Aalto University
School of Chemical
Engineering

Aalto University School of Chemical Engineering

OCCUPATIONAL SAFETY AT THE SCHOOL

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Edited by:
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FOREWORD

The School of Chemical Engineering conducts research and provides instruction every day in its numerous labs and testing facilities. Occupational safety is crucial to work and job satisfaction. In this case, it is not just a question of one's own safety, but also that of others working in the same room, the same building or even throughout the Otaniemi area. An absolute requirement of our school is that each and every person working and even just visiting here take occupational safety matters into consideration.

This guide standardises occupational safety practices at the School of Chemical Engineering. The occupational safety guidelines that have been in use for the various rooms, areas and buildings of the school serve as the basis for this guide. The aim of this guide is to provide a comprehensive presentation of matters involving occupational safety. Therefore, it is also to be used as a learning resource in the school's student labs. In addition to the guide, various workstations have their own, detailed guidelines based on special regulations concerning each type of work.

We have long given attention to occupational safety, with the first written safety guidelines being laid down in the 1970s. Indeed, this guide has been in the works over the years and decades, with many people contributing to developing its content. Their contribution to the promotion of occupational safety is very much appreciated!

Janne Laine
Professor
Dean of the School of Chemical Engineering

A WORD FROM THE EDITOR

Instruction in occupational safety and its related culture and philosophies help employees in properly handling and dealing with hazardous chemicals. Chemicals are, at any rate, one part of our lives, and we must be able to deal with them well. This guide is not exhaustive and is constantly being updated. Sections on, for example, microbiology and biochemistry, which form their own entity, are not found in the guide. Any suggestions for improvement or correction will be taken into consideration, if necessary.

The handout for a safety course held at the Helsinki University of Technology Laboratory of Inorganic and Analytical Chemistry in 1973 serves as the basis for this guide. It has been revised and updated over the years. In 2000, the guide was expanded to include the Department of Chemical Technology of that time. You are now holding the joint version for the Aalto University School of Chemical Engineering. I would like to thank everyone who helped in the making of this guide.

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1. Sample of a safety data sheet (SDS)
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1 OCCUPATIONAL SAFETY

1.1 Purpose of occupational safety

Occupational safety and its development are based on the strategic goals of a workplace, which is why occupational safety is a comprehensive process that focuses on the work itself, the physical work environment, areas in immediate proximity to a workstation and personnel work management. The goal of the occupational safety function is to ensure mental and physical safety for all personnel working at various workstations as well as to prevent work accident and work-related diseases. In order to achieve these goals, the School must establish the conditions for:

- unimpeded work and learning
- the voluntary development of solution models for problems encountered in the workplace
- the development of organisation operating models
- the development of personnel work management
- integration of occupational safety in the learning process as part of professional skill

1.2 Occupational safety legislation

Regulations concerning work environment safety and health are primary found in the *Occupational Safety and Health Act* (738/2002). Several other ordinances have also been issued under this Act. Regulations concerning the oversight body for monitoring work environment conditions are found in the *Act on the Occupational Safety and Health Administration* (574/1972). Regulations concerning the procedure for monitoring compliance are found in the *Act on Occupational Safety and Health Enforcement and Cooperation on Occupational Safety and Health at Workplaces* (44/2006) and the *Decree on the Supervision of Occupational Safety and Health* (954/1973).

The purpose of the Occupational Safety and Health Act (738/2002) is to: "...improve the working environment and working conditions in order to ensure and maintain the working capacity of employees as well as to prevent occupational accidents and diseases and eliminate other hazards from work and the working environment to the physical and mental health (...) of employees."

As stated in the Act: "This Act applies to work carried out under the terms of an employment contract and to work carried out in an employment relationship in the public sector or in comparable service relation subject to public law." The Act also applies to: "...work done by apprentices and students in connection with education." Educational institutions, where the Occupational Safety and Health Act applies to work performed by students, are listed in the *Decree on compensation for accidents during study* (851/1948). In addition to this, the *Act on compensation for injuries or diseases sustained during practical training associated with studies* (1318/2002) applies to students.

In applying the Act on Occupational Safety and Health, any student performing work at an educational institution is considered an employee. In this case, members of the faculty are considered employer representatives. The administrative organs of the educational institution can be considered the employer.

1.2.1 Obligations

Under the Act on Occupational Safety and Health (738/2002):

The employer:

- is obligated to ensure the safety and health of its employees at work, by taking the necessary measures. To this end, the employer must take into consideration items related to work, working conditions and other areas of the work environment as well as the personal requirements of its employees.
- must constantly monitor its work environment, the state of the work community and the safety of work practices. The employer must also examine the impact of any measures taken on work safety and health.
- must ensure that all safety and health measures are taken into consideration as needed in every aspect of the organisation's operations.

Employees:

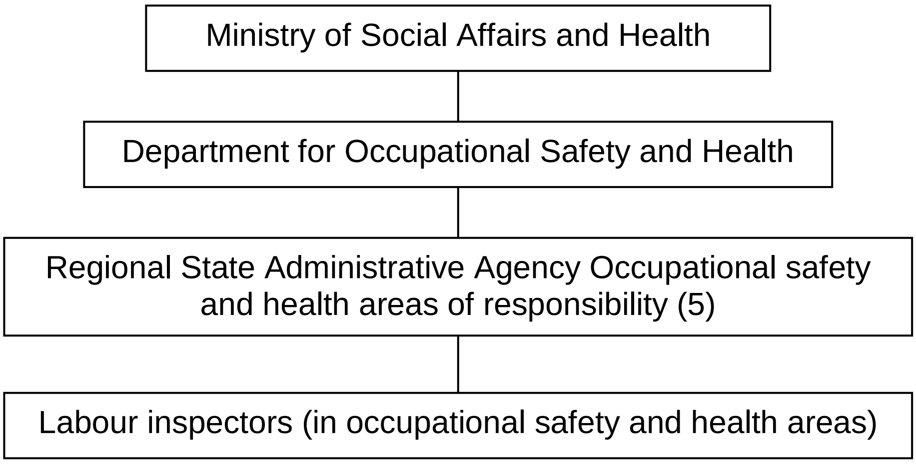
- must comply with all regulations and guidelines set forth by the employer in accordance with its authority. Employees must also maintain order and cleanliness as well as exercise care and caution in order to preserve the level of safety and health required for their work and working conditions.
- must ensure their own safety and health as well as that of other employees, using any means at their disposal and in accordance with their own experience, training and guidance received from the employer, and their professional skill.
- must refrain from engaging in the harassment of other employees or any other improper treatment, which may pose a threat to their safety or health.

The employer and employees must jointly maintain and improve occupational safety and health. Furthermore, it is required that the Occupational Safety and Health Act and related regulations be posted for all employees to see.

1.2.2 Regulatory oversight

The *Act on Occupational Safety and Health Enforcement and Cooperation on Occupational Safety and Health at Workplaces* (44/2006) applies to work performed under employment agreements and collective agreements for public servants. Application of the Act to other work is specified separately by decree. The diagram shown here (Diagram 1) presents the administrative hierarchy for occupational safety.

Diagram 1. Occupational safety administrative hierarchy



Labour inspectors conduct inspections at workplaces. As stated in Act 44/2006: "Workplace inspections shall be carried out as frequently and efficiently as is necessary for effective enforcement."

As stated in the Act: "The employer shall nominate his representative (occupational safety and health manager) (see section 1.3.5) (...) to take necessary measures to organise cooperation between the employer and the employees s and to maintain such cooperation in the workplace, as well as to contribute to the development of occupational safety and health cooperation."

"At workplaces where at least ten employees work regularly, the employees shall from among themselves choose an occupational safety and health representative and two vice representatives (see section 1.3.6) to represent them...". Clerical personnel are also eligible to do so. Representatives are selected by election primarily for a period of two calendar years. At workplaces with over twenty employees, an occupational safety and health committee, which includes employer, employee and clerical representatives, shall be formed.

The employer is required to post at the workplace the Act on Occupational Safety and Health Enforcement and Cooperation on Occupational Safety and Health at Workplaces (44/2006) and related regulations as well as the name and contact information for the applicable occupational safety authority, occupational safety manager for all employees to see.

1.3 Occupational safety chain of responsibility

Because educational institutions generally have a "line organisation", occupational safety is considered a normal part of the line organisation functions under the Occupational Safety and Health Act (738/2002). The occupational safety and health function is supervised by line administration in accordance with its duties and authorities. Its responsibilities are specified in accordance with the Occupational Safety and Health Act and the various line organisation supervisors, teachers, project managers and team leaders are responsible for providing occupational safety, work orientation and work instruction for their respective areas and personnel. The delegation of responsibilities in occupational safety and health is determined according to the duties assigned in the line organisation, supervisor/subordinate relationships and job descriptions. Part of each profit centre is responsible for overseeing occupational safety and health in its respective area. Other parts of the profit centre are taken into consideration when making decisions involving occupational safety.

1.3.1 Administration

The educational institution administration should adopt a positive attitude towards the development of occupational safety functions and the work environment. The administration is responsible for ensuring that the appropriate occupational safety guidelines and plans are in place to establish safe and healthy working conditions. The administration is also responsible for ensuring that finances are in order and there are sufficient personnel, skill and time resources for the safe performance of work and development of the work environment.

The Occupational Safety and Health Act (738/2002) requires the following of the administration:

- "If an employee works alone and as a result the work entails evident hazards or risks to the employee’s safety or health, the employer shall ensure that the hazard or risk is avoided or minimized while the employee is working alone. The employer shall also, considering the nature of the work, provide an opportunity for necessary communication between the employee and the employer, the representative appointed by the employer or other employees. The employer shall also ensure that there is an opportunity to summon help."
- "The order and cleanliness required by safety and health shall be ensured in workplaces."
- "The means of access, passages, means of egress as well as rescue access routes, work platforms and other areas where employees move due to their work shall be safe and they shall be kept in a safe condition."
- "There shall be enough satisfactory air to breathe at workplaces. The ventilation of workplaces must be appropriate and effective enough."
- "If airborne impurities, such as dust, smoke, gas or vapour, occur in a workplace to a degree which is injurious or disturbing to the employees, their spreading shall, as far as possible, be prevented by isolating the source of impurity or by placing it in a closed space or equipment. The airborne impurities shall be collected and removed to an adequate degree by means of appropriate ventilation."
- "Employees’ exposure to chemical agents that cause hazards or risks to safety or health shall be reduced to such a level that no hazard or risk from these agents is caused to the employees’ safety or health or reproductive health."
- "Special caution shall be exercised when handling, storing or transferring explosive, flammable or corrosive substances or other substances involving similar hazards. The employees shall be given such information on dangerous substances that is necessary considering the working."
- "The employees shall be given necessary instructions on the use of (alarm, fire safety, life saving and rescue systems and equipment), as also in the case of fire, drowning or other risk. Instructions shall also be given regarding the measures to be taken in the case of fire, taking the conditions in the workplace into consideration. When necessary, the instructions shall be kept available in the

workplace for inspection by the employees. When necessary, exercises shall be arranged."

1.3.2 Supervisors

Supervisory personnel bear a great deal of responsibility in overseeing occupational safety and health at an educational institution. This should be taken into consideration in orientation, work instruction and guidelines, training and, for example, earning hot work permits (see section 4.2). Supervisors immediately notify all involved parties of any hazards present and take the necessary measures. Communication is further emphasised in situations where a hazard has been detected or there is a threat of one. Supervisors are also required to submit written reports on all close call situations to the occupational safety and health organisation of the educational institution. A sample report form can be found in Appendix 2.

1.3.3 Technical, laboratory or responsible personnel

The technical and/or laboratory or responsible personnel at an educational institution oversees and co-ordinates procurement services and their local work supervision, repair operations, common areas, office facilities, sample production areas, chemical and equipment usage, portable fire extinguishing equipment, occupational health care and other official co-operation, notification obligation for substances hazardous to the health, procurement of non-bulk supplies and related occupational safety functions. Technical, laboratory or responsible personnel also serve as an advisory group that unites and co-ordinates various occupational safety personnel functions as well as provides training and guidance. Technical, laboratory or responsible personnel are also in charge of co-operation with inspecting authorities and government agencies in conducting various inspections and safety inspections on behalf of the educational institution. This co-operation comprehends matters involving, for example, occupational safety, training, first aid, electrical equipment, fire safety, radiation use, chemical use, powder use and wastewater emissions.

1.3.4 Personnel

All educational institution personnel must work in accordance with set guidelines in a safe manner, ensuring that the performance of their work will not pose any danger to other personnel, the environment, equipment or property. All set guidelines and safety regulations are to be observed. All personnel must comply with the following stipulations in the Occupational Safety and Health Act (738/2002):

- "Employees shall without delay inform the employer and the occupational safety and health representative of any such faults and defects they have discovered in the working conditions or working methods, machinery, other work equipment, personal protective equipment or other devices which may cause hazards or risks to the employees’ safety or health. Employees shall, in accordance with their experience as well as the instruction and guidance provided by the employer and according to their occupational skills and opportunities, eliminate such faults and defects they have discovered which cause evident hazards. An employee must give the report referred to above also in the case that he or she has eliminated or remedied the fault or defect."

