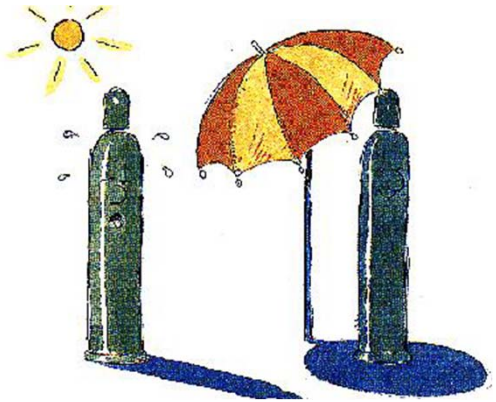
Oxygen enrichment

Protection of gas cylinders

Common cylinder pressure is very high - up to 200 Bar.

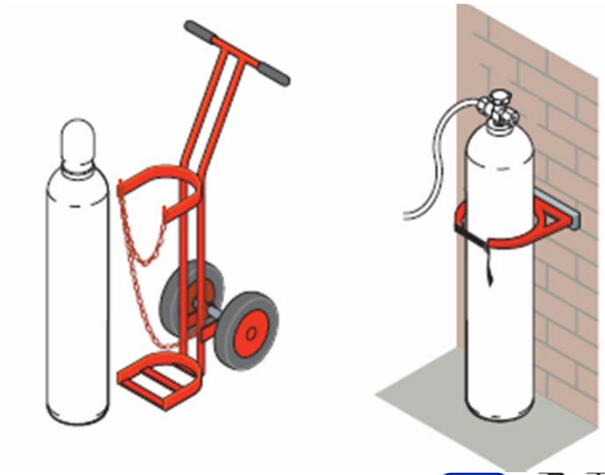
Gas cylinders temperature must not be allowed to exceed 45 °C

-risk of explosion



Gas cylinders shall be secured against damages to the valve/regulator

– The cylinder turns into a rocket if the valve is cut off



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Oxygen deficiency - danger of suffocation

- All gases (except O_2) are able to displace oxygen and cause suffocation.
- The O_2-content in the air is normally 21 %. Reducing this to 10-11 % may lead to unconsciousness
  - possibly without any warning!
- Oxygen displacement important to consider in confined spaces and in case of insufficient ventilation

Liquid nitrogen

- Direct contact with liquid nitrogen (-196 °C) may instantly cause serious frostbites in skin and eyes.
- Use designated cryo personal protection equipment
  - gloves, face shield, proper clothing and shoes
- Be aware that many materials becomes fragile at these low temperatures
- Evaporating liquid nitrogen expands ca 700x and must never be trapped inside a closed container
  - confinement in a closed container causes rapid pressure buildup and explosion
- Evaporating liquid nitrogen is also prone to displace oxygen in the air - danger of suffocation

Gases dangerous to health

- Different types:
- Gases affecting oxygen up-take and absorption
  - Examples: CO2, CO
- Gases irritating the organism
  - Examples: NH3, Cl2, NOx-gases
- Gases affecting the sentral nervous system
  - Examples: hydro carbons, solvents
- Consider using protecting equipment
  - gas mask, fresh air supply system, personal gas monitor/alarm, etc.
- A proper gas alarm system might be required

Flammable gasses

- Gases that can be ignited and burn in air
- Ignition depends on
  - gas concentration within gas specific upper (UEL) and lower (LEL) explosion limits
  - sufficient ignition energy (gas specific)
- Flammable gases shall be kept apart from oxidizing gases and flammable materials
- Examples of flammable gases at the NT-faculty:
  - Propane, hydrogen, acetylene
- *Oxidizing gases* are not flammable themselves, but can significantly support and enhance an existing fire
  - Examples: O_2, N_2O

Oxygen enrichment

- Even a small increase in oxygen concentration in the air can significantly increase ignitability
- Materials that in normal air is not flammable, may catch fire in an oxygen enriched atmosphere
- Oils, fat, etc, must never be used together with oxygen
- Clothes exposed to pure oxygen may remain highly flammable a long time afterwards (many hours)