- Employees shall use and care for the personal protective equipment and other equipment the employer has provided for them (...). Employees shall in their work wear such appropriate clothing that does not cause a risk of injury."
- "Safety devices or guards installed in machinery, work equipment or other device or a building shall not be removed or disconnected without a special reason. If an employee, owing to the work task, temporarily has to remove a safety device or guard, he or she must restore or reconnect it as soon as possible."
- "Machinery, work equipment or other devices shall be used, maintained, cleaned and serviced appropriately."

1.3.5 Occupational safety and health manager

Educational institutions must have a mandatory occupational safety and health manager. Their duties are determined according to what is required by the Act on Occupational Safety and Health Enforcement and Cooperation on Occupational Safety and Health at Workplaces (44/2006) and workplace occupational safety and health function. The occupational safety and health manager assists with and advises the educational institution line organisation on occupational safety and health matters and handles all occupational safety and health connections with various authorities.

1.3.6 Occupational safety and health representatives

The duties of occupational safety and health representatives are determined according to what is required by the Act on Occupational Safety and Health Enforcement and Cooperation on Occupational Safety and Health at Workplaces (44/2006) and valid agreements. Occupational safety and health representatives co-operate with all groups in the development of healthy and safe working conditions and methods.

Occupational safety and health representatives and vice representatives are experts in their respective areas. They are familiar with the working conditions and hazards of their area. Occupational safety and health representatives have an obligation to address any failure to comply with occupational safety and health guidelines as well as provide advice and guidance on the use of safe work practices. Occupational safety and health representatives conduct inspections in their area together with supervisors. An inspection report, which contains information on any shortcomings found, the timetable for taking necessary measures and the person responsible, is drafted. The report is submitted to the supervisor and occupational safety and health manager.

1.4 Occupational safety and health co-operation

Occupational safety and health involves a great deal of co-operation with various parties, such as permanent co-operation with occupational health care (occupational risk assessments, ergonomics, etc.) as well as various authorities and service providers, such as fire departments, environmental agencies, occupational safety organisations, security providers, training providers and waste management services. Occupational safety co-operation involving occupational safety and health at educational institutions is handled by technical personnel, which also monitors and co-ordinates this co-operation.

1.4.1 Training

The goal of training and guidance is to manage risks related to work environment practices as well as ensure the use of safe operating methods in the performance of work. Thorough familiarisation, work guidance and, for example, a hot work permit and Occupational Safety Card provide a solid foundation for safe work.

1.4.2 Occupational health care

Current legislation (e.g. *Occupational Health Care Act* (1383/2001) and *Government Decree on the principles of good occupational health care practice, the content of occupational health care and the qualifications of professionals and experts* (708/2013)), official regulations and related agreements are observed in occupational health care. As stated in Government Decree 708/2013: "The aim of occupational health care is to ensure that the work, the working environment and the workplace community are healthy and safe, to prevent work related health risks and problems and to maintain, promote and monitor the health, working capacity and functional capacity of employees at the different stages of their working careers."

As stated in the Occupational Health Care Act (1383/2001): "The employer shall have a written occupational health care action plan, which shall include the general aims of occupational health care (...) (the need for) occupational health care professionals and experts (...) which are used to promote the prevention of work-related illnesses and accidents, the healthiness and safety of the work and the working environment, the functioning of the workplace community and the health, working capacity and functional capacity of employees." This function involves, among others, an occupational safety action plan, which is approved on an annual basis.

1.5 Compensation for work accidents and occupational diseases

Under social insurance legislation, employees are eligible to receive compensation for any financial losses resulting from work accidents and work-related diseases. The laws pursuant to this include the *Employment Accidents Insurance Act* (608/1948) and *Act on Occupational Diseases* (1343/1988) and related *Decree on Occupational Diseases* (1347/1988).

The employer is required to take out insurance for its employees from an accident insurance provider. In the event of an accident, the injured party must be taken for medical treatment as quickly as possible. An accident/occupational disease report must be submitted to the insurance provider, and the injured party must be given an insurance certificate, which is used to receive medical treatment and medicine free of charge. The recipient of compensation must provide an honest and accurate explanation concerning the accident and agree to the course of treatment given by the physician. All employees must observe set safety regulations and guidelines in the performance of their work. Failure to do so may result in a loss of compensation.

Insurance coverage specified in the Employment Accidents Insurance Act (608/1948) applies to students and employees working on an educational institution project on its premises as well as during trips between their place of residence and the workplace.

1.5.1 Student accidents

The Act on compensation for injuries or diseases sustained during practical training associated with studies (1318/2002) and Decree on compensation for accidents during study (851/1948) state that accidents occurring in laboratory or field work or other practical training work resulting from conditions specific to the type of study involved will be compensated as a work accident, provided that the studies take place at a school, institution or course of instruction specified or implied in the Act and Decree in question. Under Act 1318/2002, insurance coverage does not apply to a student's theory studies, such as during lectures on educational institution premises or independent study or during trips between the place of study and place of residence, unless the student is participating in practical training associated with the applicable curriculum or degree studies, an on-the-job learning programme, work internship or competence-based qualification at the educational institution or any other location designated by the educational provider or administrator. Compensation is determined in the same manner as for work accidents. The student's annual income, based on which the compensation amount is determined, must, however, be defined as the amount the student in question would have probably earned following graduation.

1.5.2 Scholarship employee

Scholarships do not automatically include insurance coverage, but some scholarship granters have taken out their own insurance for scholarship recipients. It is a good idea to confirm whether insurance coverage is provided and, if necessary, take out a personal insurance policy.

1.6 Guidelines for occupational safety

Technical personnel at the educational institution are responsible for setting guidelines.

1.7 Emergency plan

The *Rescue Act* (379/2011) states that: "An emergency plan shall be drawn up for a building or other site which, with regard to evacuation safety or rescue operations, is exceptionally demanding or where the risk to the safety of persons or to fire safety or the risk to the environment or cultural property, or the damage caused by any accident, may be considered serious. The drawing up of the emergency plan is the responsibility of the occupant of the building or the site."

The emergency plan shall contain the details of:

- the conclusions on the assessments of the dangers and risks;
- the safety arrangements of the building and the facilities used for the operations carried out in the building or at the site;
- the instructions for building residents and other persons on how to prevent accidents and what action to take in accidents and dangerous situations;
- any other measures related to self-preparedness at the site.

1.8 Risk assessment

As stated in the Occupational Safety and Health Act (738/2002): "The employer shall, taking the nature of the work and activities into account, systematically and adequately analyse and identify the hazards and risk factors caused by the work, the working premises, other aspects of the working environment and the working conditions and, if the hazards and risk factors cannot be eliminated, assess their consequences to the employees' safety and health. When doing so, the following matters must be taken into account among other things:

- the risk of injury and other illness;
- any accidents, occupational diseases and work-related illness and hazardous incidents at the workplace;
- the employees' age, gender, occupational skills and other personal capacities;
- factors related to workload; and
- the potential risks to reproductive health.

Technical and/or laboratory or responsible personnel are in charge of assessing risks at the educational institution. Identification of hazards and risk assessment provides a basis for identifying and specifying focal points for occupational safety functions as well as for performing work, laboratory work and exercises. A hazard assessment is conducted to evaluate and determine the hazards specified in the Occupational Safety and Safety Act (738/2002).

Personal protective equipment needed at the workplace have also determined in assessing risks (see section 5). The required personal protective equipment must be procured for all employees and students, whose safety and health must be preserved in the performance of work. Risk assessment and analysis are conducted systematically at least once a year and, if necessary, whenever work practices change. Employee sick leaves, work accidents, work-related diseases and workplace conditions should be monitored together with various co-operative partners. If any problems arise, they are dealt with immediately. Occupational safety performance is monitored in annual self-assessments conducted in connection with the risk assessment, with the necessary recommendations for improvement being made to the educational institution administration.

1.9 Student and project personnel guidance

Under the Occupational Safety and Health Act (738/2002), educational institution personnel serving as supervisors/teachers are responsible for employee and student orientation, work instruction and guidance. Orientation or work instruction is provided in accordance with a personal orientation plan, wherein the supervisor, teacher, adviser or proctor determines the need and content of the orientation or work instruction and specifies the provider of the orientation. Although orientation can be provided by a highly skilled, experienced professional in the field, such as a laboratory foreman, laboratory technician or experienced, trained project employee, supervisors are still in charge of orientation. In orientation and work instruction, it is a good idea to use an apprenticeship approach until the desired level of expertise has been achieved and the student or new employee is capable of working independently. If necessary, orientation is always provided when an employee is performing a new work task.

1.9.1 Students protective equipment in training

The teacher providing instruction at the educational institution is responsible for ensuring that students have the personal protective equipment required for study and by occupational safety legislation in laboratory and training work. In accordance with Ministry of Education and Culture *Decree on Grounds for Fees Collected from Pupils and Students* (1323/2001), a fee may be charged for this protective equipment. In connection with the hazard assessment, the teacher providing instruction at the educational institution makes the necessary plans for the procurement and use of personal protective equipment at each workstation and in training work. Technical or responsible personnel procure the necessary personal protective equipment.

1.9.2 Injury to a third party caused by a student

As stated in the *Tort Liability Act* (412/1974): "If a student in an educational establishment causes injury or damage while at work pertaining to the instruction, he/she shall be liable for damages..." The student: "...shall be liable in damages for injury or damage caused by him/her through an error or omission at work to an amount deemed reasonable in view of the extent of the injury or damage, the nature of the act, the status of the person causing the injury or damage...". "If the negligence of the employee has been merely slight, he/she shall not be rendered liable in damages." "If the injury or damage has been caused deliberately, full damages shall be awarded unless it is deemed that there are special reasons for reducing the damages."

1.10 Pregnancy

Regulations under the Occupational Safety and Health Act (738/2002) require safe working conditions where reproductive health is concerned. In accordance with Government decision 1043/1991 (*Work-related risks posed to a person's genome, foetus and reproduction*), pregnant employees may not be exposed to any chemical, physical or biological agent that poses a danger to foetal development or pregnancy (see section 3.4.1). The primary means of protecting employees are to replace hazardous substances or methods with harmless ones, minimise the amount and duration of exposure, structural or other technical preventive measures, and use personal protective equipment. If the work environment hazard cannot be eliminated, every effort should be made to reassign the employee. If there is no other work available for reassignment, the employee is entitled to a special maternity allowance period under the *Health Insurance Act* (1224/2004). More information on the special maternity allowance period can be found on the Social Insurance Institution of Finland (Kela) website (http://www.kela.fi/web/en).

Under Government decision 1043/1991, the employer is required to notify the employee of any danger posed to foetal development or pregnancy, if there are agents used or present in the workplace that may pose this kind of danger. In work of this nature, the pregnant employee is required to notify her employer of the pregnancy, either directly or through the occupational health care staff, so that the employer can take the necessary measures specified in the above Government decision.

2 HAZARDS IN THE LABORATORY AND WORKPLACE

Work accidents are most commonly caused by pieces and objects, such as projectiles and fragments as well as loads that must be lifted and moved. The most common types of accidents involve slipping and stumbling, injuries caused by objects, falling and physical overload. The injuries most commonly caused by accidents are twists and sprains, scratches, cuts and bruises.

Statistically rare, but serious work accidents occurring in laboratories involve fire, explosions, electricity and radiation as well as poisoning. Eye injuries caused by, for example, corrosive substances or glass shards are very serious and, unfortunately, also relatively common. Approximately 80% of the minor, but frequent laboratory injuries reported in Finland include cuts caused by glass, skin injuries caused by contact with corrosive substances or extremely hot or cold liquids, cuts and bruises caused by machinery and tools as well as falls and slips.

2.1 Chemical hazards

The health and safety hazards of chemical substances can be either *direct* (section 3.12) or *indirect* (section 3.13). This is taken into consideration in nearly every classification and labelling system specified in national chemical legislation. Direct hazards are when chemical substances hazardous to the health can enter the body or otherwise come into contact with human tissue. Indirect hazards comprehend the properties of chemical substances other than those directly hazardous to the health, such as the impact of incidents involving burning, explosions and corrosion on people. Chemical safety is explained in greater detail in section 3.

According to the *Chemicals Act* (599/2013), in order to prevent exposure to the harmful effects of chemicals, the user must, whenever it is reasonable to do so, choose an existing chemical or method that poses the least amount of risk.

2.2 Physical hazards

Physical hazards involve the impact that various forms of energy have on employees and their health. Major physical hazards include noise and vibration, radiation, cold and hot conditions, electricity and insufficient lighting.

2.2.1 Noise

Noise is disturbing or harmful to hearing. Noise typically occurs in production, where large amounts of energy are used for either manufacturing or transport. Provisions on noise prevention are found in the *Decree on the protection of workers from the dangers arising from noise* (85/2006). The ear may not be subjected to noise exceeding the exposure limit of 85 dB. Hearing can deteriorate even after a very short exposure to noise. The table below (Table 1) shows time limits, after which the risk of hearing damage is probable after repeated noise exposure. Typical symptoms of noise exposure include:

- blocked sensation in the ears
- ringing in the ears

- struggling to hear and understand spoken words
- constantly turning up the volume on the radio and television
- struggling to hear in noisy environments
- struggling to participate in conversation

Table 1. Risk of hearing damage in repeated exposure to noise.

Noise	Exposure time
85 dB	8 h
88 dB	4 h
94 dB	1 h
97 dB	30 min
103 dB	7 min
109 dB	1.5 min

2.2.2 Vibration

Vibration is the rapid back-and-forth movement of an object. A hand vibration is transmitted to a person's hand, thus causing the risk of accident or illness. A whole-body vibration is transmitted from a platform or seat into a person's body, thus causing the risk of accident or illness. Typical hand vibration symptoms and vibration-induced white finger (VWF), finger numbness and deterioration in grip strength. Whole-body vibrations can result in symptoms in the back.