Electrical hazards depends on:

- Path of current through the body
  - Current through the heart region particularly dangerous
- Frequency
  - Alternating current (AC) at 50 Hz considerably more dangerous than direct current (DC)
- Voltage
  - < 50 V (AC), 120 V (DC): Normally safe in «dry conditions»
  - > 50 V (AC): May induce harmful currents through the body
  - > 1 kV: May also cause skin burns from arc discharges
- Durations:
  - More than 1-2 seconds is potensially hazardous
- Current:
  - 10 mA may paralyse muscles, 50 mA may cause heart fibrillation or cardiac arrest

Impacts of electrical shocks

- Immediate injury:
  - Heart fibrillation (not pumping), cardiac arrest (full stop)
  - Breathing problems
  - Fire wounds, internal burns
  - Injuries may show up hours or days afterwards
- Long-term impacts:
  - Physical nerve damages, paralyses
  - Muscle-skeletal problems
  - Mental problems (post-traumatic stress)

Avoid currents through main body

- Avoid risk of currents through the heart region (hand-hand, hand-foot)
- Don’t grip around wires, etc that might be live.
  If you must touch the object, use the back of your hand
- *Fuses* (e.g. 16 A) are primarily meant for protecting equipment, not people
- *Earth-fault circuit-breakers* (ca 30 mA) are designed for protecting people, by diverting phase-to-earth leakage currents away from humans

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A person injuried from electricity should be hospitalized if he/she has:

- been exposed to high voltages (>1 kV)
- been exposed to currents through the heart region
- been unconscious or groggy after the incident
- got visible burns
- got symptoms of nerve damages (numbedness, paralyses, difficulties talking, etc)

Electrical equipment

- Do not use electrical equipment that is faulty
  - Report faulty equipment, enabling repair
- Cables and contacts must also be non-faulty
  - cable insulation, and strain relief and insulation in contacts must also be non-broken
- Extension leads should be used with caution
  - do not use with power-consuming equipment, e.g. ovens
- If you get an electric shock by touching equipment, stop using it immediately

Field work

- **What is field work?**
  - NTNU activity outside campus related to research and teaching: Field work and trips for collecting data/samples, field courses and excursions in connection with teaching.
  - Activity outside the regular working environment may involve increased risk

- **Guidelines and information for field work at NTNU:**

https://innsida.ntnu.no/wiki/-/wiki/Norsk/Feltarbeid Norwegian, link to all relevant information

http://www.ntnu.no/hms/retningslinjer/HMSR07E.pdf Field work HSE guidelines

http://www.ntnu.edu/hse/guidelines/d Other documents related to field work

Field work

- **The guidelines defines the roles and responsibilities**:
  - Person in charge: The participant responsible for the day-to-day follow-up of administrative and safety matters during the preparation and implementation of the field work, course or excursion.
  - Staff and students have a personal responsibility for carrying out their tasks, rectify errors or if relevant discontinue their activities for the sake of conducting the field work in a safe manner.
  - Staff and students must also act in accordance with safety routines.

Field work

Preparations for field work

- The person in charge must ensure that factors representing potential risks during the fieldwork are identified.
  - Checklist for preparation and surveying of risks. http://www.ntnu.no/hms/retningslinjer/HMSRV0701E.pdf
  - Potential risk issues associated with the participants' health shall be identified. Participants must notify professionally responsible person (e.g. about diabetes, epilepsy, pregnancy. ….).
- Based on the assessment of the risks, measures shall be implemented. (f.eks. danger of infection ---- vaccine, fall risk --- safety equipment for climbing). Necessary training of the participants must be carried out.
- The person in charge must prepare safety routines as necessary and ensure that the required security and first aid equipment is available. An emergency plan including plan for communication and notification in case of accidents etc. must be prepared.

Field work

Preparations for field work

- Responsible unit at NTNU must keep track of all the participants. Everyone must fill out a field-card. If private trips are made in relation to the field work, plan for the trip shall be provided.
- Roles and responsibilities of the field work must be clear for all participants. Likewise, delimitation of what is considered academic activity and what is leisure activity. NTNU has no responsibility for leisure activities.
- Participants should have their own accident and travel insurance.