2.2.3 Radiation

Ionising radiation is a form of energy transmitted as electromagnetic waves or particle radiation. Sources of ionising radiation include radioactive substances and certain types of equipment, such as x-ray machines and particle accelerators. The kinetic energy of individual particles in ionising radiation is strong enough to release electrons from an atom or molecule, thus ionising it. In Finland, the use of ionising radiation is monitored by STUK - Radiation and Nuclear Safety Authority.

Low-energy electromagnetic radiation does not cause ionisation. This kind of *non-ionising* radiation is found everywhere in our work and living environment and is comprised of several very different parts of radiation. These are static electrical and magnetic fields, low and high-frequency electromagnetic fields (e.g. NMR), microwave radiation, optical radiation (e.g. laser), which includes infrared radiation (IR), visible light and ultraviolet radiation (UV). The figure below (Figure 1) shows the different types of radiation.

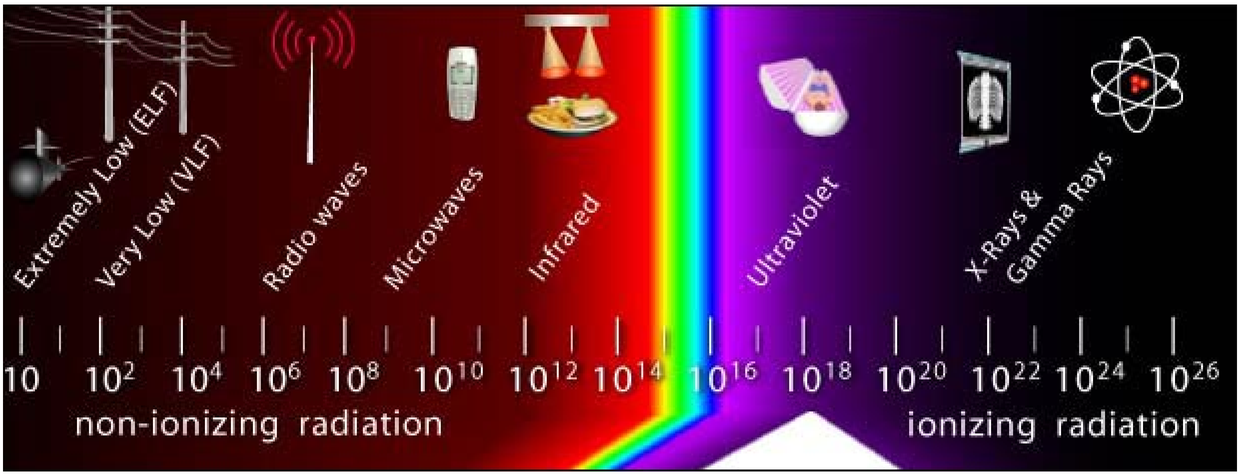


Figure 1. Non-ionising and ionising radiation.

2.2.4 Electricity

The use of electrical equipment involves the risk of electrical faults occurring in the power grid and the equipment itself. A typical electrical accident is an electric shock received from a faulty device. The number of deaths resulting from electrical accidents declined drastically from the 1950s to the early 1990s. At present, there are an average of 3-4 deaths resulting from electrical accidents each year.

2.2.5 Ventilation

Properly functioning ventilation reduces health risks, enhances job satisfaction and improves productivity. Research and development have provided the basis for good indoor air quality planning, by setting target levels for impurities, which are typically 1-10% of the concentrations known to be hazardous, i.e. HTP values (see section 3.10). There should be a continuous investment in the thorough planning of ventilation solutions. A well-executed ventilation system saves on operating costs and improves the quality of indoor air. Ventilation brings air indoors and expels it back out. Air conditioning can also involves air heating, cooling, humidifying, dehumidifying and filtering. A ventilation system serves as the "lungs" of a building, whose purifying effect is targeted at all impurities. Ventilation is the most important technical means for creating pleasant thermal conditions. Ventilation can be divided into two categories: local ventilation (e.g. vapour hood and local exhaust ventilation) and general ventilation. Air impurities should be expelled at the source, thus limiting their spread into the indoor air. Local and general ventilation is used to establish clean air work zones.

2.2.6 Lighting

Insufficient lighting adversely affects the conditions for good work performance by compromising several mechanisms, such as visual acuity, work environment satisfaction, alertness and comfort.

2.3 Biological hazards

Biological agents comprehend micro-organisms, such as bacteria, viruses, moulds, fungi and parasites. These can be found in, for example, a microbiology laboratory. Exposure to these occurs primarily through the respiratory system, skin and digestive tract. Exposure can cause infections in the respiratory system (e.g. pneumonia), digestive tract (causing vomiting and diarrhoea) or on the skin (pyoderma). In addition, exposure to microbial agents may result in hypersensitivity reactions, allergic eye infections, rhinitis, asthma or rashes as well as alveolitis. According to the Register of Occupational Diseases, moulds are the cause of some 200 new occupational diseases each year on average.

The employer is obligated to minimise health hazards, which expose or can expose employees to biological agents at work. This is regulated under, among others, the *Government decree on Chemical Agents at Work* (715/2001) and the Ministry of Social Affairs and Health *Decree on Concentrations known to be Hazardous* (795/2007).

2.3.1 Moisture damage

Exposure to biological agents is also possible in buildings with moisture damage. If the moisture damage and reasons for it are not rectified, bacteria and moulds can thrive on wet structures. This exposes the users of the building to microbial impurities. As much as half of all users of buildings with moisture/mould damage can suffer from symptoms of eye and upper respiratory infections. If this exposure is extended, it may result in an infection cycle of the upper respiratory system and, at worst, the onset of an occupational disease, such as rhinitis or asthma.

2.4 Physical stress and ergonomics

People are subjected to physical stress throughout their lives. An employee is physically stressed when performing work. Stress is necessary to a person's well-being. However, too much or too little may have adverse effects on their health. Stress is affected by the work environment and the performance of work itself as well as the person's mental and physical attributes. The amount of stress depends on the quality, quantity and duration of the stress factors.

Workload can be assessed based on an employee's level of stress. Stress can be seen in: changes occurring in bodily functions, work performance, fault responses, accidents and various feelings. Workload factors that affect an employee's physical health and working capacity include work methods, working positions, the amount of physical strain or attention required by the work as well as the specific attributes of the tools, work environment, work community and employee. Extremely stressful work tasks include load handling and lifting, working at a computer terminal or other jobs that involve difficult work positions. It is often difficult to point to just one reason why a person tires or falls ill.

The goal of ergonomics is to eliminate the friction between the work and employee so that work can be performed more easily, quickly and in a healthy manner. Ergonomic information and functions are needed when adapting work, workplaces, tools, products and work environments to the requirements and demands of people. Ergonomic can be divided into the following areas:

- Physical ergonomics, whose key areas of focus are work positions, materials handling, repetitive movements, work-related musculoskeletal disorders, workplace arrangements, safety and health.
- Cognitive ergonomics, which examines psychological functions, such as perception, memory, decision-making and motor responses, interaction between humans and other elements in a system. Key items in this interaction are mental workload, decision-making, skill performance, human-computer interaction, human reliability, work pressure and education.
- Organisational ergonomics, which examines socio-technical systems, including organisational structure, procedures and processes and optimal performance. Key areas are communications, human resources management, work design, working hour arrangements, teamwork, participative design, co-operation, new work models, organisational culture, virtual organisations, distance work and quality management.

2.5 Mental stress

Workload factors may be qualitative or quantitative in nature, thus resulting in too much or too little stress. Aspects of work affecting mental stress can be related to the amount of work, work community, work organisation, work environment or work content. At the individual level, mental health manifests itself in a desire to do work, with its performance smooth and under control. Well organised and dimensioned work is a pleasure to do, appropriately challenging and provides opportunities for learning and development.

A suitable amount of stress is part of work and does not cause any harm. Conversely, new challenges encountered in work provide a motivation to try. Meeting these challenges produces a feeling of satisfaction and is therefore rewarding. What is decisive here is how intense or long-lasting continuous workload peaks are. Also important is how personally employees experience their success or, possibly, their failure.

Excessive mental stress may lead to burnout. Burnout is an adverse reaction to long-term work stress, which presents as exhaustion, a cynical attitude and decline in professional self-esteem. On the other hand, low self-esteem or a loss of professional self-esteem could also contribute to burnout. Excessive stress compromises a person's ability to deal with a given situation. The person gradually becomes tired and their functional capacity deteriorates, their job satisfaction fades, their attitude becomes more cynical and they begin to lose their sense of control. Finally, there is a collapse in the person's self-esteem and they become exhausted and depressed.

3 CHEMICAL SAFETY

3.1 Chemical legislation

Finnish regulations concerning chemicals are based on the Chemicals Act (599/2013), but also meet the requirements laid out in the Occupational Safety and Health Act (738/2002). Finnish chemicals legislation is based on EU chemical regulations, which are continuously updated (see section 3.1.1). This is the reason why Finnish chemical regulations are also constantly being revised. The Chemicals Act and its related decrees contain regulations concerning the manufacture, import, trade and storage of chemicals that are hazardous to the health and environment. Users of a chemical need information on its composition and properties to ensure its safe use. Information on a hazardous chemical is provided by the chemical manufacturer, importer, distributor or other establishment responsible for placing a chemical on the market, using labels (section 3.7) and safety data sheets (section 3.9).

The registration of chemicals is regulated by the Ministry of Social Affairs and Health *Decree on submitting information concerning chemicals* (374/2002). Chemical information is listed in the Product Register of Chemicals (KETU), which contains information on chemicals classified as hazardous that are available on the Finnish market. KETU contains approximately 850 chemical distributors and information on over 100,000 chemicals, approximately 29,000 of which are available on the market. The Product Register of Chemicals is used by Chemicals Act oversight authorities, the Poison Information Centre and research institutes.

3.1.1 REACH Regulation

The new Regulation No. 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency (EC 1907/2006) entered into force on 1 June 2007. The Regulation is directly binding legislation for all member states. The European Chemicals Agency (ECHA) also began operations in Helsinki. A key goal of REACH is to: "...ensure a high level of protection of human health and the environment as well as the free movement of substances."

The REACH Regulation (EC 1907/2006) applies to: "...substances, on their own, in mixtures, and in articles..." for the duration of their lifecycle. The Decree is applied in the manufacture, import, distribution and use of substances. The Decree provides new procedures for ensuring the safe use of chemicals. A new feature compared to the existing legislation is specification of the intended use of the substances and drafting of "exposure scenarios". Not everything is new: for example, safety data sheets (section 3.9) will remain almost entirely the same.

REACH-compliant procedures are:

- registration
- information in the supply chain
- permit procedure
- prohibitions and restrictions
- classification and labelling

REACH Regulation procedures entered into force on 1 June 2008 and will be implemented in phases (Figure 2) until reaching their full extent by 1 June 2018. Although a majority of the obligations are placed on chemical manufacturers and EU importers, new obligations for downstream users and distributors of chemicals have also been laid out.

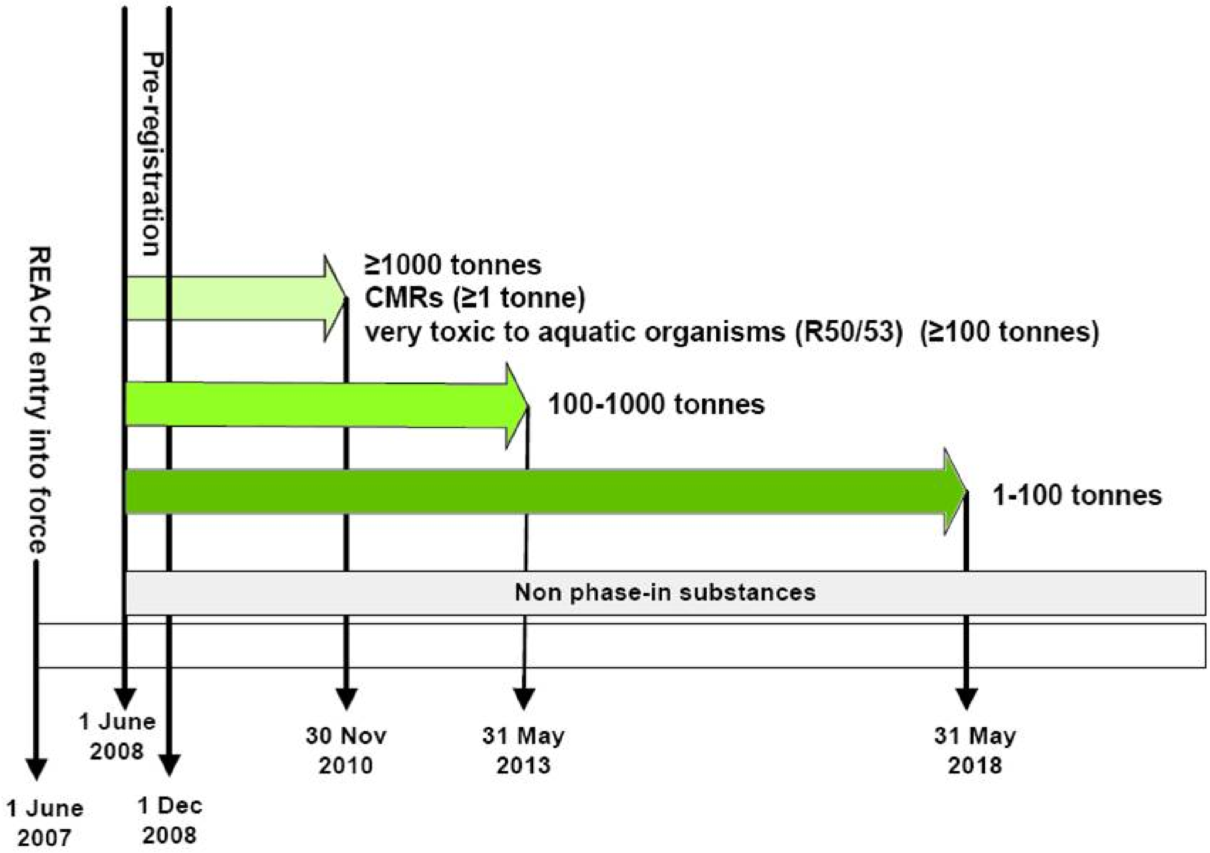


Figure 2 Phased implementation of REACH Regulation procedures

Each and every chemical manufacturer or EU importer is required to register their substances (over 1 tonne/annum) unless they are otherwise exempted from registration. Substances already on the market are to be registered in stages according to the set schedule (Figure 2), while new substances must be registered before being launched on the market. Detailed information and test results on the substance in question must be submitted in connection with the registration. Downstream users of the substance must register its use themselves, if the manufacturer has not registered the intended use in question.

Each and every EU member state has its own national chemical authorities. In Finland, these are the National Supervisory Authority for Welfare and Health (Valvira) and the Finnish Environment Institute (SYKE).

A likely outcome of the REACH Regulation is that some substances will be taken off the market and replaced with others. There are several reasons for this, including:

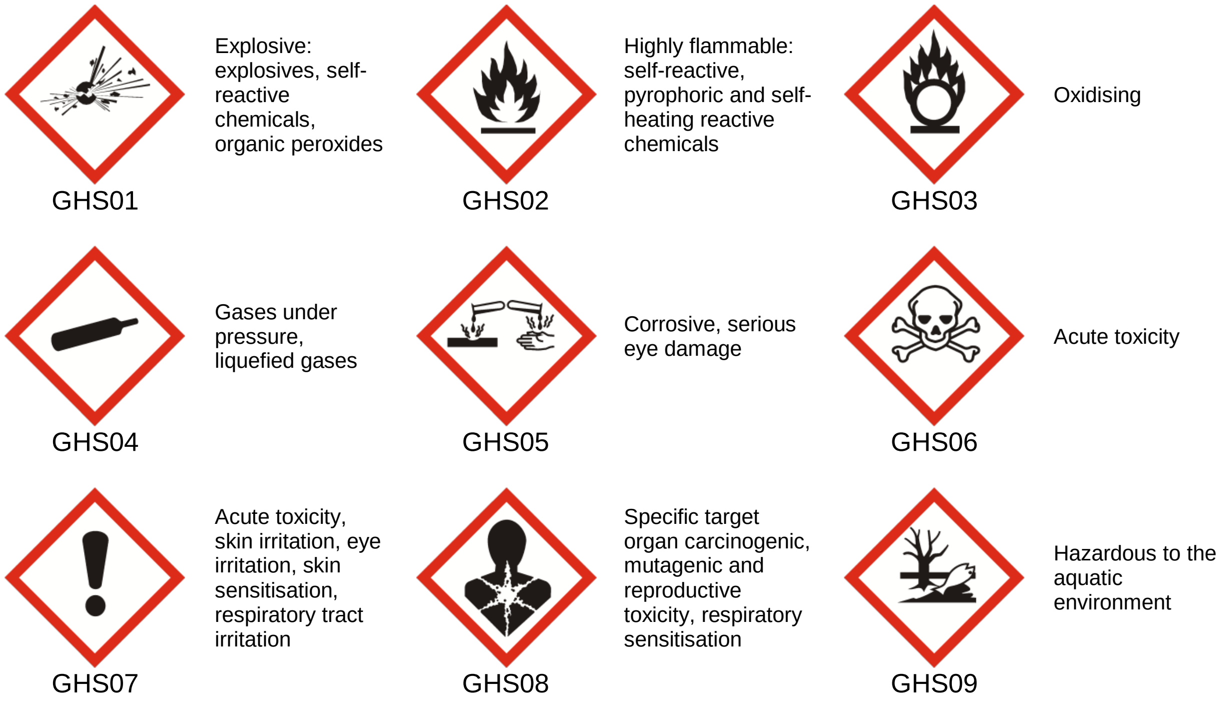
- the pressure to raise chemical prices due to costly testing requirements.
  → This might make the use of some substances unprofitable.
- the manufacture or import of some low-demand speciality chemicals might become unprofitable
- substances subject to authorisation may remain unauthorised entirely or for a specific application

3.2 Globally Harmonised System of Classifications and Labelling (GHS)

The **G**lobally **H**armonised **S**ystem of Classification and Labelling of Chemicals is a system developed under the purview of the UN. The GHS classifies chemicals (substances and preparations) based on their internal properties and uses harmonised hazard communication elements, including labels and safety data sheets. The GHS provides information on physical-chemical properties and hazards to human health and the environment, thus promoting the safe transport, handling and use of these chemicals.

The GHS also offers the opportunity to harmonise chemical regulations globally, thus facilitating trade. The new system, which is continuously being developed, covers both the packaging of chemicals being transported and packaging for use. In terms of its content, the system is based on existing elements. The differences are found in regulatory details.

In Europe, the system is being implemented by Regulation (EC) No. 1272/2008 of the European Parliament and of the Council on **C**lassification, **L**abelling and **P**ackaging of substances and mixtures, i.e. the CLP Regulation. The Regulation entered into effect on 20 January 2009. The Regulation has been applied in phases, so that substances have been classified in accordance with the CLP Regulation by 1 December 2010 and mixtures have been classified beginning 1 June 2015. Labelling compliant with existing legislation (Figure 3) have been used concurrently with CLP Regulation-compliant labelling (Figure 3) until 31 May 2015. CLP Regulation statutes concerning the classification, labelling and packaging of substances and mixtures may, however, have been applied when the Regulation enters into effect.



GHS01	Explosive: explosives, self-reactive chemicals, organic peroxides
GHS02	Highly flammable: self-reactive, pyrophoric and self-heating reactive chemicals
GHS03	Oxidising
GHS04	Gases under pressure, liquefied gases
GHS05	Corrosive, serious eye damage
GHS06	Acute toxicity
GHS07	Acute toxicity, skin irritation, eye irritation, skin sensitisation, respiratory tract irritation
GHS08	Specific target organ carcinogenic, mutagenic and reproductive toxicity, respiratory sensitisation
GHS09	Hazardous to the aquatic environment

Figure 3 GHS-compliant pictograms and their names and numbers

The new pictograms also include various risk and safety phrases as well as hazard statements. The old R and S phrases (cf. section 3.4) have been eliminated with implementation of the CLP Regulation (1278/2008). As the old R and S phrases did, the new phrases or combinations of them also describe the hazard posed by a substance or mixture in *hazard statements* (H) and the prevention of risks posed by their use in *precautionary statements* (P) or other safety-related remarks, such as response procedures, storage and disposal. Additional information on hazard properties, such as physical hazards, environmental hazards or health hazards, can also be provided in supplemental hazard information (EUH codes), which are EU-specific, but not GHS-compliant.

Hazard statements are divided as follows:

H200-H290	Physical hazards
H300-H373	Health hazards
H400-H413	Environmental hazards

Precautionary statements are divided as follows:

P101-P103	General
P201-P285	Prevention
P301-P391	Response
P401-P422	Storage
P501	Disposal

Below are a few examples of the new statements:

H226	Flammable liquid and vapour
H332	Harmful if inhaled
P102	Keep out of reach of children
P263	Avoid contact during pregnancy/while nursing
EUH014	Reacts violently with water
EUH031	Contact with acids liberates toxic gas

The captions used in old pictograms, such as "Toxic" or "Highly flammable" have been removed. A new labelling element, the *signal word*, will be added to the pictograms. If the chemical poses a more severe hazard, the label uses the signal word "Danger", while the signal word for less severe hazards is "Warning".

3.3 Classification of hazardous chemicals (old legislation)

According to the Chemicals Act (675/1993), chemicals are divided based on their hazardous properties and concentration into the following groups: *Chemicals dangerous for health* (section 3.3.1), *Flammable and explosive chemicals* (section 3.3.2) and *Chemicals dangerous for the environment* (section 3.3.3).

3.3.1 Chemicals dangerous for the health

A chemical dangerous for health is:

1. *very toxic*, if it causes death or immediate or chronic harm to the health when inhaled, ingested or absorbed through the skin in minute doses
2. *toxic, if it causes death or immediate or chronic harm to the health when inhaled, ingested or absorbed through the skin in small doses*
3. *harmful,* if it causes death or immediate or chronic harm to the health when inhaled, ingested or absorbed through the skin

4. *corrosive*, if it is capable of destroying living tissue upon coming into contact with it
5. *irritant*, if it is not corrosive, but may cause inflammation through direct, repeated or long-term contact with the skin or mucous membranes
6. *sensitising*, if it can cause an immune system reaction (sensitisation) when inhaled or absorbed through the skin, so that when an individual is exposed to the chemical again it will cause the characteristic adverse effects
7. *carcinogenic*, if it can cause or increase the incidence of cancer when inhaled, ingested or absorbed through the skin
8. *mutagenic*, if it can cause or increase the incidence of heritable mutations when inhaled, ingested or absorbed through the skin
9. *toxic to reproduction*, if it can cause or increase the incidence of adverse effects to offspring that are not heritable or decrease the reproductive functions or abilities of men or women when inhaled, ingested or absorbed through the skin.

3.3.2 Flammable and explosive chemicals

A flammable and explosive chemical is:

1. *explosive*, if it can, without added oxygen, cause a reaction, in which oxygen is released and gases rapidly form, and, when heated in specified test conditions, will explode
2. *oxidising*, if the chemical can cause a powerful exothermic reaction with other substances, particularly flammable substances
3. *extremely flammable*, if the chemical has an extremely low flashpoint and low boiling point or if it forms a flammable mixture with air
4. *highly flammable*, if
    - the chemical can heat up and spontaneously ignite at the ambient air temperature without any added energy
    - a solid chemical can immediately catch fire when coming into short-term contact with an ignition source and it continues to burn after removing the ignition source
    - a liquid chemical has a very low flashpoint
    - the chemical produces dangerous quantities of highly flammable gases when it comes into contact with water or moist air
5. *flammable,* if a liquid chemical has a very low flashpoint

3.3.3 Chemicals dangerous for the environment

A chemical is *dangerous for the environment*, if the chemical can cause immediate or delayed danger to the environment or part of it.

3.4 Classification and pictograms of hazardous chemicals (old legislation)

According to the old Chemicals Decree (675/1993), hazardous chemicals were classified into groups, which describe the dangerous properties of chemicals and their concentration (Ministry of Social Affairs and Health *Decree on chemical classification principles and labelling* 807/2001). The chemical classification is indicated with a chemical pictogram and its hazard code (Figure 4) as well as a standard phrase indicating the risk (*R phrases*). The classification principles also specify which safety phrases (S phrases) must be used on the chemical label.

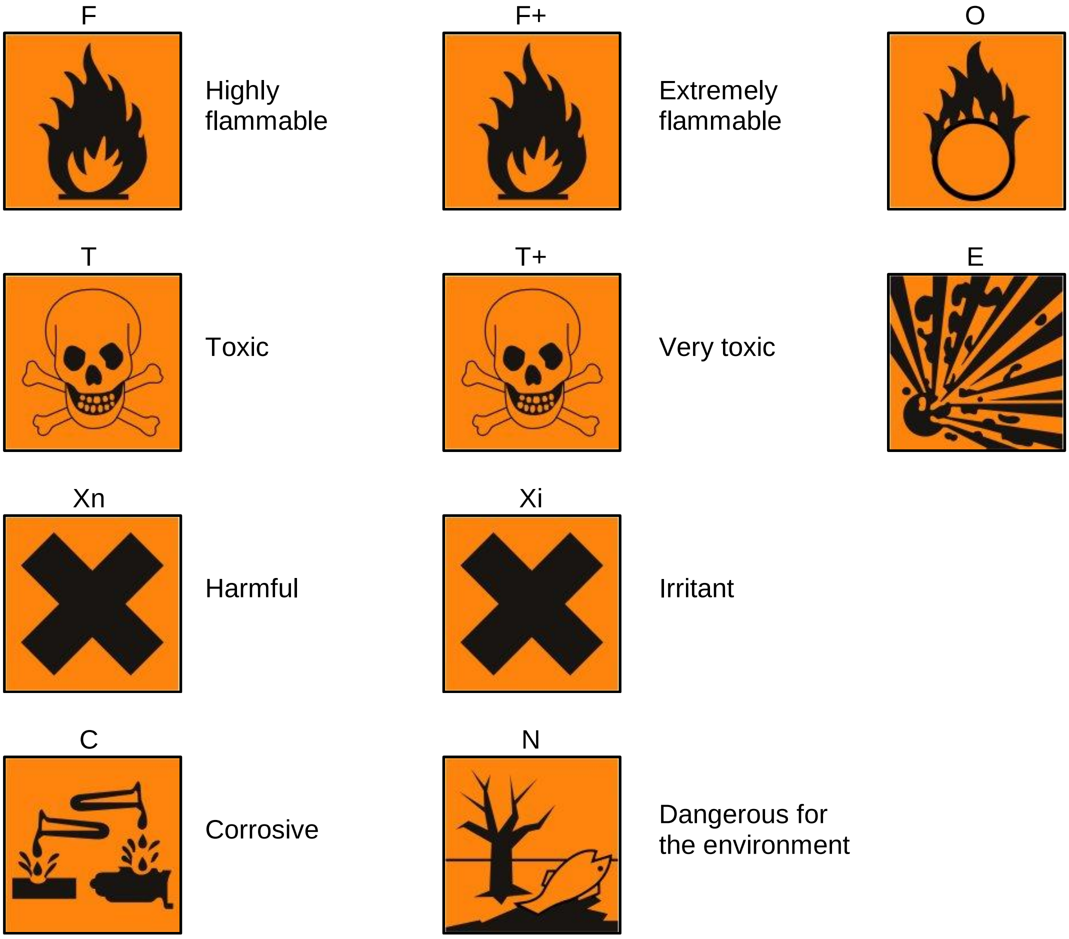


Figure 4 The old warning label hazard codes, pictograms and their names. The letter (hazard code) above the pictogram indicates the pictograms on the List of dangerous substances.