FIELD-CARD FOR PARTICIPANT

Name: _____

INFORMATION ABOUT THE PROJECT:
Project name/objective: _____

Where: _____ Duration: From: _____ To: _____

NAME OF PERSON IN CHARGE OF THE PROJECT: _____

NEXT-OF-KIN (name, address, phone number):

☐ I confirm that I have read the NTNU guidelines for fieldwork, field courses, research cruises, on-site inspections and excursions

☐ I confirm that I will comply with the safety routines that apply to the project, and that I will not engage in behaviour that might jeopardise my own safety or the safety of others during any part of the project

PLACE/DATE: _____ SIGNATURE: _____

The completed card must be stored on the department's premises

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Field work

Conduct of fieldwork

- YOU have a personal responsibility for your own safety.
- YOU have to be aware of your limits and notify the person in charge if you do not feel safe concerning tasks involved in the field work.
- Supervisor/ professionally responsible shall ensure that security practices etc. are evaluated and adjusted when necessary.

Personal protective equipment

Use certified protective equipment appropriate for the different working operations

Personal protective equipment

Working environment act:

Worker shall use mandatory protective equipment, be attentive and otherwise contribute to preventing accidents and health risks.

Failure to comply with this instruction could lead to suspension from the lab.

Eye protection

Instructions for the use of eye protection at NT-faculty:

http://www.nt.ntnu.no/innsida-dokumentlager/HMS/oyeverninstruks-12-08.pdf

Eye protection shall be used:

- When specified in the safety data sheets for chemicals.
- When this is specified in the devices safety card.
- When there is risk of splashes and when working with liquid nitrogen, pressure and mechanical work with risk for eye damage.
- Labs where eye protection is mandatory, are marked with this sign →

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Eye protection

Different types of eye protection for different work operations

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Hearing protection

Different types of hearing protection for different purposes

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Gloves

When selecting type of gloves, you should pose several questions:

- What type of work shall the gloves be used for?
- What shall the gloves protect against?
- For how long time will they be used?

Read more about this in the laboratory handbook!

Clothing

Laboratory coat

- Should be made of cotton
- Should be whole and clean!