The most common hazardous substances are listed on the List of dangerous substances (*Ministry of Social Affairs and Health Decree on the List of dangerous substances* 509/2005). This Decree validates the pictograms, their names and hazard codes as well as the R and S phrases of approximately 3,000 substances. The list is constantly updated. The classifications and labels specified in this Decree (807/2001) have replaced by the new Globally Harmonised System of Classification and Labelling (GHS) pictograms and hazard codes (see section 3.2).

3.5 Substances classified as carcinogenic, mutagenic and toxic for reproduction (CMR)

In accordance with the *Government decree on the Prevention of Work-related Cancer Risks* (716/2000), the Ministry of Social Affairs and Health has confirmed by decree a list: "...containing such carcinogens which cause cancer risks to employees exposed to them and which at the workplace shall be recorded (...) on a register of persons in their occupation exposed to carcinogenic substances and processes (list of exposed workers) (*Act respecting a registry of employees exposed in their work to carcinogenic* *agents* 717/2001). Carcinogenic agents are listed in the Ministry of Labour *Decision on factors causing cancer risks* (838/1994). The employer must minimise the exposure of its employees to these substances.

The risk of cancer can be described with a toxic dose of TD_{50}. This figure indicates a dose that will cause cancer in 50% of the test animals for a specific time period. Europe also uses its own index, T_{25}, which indicates a dose that will cause cancer in 25% of the test animals for a specific time period. The United States uses the "benchmark dose" approach, in which the basis is a dose that causes cancer in 10% of the test animals (BMD_{10}, LED_{10}).

3.5.1 Substances hazardous to foetuses and pregnant women

The list below, which is based on the Ministry of Labour *Decision on agents at work hazardous to the genome, foetus and reproduction* (1044/1991), is a list of chemical, physical and biological exposure agents that are considered harmful to the health of the foetus or pregnant women:

- Anaesthetic gases
- Mercury and its compounds
- Ionising radiation
- Lead and its compounds
- Organic solvents
- Pesticides hazardous to pregnancy or offspring
- Carbon monoxide
- Chemotherapeutic agents
- Second-hand cigarette smoke
- Chemicals with warning labels (-> see GHS section 3.5)
    - R45 or R49 (may cause cancer/may cause cancer by inhalation) -> H350
    - R46 (may cause heritable genetic damage) -> H340, H341
    - R61 or R63 (may cause harm to the unborn child) -> H360, H361
    - R40 (limited evidence of a carcinogenic effect) -> H351

3.6 Transport of chemicals by road

The *Act on Transport of Dangerous Goods* (719/1994), based on European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), and *Government Decree on the Transport of Dangerous Goods by Road* (194/2002) regulate over-the-road transport of hazardous substances. As stated in Decree 194/2002: ”The consignor of dangerous goods may hand over for carriage only consignments that comply with the provisions. In addition, the consignor shall in particular:

- ascertain that the dangerous goods are classified in compliance with the provisions and that they may be carried by road;
- furnish the carrier with the information necessary for the transport, the required consignment note or the corresponding dispatch document and other documents, like authorisations, approvals, notifications and certificates;
- use only packaging and tanks approved for and suited to the transport of the dangerous substances concerned and bearing markings complying with the provisions;

- comply with the requirements on the means of dispatch and forwarding restrictions;
- ensure that empty unclean and not degassed tanks as well as empty unclean vehicles and large or small bulk containers are appropriately marked and labelled and that empty unclean tanks are closed and present the same degree of leakproofness as if they were full."

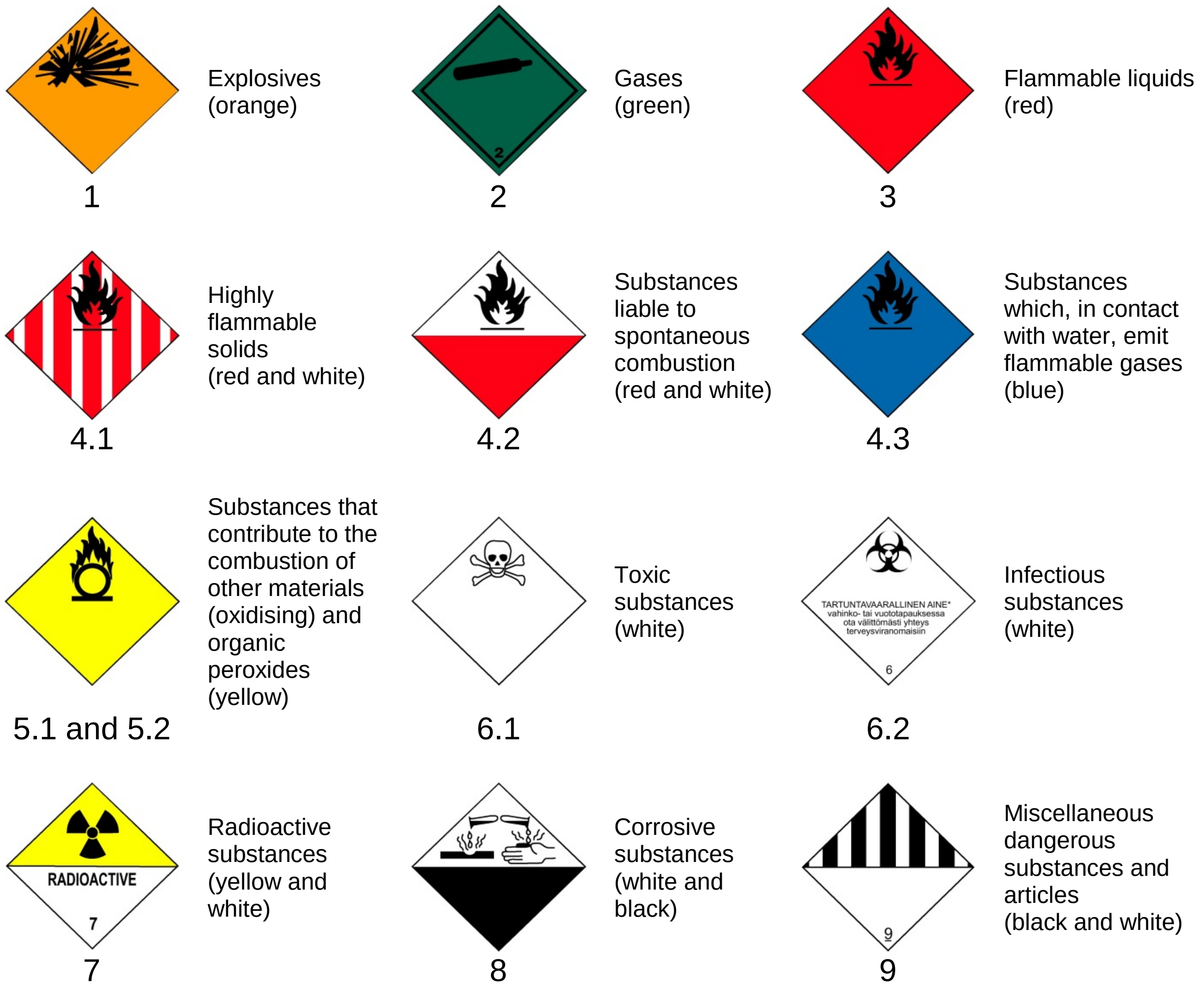
"The packer (of hazardous substances) shall be subject, in particular, to the following obligations:

- to comply with the requirements concerning packing and mixed packing;
- when preparing packages for carriage, to comply with the requirements concerning marking and labelling of the packages." (see section Figure 5)

When transporting hazardous substances by road, they are divided into the following classes:

Class 1	Explosive substances and articles
Class 2	Gases
Class 3	Flammable liquids
Class 4.1	Flammable solids, self-reactive substances and solid, desensitised explosives
Class 4.2	Substances liable to spontaneous combustion
Class 4.3	Substances which, in contact with water, emit flammable gases
Class 5.1	Oxidising substances
Class 5.2	Organic peroxides
Class 6.1	Toxic substances
Class 6.2	Infectious substances
Class 7	Radioactive substances
Class 8	Corrosive substances
Class 9	Miscellaneous dangerous substances and articles

Hazardous substances divided into ADR Classes are labelled with ADR symbols and labels (Figure 5). The symbols and labels are the same type of pictograms used for chemicals (see Figure 3 and Figure 4).



1 Explosives (orange)

2 Gases (green)

3 Flammable liquids (red)

4.1 Highly flammable solids (red and white)

4.2 Substances liable to spontaneous combustion (red and white)

4.3 Substances which, in contact with water, emit flammable gases (blue)

5.1 and 5.2 Substances that contribute to the combustion of other materials (oxidising) and organic peroxides (yellow)

6.1 Toxic substances (white)

6.2 Infectious substances (white)

7 Radioactive substances (yellow and white)

8 Corrosive substances (white and black)

9 Miscellaneous dangerous substances and articles (black and white)

Figure 5 Hazardous substance transport classes and their symbols and labels. Placard colours are listed in parentheses.

Regulations compliant with Act 719 and Decree 194/2002 are observed in the transport of hazardous wastes (see section 6.3) for further waste processing.

3.7 Chemical packaging and labelling

The chemical manufacturer, importer and distributor must ensure that the packaging in which the chemical is being delivered is durable and safe. The form or ornamentation of the packaging must not be misleading to the chemical user. It must not have a similar appearance or design as the packaging used for foodstuffs or products intended for human consumption, animal feed, medicinal preparations or cosmetic preparations. The chemical preparation must be sealed and, if necessary, resealable, and it must be able to withstand the wear and tear of ordinary use and storage. The packaging must bear required safety information, hazard pictograms and user instructions. The figure below (Figure 6) is a sample product CLP-compliant label.

K40676923 003 1.09623.2500 2.5 l 31.01.13 UN 1173

Charge/Lot · min. verw. bis/min. shelf life

$CH_3COOC_2H_5$
M = 88.11 g/mol

Specification:

Purity (GC)	≥	99.5	%
Identity (IR)			conforms
Appearance			clear
Colour	≤	10	Hazen
Titrable acid	≤	0.0008	meq/g
Density (d 20 °C/20 °C)		0.901 - 0.904	
Boiling point		76 - 78	°C
Readily carbonizable substances			conforms
Ethanol (GC)	≤	0.1	%
Methanol (GC)	≤	0.1	%
Methyl acetate (GC)	≤	0.1	%
Al (Aluminium)	≤	500	ng/g
B (Boron)	≤	20	ng/g
Ba (Barium)	≤	100	ng/g
Ca (Calcium)	≤	500	ng/g
Cd (Cadmium)	≤	50	ng/g
Co (Cobalt)	≤	20	ng/g
Cr (Chromium)	≤	20	ng/g
Cu (Copper)	≤	20	ng/g
Fe (Iron)	≤	100	ng/g
Mg (Magnesium)	≤	100	ng/g
Mn (Manganese)	≤	20	ng/g
Ni (Nickel)	≤	20	ng/g
Pb (Lead)	≤	100	ng/g
Sn (Tin)	≤	100	ng/g
Zn (Zinc)	≤	100	ng/g
Evaporation residue	≤	0.001	%
Water	≤	0.05	%

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Danger. Highly flammable liquid and vapour. Causes serious eye irritation. May cause drowsiness or dizziness. Repeated exposure may cause skin dryness or cracking. Keep away from heat/sparks/open flames/hot surfaces. - No smoking. Ground/bond container and receiving equipment. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.

Gefahr. Flüssigkeit und Dampf leicht entzündbar. Verursacht schwere Augenreizung. Kann Schläfrigkeit und Benommenheit verursachen. Wiederholter Kontakt kann zu spröder oder rissiger Haut führen. Von Hitze/Funken/offener Flamme/heißen Oberflächen fernhalten. Nicht rauchen. Behälter und zu befüllende Anlage erden. BEI KONTAKT MIT DEN AUGEN: Einige Minuten lang behutsam mit Wasser spülen. Vorhandene Kontaktlinsen nach Möglichkeit entfernen. Weiter spülen.