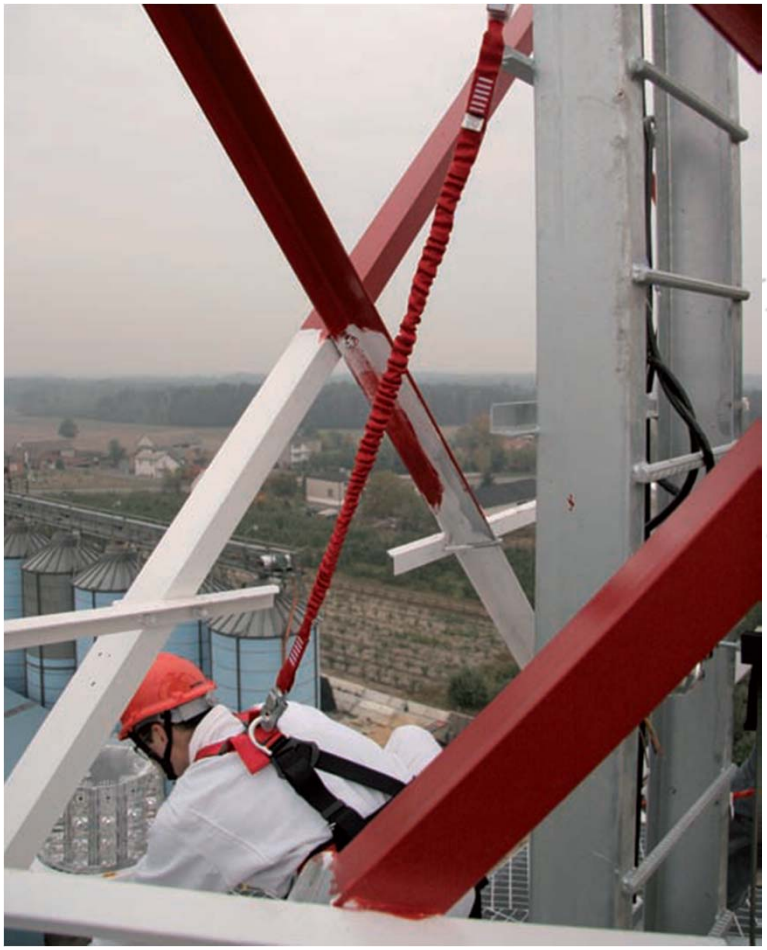
Working clothes and shoes

- Adapted for different purposes

Special protective equipment

Examples:

- Laser safety goggles
- Respiratory protective equipment
- Helmet
- Fall protection safety equipment



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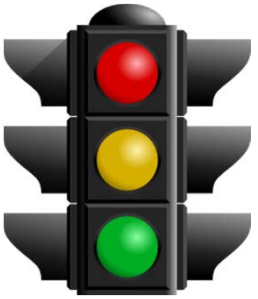
Risk assessment



Risk assessment shall be carried out:

- Prior to a specific working task or process
- Prior to significant changes in an existing activity

Necessary measures revealed by the assessment process shall be carried out before starting work

Risk assessments shall be documented in writing

Risk assessment of master thesis

- Prior to master thesis work a risk assessment shall be carried out as part of the application/plan.
  The written assessment will become a part of the thesis
  - Details of this procedure is not yet finally decided by the faculty
- The assessment shall be done in cooperation with your supervisor. Also, the HSE-coordinator and others at the departments can give advices on how to carry out the assessment.
- Risk assessment is meant to inspire both students and supervisor to improve safety in laboratory work
- Knowledge of risk assessment is vital in working life and is an important learning objective at NTNU

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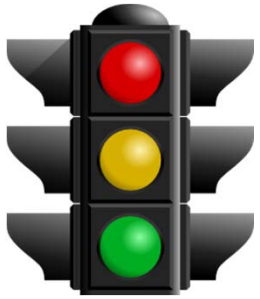
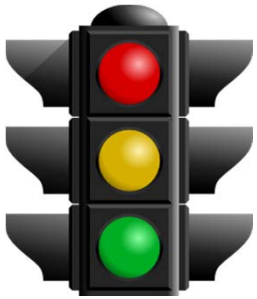
Purpose of risk assessment



- Better understanding of risk aspects of your own activity
- Reducing the probability of accidents and long-term exposure to hazardous substances, etc
- Reducing any consequences of accidents if they, despite the safety measures, occurs.
- Focusing systematically on safety issues
- Documentation of risk aspects
- Fulfilling legal requirements from authorities

In a risk assessment you shall consider:



- What can possibly go wrong?
- What are the chances of things to go wrong?
- What could be the consequences?
- What measures can we take to reduce the risk?
  - Avoiding the incidence, or minimize the potential consequences

The risk assessment includes identifying all the existing safety measures:

- Guidelines and instructions, mandatory training before use, mandatory protective equipment…….
- Previously performed risk assessments?

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Tools for risk assessment

- Form for describing the working task and identifying risky aspects
- Form for describing and evaluating the risks (the «main» form):
  - probabilities, consequences, safety measures, etc.
- Risk «matrix», acceptance criteria
  - What are the acceptable risk levels? («ok», «to be considered», «not acceptable»)

Forms:

NTNU HMS	Kartlegging av risikofylt aktivitet	Utarbeidet av	Nummer	Dato
		HMS-avd.	HMSRV2601	22.03.2011
		Godkjent av	Side	Erstatter
		Rektor	1 av 1	01.12.2006

Enhet: **Dato:**

Deltakere ved kartleggingen (m/ funksjon):

Kort beskrivelse av hovedaktivitet/hovedprosess:

ID nr.	Aktivitet/prosess	Ansvarlig	Eksisterende dokumentasjon	Eksisterende sikringstiltak	Lov, forskrift o.l.	Kommentar

NTNU HMS/KS	Risikovurdering	utarbeidet av	Nummer	Dato
		HMS-avd.	HMSRV2603	04.02.2011
		godkjent av	side	Erstatter
		Rektor	1 av 1	9.2.2010

Enhet: **Dato:**

Linjeleder:

Deltakere ved risikovurderingen (m/ funksjon):

ID nr	Aktivitet fra kartleggings-skjemaet	Mulig uønsket hendelse/ belastning	Vurdering av sannsyn-lighet (1-5)	Vurdering av konsekvens: Menneske (A-E)	Ytre miljø (A-E)	Øk/ materiell (A-E)	Om-dømme (A-E)	Risiko-verdi	Kommentarer/status Forslag til tiltak

Sannsynlighet
1. Svært liten
2. Liten
3. Middels
4. Stor
5. Svært stor

Konsekvens
A. Svært liten
B. Liten
C. Moderat
D. Alvorlig
E. Svært alvorlig

Risikoverdi (beregnes hver for seg):
Menneske = Sannsynlighet x Konsekvens Menneske
Ytre miljø = Sannsynlighet x Konsekvens Ytre miljø
Økonomi/materiell = Sannsynlighet x Konsekvens Øk/matriell
Omdømme = Sannsynlighet x Konsekvens Omdømme

Risk matrix - acceptance criterias:

KONSEKVENS						
	Svært alvorlig	E1	E2	E3	E4	E5
	Alvorlig	D1	D2	D3	D4	D5
	Moderat	C1	C2	C3	C4	C5
	Liten	B1	B2	B3	B4	B5
	Svært liten	A1	A2	A3	A4	A5
		Svært liten	Liten	Middels	Stor	Svært stor
		SANNSYNLIGHET				

Red	Not acceptable risk. Measures must be taken to reduce the risk before allowing the work to start
Yellow	In doubt - to be considered further. If reasonable measures are available, they shall be taken
Green	Risk acceptable. No measures necessary.

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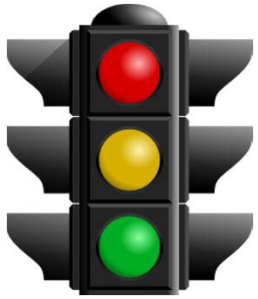
Further information



Unfortunately, some guidelines, forms, etc, are, at the moment, only available in norwegian

https://innsida.ntnu.no/wiki/-/wiki/Norsk/Risikovurdering

Fume cupboards (ventilation cabinets)

Fume cupboard is the most important protective device in the laboratory.

- Fume cupboard shall prevent the inhalation of hazardous and irritating vapors and particles.
- Proper functioning of the cabinet and **correct use** is essential for the necessary protection to be achieved.
- For some types of equipment and work processes, different types of ventilation hoods are used. Make sure that necessary protection is achieved.

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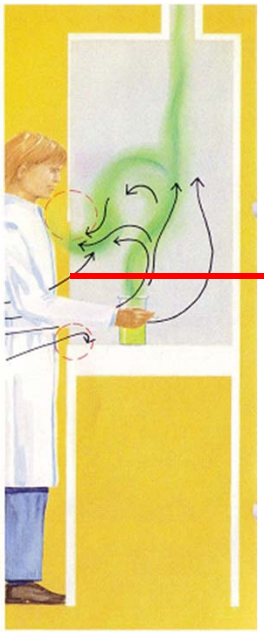
Correct use of fume cupboards

- Make sure that the cabinet is turned on. Learn how to operate the control panel.
- Remove all you don't need while working (equipment, bottles…). Objects will prevent free airflow and can create turbulence causing risk of leakage.
- Highest working opening is 30 cm. This is marked on the fume cupboard. Higher opening increases the risk of leakage. The risk will vary with the gravity and vapor pressure of different vapors.