Danger. Liquide et vapeurs très inflammables. Provoque une sévère irritation des yeux. Peut provoquer somnolence ou vertiges. L'exposition répétée peut provoquer dessèchement ou gerçures de la peau. Tenir à l'écart de la chaleur/des étincelles/des flammes nues/des surfaces chaudes. - Ne pas fumer. Mise à la terre/liaison équipotentielle du récipient et du matériel de réception. EN CAS DE CONTACT AVEC LES YEUX: rincer avec précaution à l'eau pendant plusieurs minutes. Enlever les lentilles de contact si la victime en porte et si elles peuvent être facilement enlevées. Continuer à rincer.

Pericolo. Liquido e vapori facilmente infiammabili. Provoca grave irritazione oculare. Può provocare sonnolenza o vertigini. L'esposizione ripetuta può provocare secchezza o screpolature della pelle. Tenere lontano da fonti di calore/scintille/fiamme libere/superfici riscaldate. - Non fumare. Mettere a terra/massa il contenitore e il dispositivo ricevente. IN CASO DI CONTATTO CON GLI OCCHI: sciacquare accuratamente per parecchi minuti. Togliere le eventuali lenti a contatto se è agevole farlo. Continuare a sciacquare.

Peligro. Líquido y vapores muy inflamables. Provoca irritación ocular grave. Puede provocar somnolencia o vértigo. La exposición repetida puede provocar sequedad o formación de grietas en la piel. Mantener alejado de fuentes de calor, chispas, llama abierta o superficies calientes. - No fumar. Conectar a tierra/enlace equipotencial del recipiente y del equipo de recepción. EN CASO DE CONTACTO CON LOS OJOS: Aclarar cuidadosamente con agua durante varios minutos. Quitar las lentes de contacto, si lleva y resulta fácil. Seguir aclarando.

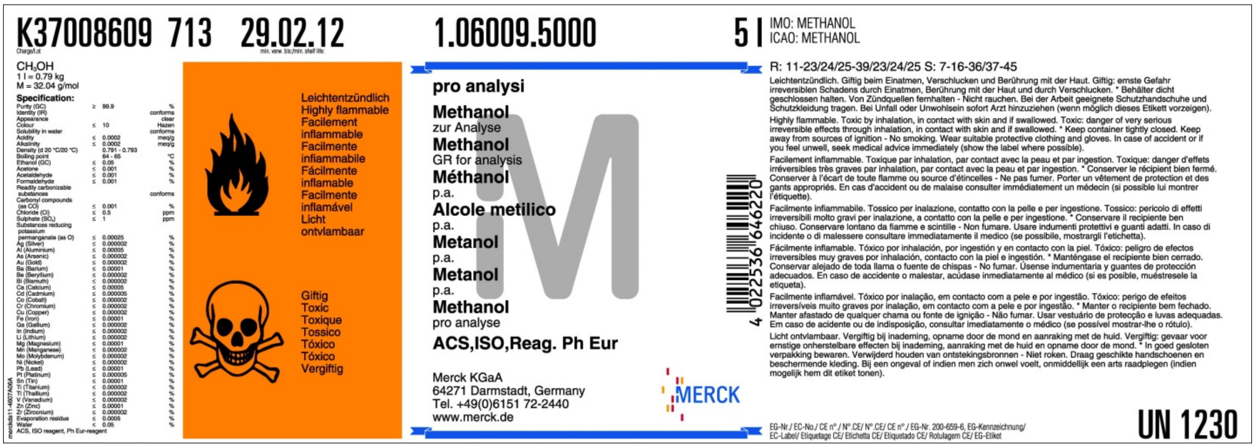
Perigo. Líquido e vapor facilmente inflamáveis. Provoca irritação ocular grave. Pode provocar sonolência ou vertigens. Pode provocar pele seca ou gretada, por exposição repetida. Manter afastado do calor/faísca/chama aberta/superfícies quentes. - Não fumar. Ligação à terra/equipotencial do recipiente e do equipamento receptor. SE ENTRAR EM CONTACTO COM OS OLHOS: enxaguar cuidadosamente com água durante vários minutos. Se usar lentes de contacto, retire-as, se tal lhe for possível. Continuar a enxaguar.

Gevaar. Licht ontvlambare vloeistof en damp. Veroorzaakt ernstige oogirritatie. Kan slaperigheid of duizeligheid veroorzaken. Herhaalde blootstelling kan een droge of een gebarsten huid veroorzaken. Verwijderd houden van warmte/vonken/open vuur/hete oppervlakken. - Niet roken. Opslag-en opvangreservoir aarden. BIJ CONTACT MET DE OGEN: voorzichtig afspoelen met water gedurende een aantal minuten; contactlenzen verwijderen, indien mogelijk; blijven spoelen.

IMO: ETHYL ACETATE

Figure 6 Example of CLP-compliant hazard labelling for a hazardous substance.

Hazardous chemical labelling must not be removed or marred. If the labelling becomes illegible or the packaging has been changed, the holder of the chemical must ensure that labelling equivalent to the original, which clearly indicates the hazardous chemical contained in the packaging, is replaced. The figure below (Figure 7) is hazardous chemical label according to old legislation.



K37008609 713 29.02.12 1.06009.5000 5 l

Charge/Lot · min. verw. bis/min. shelf life:

IMO: METHANOL
ICAO: METHANOL

CH_3OH
1 l = 0.79 kg
M = 32.04 g/mol

Specification:

Purity (GC)	≥	99.9	%
Identity (IR)			conforms
Appearance			clear
Colour	≤	10	Hazen
Solubility in water			conforms
Acidity	≤	0.0002	meq/g
Alkalinity	≤	0.0002	meq/g
Density (d 20 °C/20 °C)		0.791 - 0.793	
Boiling point		64 - 65	°C
Ethanol (GC)	≤	0.05	%
Acetone	≤	0.001	%
Acetaldehyde	≤	0.001	%
Formaldehyde	≤	0.001	%
Readily carbonizable substances			conforms
Carbonyl compounds (as CO)	≤	0.001	%
Chloride (Cl)	≤	0.5	ppm
Sulphate (SO_4)	≤	1	ppm
Substances reducing potassium permanganate (as O)	≤	0.00025	%
Ag (Silver)	≤	0.000002	%
Al (Aluminium)	≤	0.00005	%
As (Arsenic)	≤	0.000002	%
Au (Gold)	≤	0.000002	%
Ba (Barium)	≤	0.00001	%
Be (Beryllium)	≤	0.000002	%
Bi (Bismuth)	≤	0.000002	%
Ca (Calcium)	≤	0.00005	%
Cd (Cadmium)	≤	0.000005	%
Co (Cobalt)	≤	0.000002	%
Cr (Chromium)	≤	0.000002	%
Cu (Copper)	≤	0.000002	%
Fe (Iron)	≤	0.00001	%
Ga (Gallium)	≤	0.000002	%
In (Indium)	≤	0.000002	%
Li (Lithium)	≤	0.000002	%
Mg (Magnesium)	≤	0.00001	%
Mn (Manganese)	≤	0.000002	%
Mo (Molybdenum)	≤	0.000002	%
Ni (Nickel)	≤	0.000002	%
Pb (Lead)	≤	0.00001	%
Pt (Platinum)	≤	0.000005	%
Sn (Tin)	≤	0.00001	%
Ti (Titanium)	≤	0.000002	%
Tl (Thallium)	≤	0.000002	%
V (Vanadium)	≤	0.000002	%
Zn (Zinc)	≤	0.00001	%
Zr (Zirconium)	≤	0.000002	%
Evaporation residue	≤	0.0005	%
Water	≤	0.05	%

ACS, ISO reagent, Ph Eur-reagent

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Leichtentzündlich
Highly flammable
Facilement inflammable
Facilmente infiammabile
Fácilmente inflamable
Facilmente inflamável
Licht ontvlambaar

Giftig
Toxic
Toxique
Tossico
Tóxico
Tóxico
Vergiftig

pro analysi
Methanol
zur Analyse
Methanol
GR for analysis
Méthanol
p.a.
Alcole metilico
p.a.
Metanol
p.a.
Metanol
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Leichtentzündlich. Giftig beim Einatmen, Verschlucken und Berührung mit der Haut. Giftig: ernste Gefahr irreversiblen Schadens durch Einatmen, Berührung mit der Haut und durch Verschlucken. * Behälter dicht geschlossen halten. Von Zündquellen fernhalten - Nicht rauchen. Bei der Arbeit geeignete Schutzhandschuhe und Schutzkleidung tragen. Bei Unfall oder Unwohlsein sofort Arzt hinzuziehen (wenn möglich dieses Etikett vorzeigen).

Highly flammable. Toxic by inhalation, in contact with skin and if swallowed. Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed. * Keep container tightly closed. Keep away from sources of ignition - No smoking. Wear suitable protective clothing and gloves. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

Facilement inflammable. Toxique par inhalation, par contact avec la peau et par ingestion. Toxique: danger d'effets irréversibles très graves par inhalation, par contact avec la peau et par ingestion. * Conserver le récipient bien fermé. Conserver à l'écart de toute flamme ou source d'étincelles - Ne pas fumer. Porter un vêtement de protection et des gants appropriés. En cas d'accident ou de malaise consulter immédiatement un médecin (si possible lui montrer l'étiquette).

Facilmente infiammabile. Tossico per inalazione, contatto con la pelle e per ingestione. Tossico: pericolo di effetti irreversibili molto gravi per inalazione, a contatto con la pelle e per ingestione. * Conservare il recipiente ben chiuso. Conservare lontano da fiamme e scintille - Non fumare. Usare indumenti protettivi e guanti adatti. In caso di incidente o di malessere consultare immediatamente il medico (se possibile, mostrargli l'etichetta).

Fácilmente inflamable. Tóxico por inhalación, por ingestión y en contacto con la piel. Tóxico: peligro de efectos irreversibles muy graves por inhalación, contacto con la piel e ingestión. * Manténgase el recipiente bien cerrado. Conservar alejado de toda llama o fuente de chispas - No fumar. Úsense indumentaria y guantes de protección adecuados. En caso de accidente o malestar, acúdase inmediatamente al médico (si es posible, muéstresele la etiqueta).

Facilmente inflamável. Tóxico por inalação, em contacto com a pele e por ingestão. Tóxico: perigo de efeitos irreversíveis muito graves por inalação, em contacto com a pele e por ingestão. * Manter o recipiente bem fechado. Manter afastado de qualquer chama ou fonte de ignição - Não fumar. Usar vestuário de protecção e luvas adequadas. Em caso de acidente ou de indisposição, consultar imediatamente o médico (se possível mostrar-lhe o rótulo).

Licht ontvlambaar. Vergiftig bij inademing, opname door de mond en aanraking met de huid. Vergiftig: gevaar voor ernstige onherstelbare effecten bij inademing, aanraking met de huid en opname door de mond. * In goed gesloten verpakking bewaren. Verwijderd houden van ontstekingsbronnen - Niet roken. Draag geschikte handschoenen en beschermende kleding. Bij een ongeval of indien men zich onwel voelt, onmiddellijk een arts raadplegen (indien mogelijk hem dit etiket tonen).

EG-Nr./ EC-No./ CE n°./ N°.CE/ N°.CE/ CE n°./ EG-Nr. 200-659-6, EG-Kennzeichnung/
EC-Label/ Etiquetage CE/ Etichetta CE/ Etiquetado CE/ Rotulagem CE/ EG-Etiket

UN 1230

Figure 7 Example of hazard labelling for a hazardous substance according to old legislation.

3.8 Chemical registry numbers

3.8.1 CAS registry number

The **C**hemical **A**bstracts **S**ervice registry number is a number series issued to American Chemical Society chemicals that is commonly used to identify substances.

3.8.2 UN number

The UN number identifies hazardous substances for international transport. It is a four-digit number, which used to identify a hazardous substance or article or a group of substances with similar hazard properties that is to be transported. A single substance may have multiple UN numbers, depending on the concentration or phase of the substance. The UN numbers of substances are listed in, for example, the United

Nations *Recommendations on the Transport of Dangerous Goods* and can be found on the Ministry of Transport and Communications website (Trafi.fi).

3.8.3 EC number

The EC number is the number used on the Ministry of Social Affairs and Health List of Dangerous Substances. The EC number of a substance is, for existing substances (commercially available between 1 January 1971-18 September 1981), the *EINECS* number (**E**uropean **I**nventory of **E**xisting **C**hemical **S**ubstances) and for new substances (commercially available beginning from 19 September 1981), the *ELINCS* number (**E**uropean **L**ist of **N**otified **C**hemical **S**ubstances) as well as substances that no longer meet the definition of a polymer, the NLP number (**N**o-**L**onger **P**olymers). The EINECS number contains both the anhydrous and hydrated form of the substance, while anhydrous and hydrated forms often have different CAS numbers (cf. section 3.8.1). The EC number is a seven-digit XXX-XXX-X-type number, which begins with 200-001-8 (EINECS), 400-010-9 (ELINCS) and 500-001-0 (No Longer Polymers)

3.8.4 RTECS number

The RTECS number is the identifier used in the **R**egistry of **T**oxic **E**ffects of **C**hemical **S**ubstances', which is published by NIOSH (National Institute of Occupational Safety and Health).

3.8.5 ICSC number

The ICSC number is used for International Chemical Safety Cards.