No,
no,
NO



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Correct use of fume cupboards

- Work with calm movements and so deep in to the cabinet as possible(minimum 15-20 cm and in the center) to avoid turbulence and risk of leakage.
- Avoid traffic in close proximity to the cabinet while you work. The air current from a passing person may lead to leakage from the cabinet. Close doors and windows near by the cabinet.
- **Slide the hatch down after use**. This is very important in order to utilize the ventilation capacity for best possible functioning of all cabinets. It is also important with respect to prevent leakage of chemical vapors and in order to save energy.
- Ask the HSE-Coordinator at the department if you have questions about fume cupboards.

Sterile- and Safety cabinets

- See Laboratory Handbook for description of different types.
- **Sterile cabinets:** A laminar flow of filtered air (particle-free, sterile) is blown across the work surface to protect the sample/product. Does not protect the operator.
- **Safety cabinets, class II**: Sterile filtered air is circulating in the cabinet. Both operator, product and environment is protected from contamination.

Sterile cabinet

Safety cabinet class II

Safety cabinets

- **Safety cabinets class II** shall provide the operator a high level of protection against exposure to e.g. infection from biological agents.
- This requires **correct use**. As for fume cupboards it is very important that the airflow is not obstructed to avoid turbulence and danger of leakage. Training shall be given.
- Work surfaces shall be disinfected before and after use. Many cabinets have UV light disinfection.
- Air outlet from the cabinet can be connected to the ventilation system or filtered air is expelled to the room. The latter type must not be used for work that involves chemicals that require ventilation.
- See Laboratory handbook.

Alarms and measuring equipment

Gas detector/ alarm for personal use

Measurement of UV radiation

Measurement of airflow in ventilation cabinets

Gas detector/ alarm for installation in the lab- alerts alarm center

Measurement of ionizing radiation

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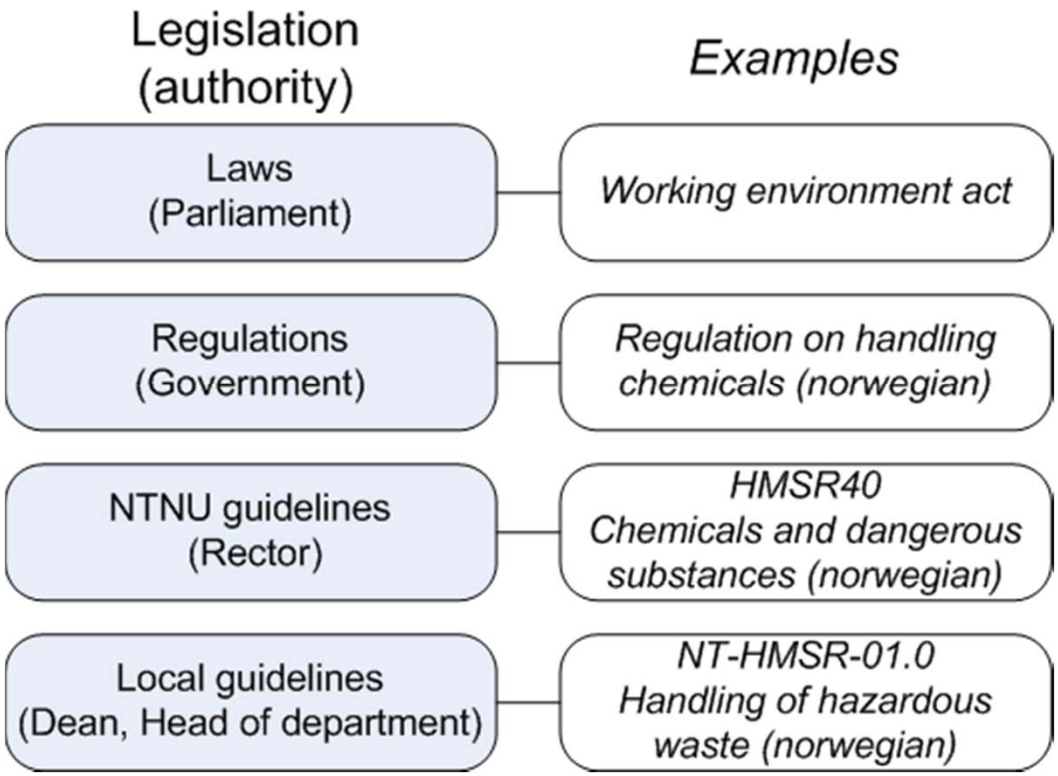
Administrative protective measures