3.9 Safety data sheets

A safety data sheet (see example in Appendix 1) is provided for in the REACH Regulation (EC 1907/2006) (c.f. section 3.1.1) and must be drafted, for example, if a substance or mixture has been classified under EU law as hazardous or slowly biodegradable, bioaccumulative and toxic. The substance or mixture supplier must provide a safety data sheet to the recipient of the substance or mixture. As opposed to previous legislation, possible exposure scenarios are appended to the safety data sheet, describing the necessary risk management measures for each use.

As stated in Commission Regulation (EU) No 453/2010 amending Regulation (EC) No 1907/2006 of the European Parliament and of the Council on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH): "The safety data sheet shall enable users to take the necessary measures relating to protection of human health and safety at the workplace, and protection of the environment. The writer of the safety data sheet shall take into account that a safety data sheet must inform its audience of the hazards of a substance or a mixture and provide information on the safe storage, handling and disposal of the substance or the mixture."

A REACH-compliant safety data sheet includes the following sections:

1. Identification of the substance/mixture and of the company/undertaking
2. Hazards identification
3. Composition/information on ingredients

4. First aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

3.10 Permissible exposure limits

3.10.1 Harmful air impurities in the workplace

Harmful substances can have a powerful effect on the body when inhaled. This is why the quality of indoor air is crucial to the health of employees. The Ministry of Social Affairs and Health specifies the maximum permissible exposure limits of air impurities in its *Decree on Concentrations Known to be Hazardous* approximately every two years. The most recent decree is 1213/2011. These "HTP values" (concentrations known to be hazardous) are lower concentrations that are believed to be capable of harming the health of employees. At concentrations lower than HTP$_8$, it is believed that nearly all employees can work continuously eight hours a day and five days a week without suffering any adverse effects. HTP values can also be applied to air impurities causing sudden impacts at a 15-minute and/or momentary mean concentration. The employer must take HTP values into consideration when assessing the exposure of its employees. In addition to this, a binding exposure limit, which cannot be exceeded even momentarily, applies to some substances. HTP values are stated either in parts per million (ppm) or mass concentrations (mg/m^3).

An example of a hazardous indoor air impurity involves hydrogen sulphide (H_2S), which is an extremely toxic, foul-smelling gas. Its maximum permissible concentration for long-term exposure is 10 ppm (cm^3/m^3), i.e. 15 mg/m^3. The odour threshold for hydrogen sulphide is, however, approximately 0.015 ppm.

The symptoms of hydrogen sulphide poisoning present as follows:

15-20 mg/m^3	causes eye irritation and inflammation (long exposure time)
20-70 mg/m^3	causes headaches, nausea and irritation of mucous membranes
70-100 mg/m^3	causes difficulty in breathing, heart palpitations and dizziness
over 100 mg/m^3	acute poisoning, mortal danger

3.10.2 Other exposure and concentration terms

All over the world, various terms are used to describe the toxicity or adverse effects of chemicals. Several new terms are also being introduced with REACH. Below is a list of terms used throughout the world and new terms introduced with implementation of REACH:

- DNEL (**D**erived **n**o-**e**ffect **l**evel)
    - Exposure level, at which adverse effects are no longer expected Set based on toxicity tests conducted on animals or epidemiological data.
- DMEL (**D**erived **m**inimal **e**ffect **l**evel)
    - Are established above all for carcinogenic substances for which a toxicological adverse-effect threshold cannot be determined.
- PNEC (**P**redicted **n**o **e**ffect **c**oncentration)
    - Concentration, at which adverse effects can no longer be found in the environment
- LOAEL (**L**owest **o**bserved **a**dverse **e**ffect **l**evel)
    - Lowest concentration, at which there is a physiological and toxicological effect
- NOAEL (**N**o **o**bservable **a**dverse **e**ffect **l**evel)
    - The highest concentration, at which there is no physiological or toxicological effect

3.11 Explosive atmospheres (ATEX)

The purpose of the *Government decree on prevention of the danger caused by explosive atmospheres (576*/2003) is to prevent the hazards posed by explosive atmospheres to ensure employee safety and health as well as to maintain general safety and prevent personal injury and property damage. The Decree is based on Directive 1994/9/EC (*Decree on equipment and protective systems intended for use in potentially explosive atmospheres* 917/1996) and Ministry of Trade and Industry *Decision on equipment and protective systems intended for use in potentially explosive atmospheres* (918/1996). As specified in Decree 576/2003:

- "...an explosive atmosphere is defined as a mixture of dangerous substances with air, under atmospheric conditions, in the form of gases, vapours, mist or dust in which, after ignition has occurred, combustion spreads to the entire unburned mixture."
- an explosive state is a state in which an explosive atmosphere can occur, to the extent that special safety measures for protecting employee health and safety or maintaining general safety or preventing personal injury and property damage becomes necessary.

On the basis of the Decree, an employer, whose employees may be exposed to a risk of explosion caused by flammable liquids, gases or dust, must draft and keep up to date an **explosion protection document (EPD)**, which shows:

- that the explosion risks have been determined and assessed
- that adequate measures will be taken
- those places which have been classified into zones
- those places where the minimum requirements will apply.
- that the workplace and work equipment, including warning devices, are designed, operated and maintained with due regard for safety
- that arrangements have been made for the safe use of work equipment

Hazardous areas are classified into zones based on the frequency and duration of an explosive atmosphere. The table below (Table 2) shows the zone classifications. The zones in question must be marked by an Ex symbol (Figure 8) and only CE-marked (Figure 14) electrical equipment may be used in these zones.

Table 2 ATEX zone classifications

Class	**Definition**
0	Zone in which an explosive mixture of air and a flammable substance in the form of gas, vapour or mist is continuously present, present for long periods of time or frequently present.
1	Zone in which an explosive mixture of air and a flammable substance in the form of gas, vapour or mist is likely to occasionally occur in normal operation.
2	Zone in which an explosive mixture of air and a flammable substance in the form of gas, vapour or mist is not likely to occur in normal operation and, if it occurs, it only lasts for a brief period of time.
20	Zone in which an explosive mixture of air and a flammable dust is continuously present, present for long periods of time or frequently present.
21	Zone in which an explosive mixture of air and a flammable dust is likely to occasionally occur in normal operation.
22	Zone in which an explosive mixture of air and a flammable dust is not likely to occur in normal operation and, if it occurs, it only lasts for a brief period of time.

Figure 8 Explosive atmosphere zone symbol.

3.12 Direct chemical hazards

In principle, substances cannot be divided into toxic and nontoxic, but rather the basis for classification should be that all substances could be hazardous to the health. Use of the word "poisons" usually refers to substances, which quickly cause an adverse reaction in the body upon ingesting them. Chemical dangerous for the health' refers to chemicals [element, compound or mixture] which, if introduced into the body even in small doses, may harm human health because of their chemical properties. Chemicals dangerous for the health are still classified according to their effect as very topic, toxic, harmful, corrosive, etc. (see section 3.2) "'Chemicals dangerous for the environment' refer to chemicals which may cause harm to living nature if released into the environment even in small doses."

The effect a chemical substance has on the body depends on a number of factors, among them:

- the route that a chemical enters the body
- the amount of a chemical entering the body
- the specific toxicological properties of a chemical
- the amount of time exposed to a chemical
- the individual sensitivity of the person exposed to a chemical.

3.12.1 Entry of substances into the body

In physiological terms, a substance can be considered as having entered the body when it has entered the bloodstream and, through it, spread to all organs. This is required for systemic poisoning or illness to occur. Chemical substances can also cause localised symptoms, such as on the skin or in the lungs, even when chemicals have not entered the bloodstream.

The main routes for chemical substances to enter the body are

- through the respiratory tract
- absorption through the skin
- through the digestive tract by ingestion

Absorption of substances through the respiratory tract is extremely effective, because they gain nearly immediate access to the bloodstream through the alveoli. On the other hand, the mucous membranes in the respiratory tract are sensitive to the irritant and corrosive effects of substances, which can also lead to serious health concerns.

Many substances can be absorbed into the body through the skin as well as through wounds and abrasions. All organic solvents, in particular, are these kinds of substances. Substances harmful to the digestive tract can enter the body, for example, by handling them and then failing to properly wash the hands before eating or smoking. The entry of substances into the digestive tract does not necessarily lead to their absorption into the body - the solubility of the substance in the digestive fluids as well as its reactivity and physical state depend on whether it will be absorbed into the body or secreted from it. As a rule, absorption through the respiratory tract is more effective than through the digestive tract. The amount of a toxic substance accidentally ingested is also usually relatively small.

3.12.2 Effect of substances on the body

The effect that harmful substances have on the body can be divided into two categories: acute (short-term) effects and chronic (long-term) effects. A school chemistry laboratory primarily sees only acute effects, as chronic effects usually require a long period of exposure. Chronic effects are more common in the workplace.

3.12.2.1 Acute effects

Irritants primarily affect the mucous membranes in respiratory organs and the eyes as well as the skin, with common symptoms being coughing, a stinging sensation in the eyes, redness and a burning sensation of the skin. Highly water-soluble substances, such as lye mist, ammonia and hydrochloric acid, mainly irritate the eyes and upper respiratory tract. Poorly water-soluble substances, such as nitrogen dioxide, irritate deeper parts of the lungs. In this case, it may take some time after exposure before the effect is felt.

Corrosive substances destroy tissue. There is very little difference between irritants and corrosive substances. All strong acids and bases, in high enough concentrations, are corrosive.

Intoxicants disable the function of the central nervous system, causing a certain state of intoxication. Intoxicants are primarily nonpolar solvents (e.g. hydrocarbons, alcohols, ethers). High concentrations can lead to unconsciousness and respiratory paralysis.

Chemical respiratory irritants disable respiration primarily by either preventing the flow of oxygen in the body (e.g. carbon monoxide, nitrites) or affecting the part of the central nervous system that regulates breathing (hydrogen sulphide). Cyanide (HCN) blocks cell respiration.

Asphyxiant gases (e.g. nitrogen, hydrogen, noble gases) dilute the oxygen concentration of breathing air. Oxygen is necessary for life and brain functions. If blood does not receive oxygen, cellular functions will cease. If this happens, the person will lose consciousness. In addition to stroke and coma, this condition can also result in death. If oxygen levels decrease gradually, the symptoms resemble a feeling of nausea and the victim will not necessarily notice that they are being asphyxiated. The first symptoms present when the oxygen concentration, which is normally 21% by volume, drops to 18%. When the oxygen concentration reaches 10-18% by volume, the symptoms are dizziness, headache, slurred speech, fading consciousness and loss of muscle control. When the oxygen concentration is less than 6% by volume, the loss of consciousness is immediate. Oxygen concentration can drop dramatically when handling, for example, liquefied gases (cf. section 3.14.3.4).

3.12.2.2 Chronic effects

General poisons affect multiple organs simultaneously (e.g. lead, mercury).

Tissue poisons affect a certain tissue or organ: for example, benzene affects bone marrow (disrupts the production of blood cells), while cadmium affects the kidneys.

Nervous system poisons affect the central nervous system (e.g. carbon bisulphide, methanol and ethanol).

Sensitising substances: After long-term exposure, employee skin or respiratory organs may become sensitised to some substances (e.g. formaldehyde, nickel and cobalt compounds, chromates), after which even the smallest trace amounts can cause an allergic rash, rhinitis or asthma.

Substances that cause pneumoconiosis cause permanent changes in the lungs after long-term exposure (e.g. quartz dust, asbestos and talc).

Carcinogenic substances cause growths after long-term exposure (e.g. chloroform).

Some substances also have other effects: for example, *teratogenic* substances, which cause prenatal defects, *mutagenic* substances, which damage the genome and substances hazardous to reproduction.

3.12.3 Movement, changing and secretion of substances in the body

A substance absorbed into the body first enters the bloodstream, which carries it to all parts of the body. The substance can be transferred from the blood to tissue, where it is stored or enriched: for example, mercury is primarily stored in the brain, liver and kidneys, while lead is stored in the bones. Any abnormality in bodily functions might release substances stored in tissue back into the bloodstream, sometimes causing poisoning symptoms long after the substance entered the body. The adverse effects of a substance absorbed into the body often present first in "target organs". Target organs include the liver and kidneys as well as the brain and nervous tissue.

Chemical substances can also change into other compounds inside the body. For example, methanol is oxidised first into formaldehyde and then formic acid, which is an extremely toxic substance that can damage the optic nerves.

All substances that enter the body are eventually secreted out of it. Substance enrichment is a situation in which the rate of secretion is slower than the rate at which the substance is entering the body.

The biological half-life of a substance is the time it takes for half of the substance inside the body to be secreted out. This time can vary due to a variety of factors, but it still provides an idea of how long different substances stay inside the body. For example, the half-life of solvents ranges from a few minutes to a day, while the half-life of some heavy metals can be decades.

3.12.3.1 Nanoparticles

Nanoparticles are particles whose diameter ranges from slightly under 100 nanometres to approximately one nanometre. To understand how small a nanoparticle is, use the following analogy: the size of a ping pong ball in relation to the Earth is equivalent to the size of a nanoparticle to a ping pong ball. Technology and material research projects have, however, found that, as the size of the particle decreases, the surface area to weight ratio increases, and this is associated with the rapidly increasing reactivity of particles. Reactivity is usually harmful when particles interact with living organisms.