- *Legislation and guidelines*



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Administrative protective measures - Important documents

Safety card	Bills at entrances showing names of the Head of dept, HSE-coordinator, safety representative
Room card	Bills outside entrances to laboratories showing vital information on safety issues to fire fighters and others
Apparatus card	Bills situated by the instruments telling who is responsible, what to do in emergency situations, etc.
Operating instructions	How to perform a working task or using an instrument. Copies available in the lab.
Risk assessments	Documentation of risks. Copies available in the lab.
Safety data sheets	Safety information on dangerous substances. Copies available in the lab.
Records of substances and products	Electronic archive on dangerous substances (EcoOnline). Read access for all people at NTNU.

Administrative protective measures
- Qualifications and training

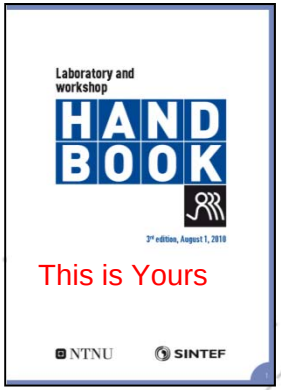
- Courses given by NTNU, HSE dept.
- Special courses outside NTNU
- Local courses and training at the faculty, departments
- Self-studies

Where to find information about HSE

Laws, regulations and guidelines for HSE in Norway

- Laws and regulations: www.lovdata.no
- Norwegian Labour Inspection Authority: www.arbeidstilsynet.no
- Climate and Pollution Agency: http://www.klif.no/
- Norwegian Radiation Protection Authority : www.nrpa.no
- Directorate for Civil Protection and Emergency Planning : www.dsb.no

Where to find information about HSE



HSE guidelines at NTNU

HSE-information on **innsida.ntnu.no** is currently mostly in Norwegian. English content is being prepared.

- All HSE guidelines (Norwegian):
  https://innsida.ntnu.no/web/guest/wiki/-/wiki/Norsk/HMS+retningslinjer+-+samleside
- Forms and documents for HSE (Norwegian):
  https://innsida.ntnu.no/wiki/-/wiki/Norsk/HMS+skjema
- HSE at NTNU, objectives and principles for HSE work, HSE-links:
  https://innsida.ntnu.no/hms http://www.ntnu.edu/hse
- HSE guidelines and forms in English:
  http://www.ntnu.edu/hse/guidelines/t
- Laboratory- and workshop handbook (new 2012-08) provides important information and guidelines about laboratory safety.
  http://www.ntnu.edu/hse/labhandbook

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Where to find information about HSE

HSE guidelines and information for NT-faculty (in Norwegian)

- HSE guidelines, HSE organization, HSE training etc.
  https://innsida.ntnu.no/web/guest/wiki/-/wiki/Norsk/HMS+ved+NT
- Emergency preparedness and crisis management at NT:
  https://innsida.ntnu.no/wiki/-/wiki/Norsk/beredskap+ved+nt

Local conditions at the various Departments

Departments have their own guidelines, procedures and documentation that you need to know for the relevant areas:

- ✓ Laboratories, instruments, work processes…….

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Who to ask about HSE-issues?

- Academic supervisor
- Engineer associated with laboratory or team
- Person responsible for instrument / device ("Instrumentansvarlig")
- Person responsible for laboratory ("Romansvarlig")
- HSE-coordinator at the Department
- HSE-coordinator at the Faculty
- Student representative http://nt.studentrad.no/

Head of Department has the overall HSE responsibility

Overview of HSE roles at NT-faculty can be found here

https://innsida.ntnu.no/wiki/-/wiki/Norsk/HMS-roller+ved+NT (in Norwegian)

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