The smallest nanoparticles can easily enter the body through the respiratory tract, after which they spread unimpeded into other organs and different cell types, for example, via ion channels. For example, titanium dioxide and silicon dioxide nanoparticles, different carbon nanotubes and metal nanoparticles, such as silver, gold and manganese particles, can be absorbed into the body through the lungs. Manganese particles are a cause for significant concern, because they have been found to enter the olfactory cortex of the brain through the nerve endings of the olfactory epithelial cells in the nose.

Even though there is no systematic data available on the health effects of nanoparticles and the effects of nanoparticles have not been studied in humans, there is an abundance of data on many particle types that was produced by means of animal testing or cell cultures. Titanium and silicon dioxide nanoparticles are known to cause pneumonia and the formation of scar tissue in the lungs. Certain carbon nanotubes also produce pneumonia symptoms in test animals. Some nanoparticles have been found to enter the brain through the lungs, causing changes in the concentrations of key neurotransmitters in the brain. What this means from a health standpoint is still not understood.

3.12.4 Substance toxicity comparison

The comparison of substance toxicity is typically done based on animal testing. Toxicity is most often described by an oral LD_{50} (lethal dose) value. The LD_{50} value is expressed as milligrams of substance per kilogram of the body weight of the test animal that causes the death of half the test animals (rats, mice) administered the dose within a certain period of time. A dangerous dose for humans can be estimated by multiplying the LD_{50} value by the body weight. For example, the LD_{50} value for As_2O_3 (orally administered, rat) is 14.6 mg/kg. For a person weighing 70 kg, a lethal dose is thus 70 x 14.6, or 1,022 mg. The LD_{50} value can also determine an exposure through the skin. The LD_{Lo} value is the lowest lethal value.

The value LC_{50} (lethal concentration) is used for toxic gases. It expresses the concentration that will cause the death of half of the test animals within a certain period of time when inhaled. A dangerous concentration for human is the same, because the surface area of the lungs can be considered proportional to the body weight.

In the classification of very toxic and toxic substances, not only LD_{50} and LC_{50} values are taken into consideration, but also experiences with accidents involving people and the specific properties of substances, such as liquidity, volatility, absorption through the skin and special biological effects.

3.13 Indirect chemical hazards

Indirect chemical hazards are caused by the indirect effects of substances. The most critical of these hazards are the risk of fire and explosion. (see section 3.2.2) An explosion involves a rapid burn rate and considerable rise in pressure. All combustible dust, vapours and gases, mixed in the right proportion with air or another flammable substance, may explode. Flammable liquid vapours form a combustible mixture with air only in certain mixture conditions, which also determine the burn rate. The lower and upper explosive limit (flammable limit) is the concentration, below or above which the vapour/air mixture will not burn. Explosive limits change drastically if the pressure or temperature is abnormal. The explosive limits for the vaporised components of a substance are listed as percentage by volume of air. The lower explosive limit of dusty solids is listed, if such a limit has been set, with a unit of weight per each unit of volume (mg/m^3 or g/m^3). The examples below show the explosive limits of chemicals in air (Table 3).

Table 3 Examples of explosive limits (% by volume) in air

Chemical	lower	upper
Ammonia	15	30
Acetone	2.2	12.8
Diethyl ether	1.7	36
Propane	2.2	9.5
Hydrogen sulphide	4.3	45.5
Hydrogen	4.0	75

Chemicals that react strongly with one another pose typical indirect hazards. These kinds of chemicals should be stored in such a manner that they cannot react with one another (see section 3.15). Chemical pairs that react strongly with one another include inorganic acids and organic solvents, oxidising substances (cf. section 3.13.2) and organic substances, and acids and bases.

3.13.1 Flammable gases and flammable liquids

Some of the chemicals used in a laboratory are extremely combustible and incendiary substances. Flammable gases are gases with a boiling point in a normal atmosphere of no higher than 20°C and which form combustible mixtures with air. Flammable liquids are liquids with a flashpoint of 100°C or lower. The flashpoint is the lowest temperature at which a fluid will evaporate, in a normal atmosphere, a large amount of vapour, thus forming a flammable gaseous mixture on the surface of the liquid. Flammable liquids are divided into four categories according to their combustibility:

Extremely flammable liquid:	Flashpoint no higher than 0°C Boiling point no higher than 35°C
Highly flammable liquid:	Flashpoint lower than 21°C
Flammable liquid:	Flashpoint 21-55°C
Combustible liquid:	Flashpoint over 55°C and no higher than 100°C

As extremely flammable and highly flammable liquids are extremely volatile in open containers at room temperature, there is always an explosion and fire hazard. Likewise, many flammable liquids can be ignited by a spark and explode if stored in open containers. Conversely, the ignition of combustible liquids (flashpoint over 55°C) often causes problems. The table below (Table 4) list examples of flammable liquids.

Table 4 Examples of flammable liquids

Chemical	Flashpoint/°C	Boiling point/°C	Category
Benzene	-40		extremely flammable
Ethyl ether	-40	34,6	extremely flammable
Acetone	-20	56	highly flammable
Ethanol	12	78,3	highly flammable
1-Butanol	34	117-118	flammable
Acetic acid	39	116-118	flammable

Combustible and other types of liquids will ignite without a spark if the temperature is high enough. The auto-ignition temperature is the lowest temperature at which each substance will spontaneously ignite without an external source of ignition. If the auto-ignition temperature is low enough (e.g. 100°C for carbon bisulphide or 180°C for diethyl ether), the liquid can ignite, for example, when being heated on a hotplate.

3.13.2 Oxidising substances

Oxidising substances do not burn themselves, but they cause other flammable substances to ignite. The process of oxidisation can be explosive. For example, when handling perchlorates (ClO_4^-), such as perchloric acid ($HClO_4$) and nitrates (NO_3^-), such as nitric acid (HNO_3), care must be taken to ensure that they do not come into contact with organic substances. Special care must be taken when handling oxidising substances.

3.13.3 Explosive substances

Some chemicals in diluted concentrations do not pose a serious risk, but when they are concentrated they are explosive. Such chemicals include perchloric acid ($HClO_4$) and picric acid (2,4,6-trinitrophenol (TNP)). Perchloric acid is unstable at a concentration over 72% and, when dry or drying, can explode from even the slightest contact (see Figure 9). Picric acid is normally used wet with greater than 10% water, but when dry or drying it can explode from even the slightest shock.

Figure 9 Damages to a vapour hood from a perchloric acid (< 1l) explosion.

3.14 Avoiding hazards

3.14.1 General guidelines for laboratory work

All accidents have a cause and most accidents can be prevented in advance. Successful laboratory work requires care, cleanliness and a systematic approach to doing things. These factors are also crucial to the prevention of accidents. A basic requirement for safety is knowing what to do, a reasonable level of caution and anticipation of dangerous situations. Below are a few key guidelines to follow in laboratory work:

Consider any possible sources of danger before beginning work, such as:

- whether poisonous gases will be produced
- whether there is a risk of fire or explosion
- whether the chemicals to be used are toxic, corrosive or generally hazardous
- the need to read the user safety instructions

Be constantly aware of what you are doing. Ensure that:

- you are using the correct reagents (read every label at least twice!)
- you are using the right temperatures
- you are following the work instructions precisely

Maintain cleanliness and order

- immediately dry any liquids spilled on the floor (slip hazard)
- keep your worktable and instruments clean
- immediately wipe reagent bottles clean of any substances that may have splashed onto them

Wear the proper apparel and use any necessary personal protective equipment (cf. section 5)

- a lab coat and protective eyewear are always to be worn in a laboratory!
- wear pants and shoes (or sandals with socks on underneath)
- if necessary, also use the right type of protective gloves and respiratory protection
- a vapour hood is always to be used when necessary, such as when the lab work being done produces hazardous chemical vapours

Be constantly aware of the other people working in the laboratory

- beware of any hazardous work being performed by others in the laboratory
- unauthorised personnel may not enter the laboratory If you should notice any unauthorised personnel in the laboratory or in other school facilities, please notify security

Shut off any unused Bunsen burners and equipment. Never have an open flame near highly flammable liquids. Do not disturb your neighbour when he/she is performing a test, do not let yourself be distracted; for example, **keep your mobile phone turned off** when in the school laboratory. **Also, do not wear contact lenses** when working in a laboratory.

Learn the location of alarms, emergency showers, extinguishers and first aid supplies as well as how to use them properly.

Never touch door handles or railing with protective gloves and always remove them when using a computer – this prevents any chemical residues on the gloves from contaminating the door handles, railings and computer keyboard and mouse. Eating, drinking and smoking in the laboratory is prohibited. Remove your safety apparel and thoroughly wash your hands whenever leaving the laboratory.

3.14.2 Examples of safe laboratory work practices

Below are a few examples of safety considerations concerning equipment and operations used in laboratory work.

3.14.2.1 Handling glass

Do not use broken glassware (see section 6.4). If you are heating glassware, ensure that the glass grade can withstand heat (e.g. Pyrex® or Duran®). When cutting glass tubes or pushing a tube through cork, protect your hands with gloves. Do not use excessive force. Glass moves better when wetted first. Be careful when removing a rubber hose from glass – if a hose is stuck, cut it loose.

3.14.2.2 Bottles

Do not overfill bottles – always leave space for the liquid to expand (approx. 10%). Do not carry bottles at the neck and do not carry too many at one time. If necessary, use a carrying case or safety container.

Do not cork a bottle containing hot liquid, so that a vacuum will not form when the liquid cools. While in storage, some substances (e.g. formic acid, hydrogen peroxide, concentrated ammonia and nitric acid) produce gases, which also cause a rise in pressure in the bottle. Open the bottles containing these substances in a vapour hood, while behind a protective plate or the vapour hood hatch and protect your hands. Follow the same procedure if a cork is stuck in the bottle.

3.14.2.3 Bunsen burner

If the air ports on a Bunsen burner (Figure 10) are opened too wide, the gas will ignite inside the barrel. This will produce highly toxic carbon monoxide gas and the barrel will become extremely hot. If this happens, shut off the burner, reduce the air port apertures and relight the burner.

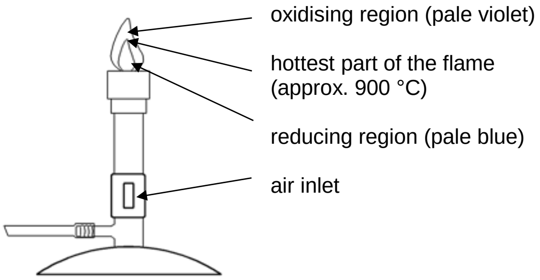


Figure 10 Standard Bunsen burner

3.14.2.4 Heating liquids with a Bunsen burner

NOTE! Flammable liquids may NOT be heated with an open flame! Use intact, heat-resistant glassware (cf. section 3.14.2.1)

In a test tube: Heat the liquid contained in the test tube carefully with a small flame, heating the liquid on the side of the tube just below its meniscus while moving the tube. Never heat from the bottom of the tube and never point the mouth of the tube at yourself or co-workers.

Beaker: The beaker is placed on a tripod stand and aluminium oxide mesh guaze.

Hot water bath: The most common way to heat liquids contained in test tubes. A special test tube rack is placed into the water-filled beaker, which is then heated as above.

3.14.2.5 Heating solid substances

In a test tube (small amount): Carefully over a small flame, moving the test tube. Never point the test tube mouth at yourself or co-workers.

In a crucible: Placed on a clay triangle mounted to a tripod stand.

In an electric lab oven: If more heat is required, an electric lab is used. Note! Crucibles cool very slowly, so do not touch with bare hands.

3.14.2.6 Electrical equipment

Read the operating instructions before turning the equipment on. If you notice any faults in the equipment, turn it off (if possible) and immediately report the faulty device to your supervisor, the person in charge of equipment or the laboratory technician. Keep all electric equipment and their wires dry and clean. If any equipment is doused with water, shut off the mains power, pull out the power cord and dry the equipment. Never touch electrical equipment with wet hands!

3.14.2.7 Gas cylinders and line

Gas cylinders are to be securely fastened to, for example, the wall. Read the pressure relief valve instructions before using a gas cylinder or gas supplied by a gas line.

Instructions on the handling of gas cylinders:

- Never lift a gas cylinder by its hood or valve cap.
- Always use a cylinder hand truck or cylinder rack when moving cylinders.
- The valve cap or guard must be mounted whenever moving a cylinder.
- Use soapy water to check for leaks (e.g. ready-made leak detection fluid).
- Always use the proper pressure regulator intended for the gas in question. The use of spacers is expressly prohibited. Check the correct pressure rating before connecting the cylinder.
- Measures must be taken to prevent backflow into the cylinder (e.g. with a check valve) before connecting the cylinder.
- Open the cylinder valves slowly.
- Cylinders must be reliably prevented from tipping over.
- Cylinders must be protected against mechanical shocks.
- Always close the valve when the cylinder is not in use.
- Empty gas cylinders must always be handled as if they were full.

3.14.2.8 Underpressure and overpressure work

When performing tasks that involve under or overpressure, there is always a risk of equipment "explosion". Only use parts (e.g. hoses, glassware) specifically intended for the purpose in question.

3.14.2.9 Equipment instructions

Key operating instructions, calibration instructions (if any) and the name of the equipment supervisor for all large laboratory equipment should be posted next to the workstation. The operating instructions contain information on, for example, whether to keep an equipment usage log, how often the equipment should be calibrated and whether it requires a specially appointed supervisor. The equipment supervisor provides instruction on the correct use and technical capabilities of the equipment.

3.14.3 Handling chemicals

Always treat unknown chemicals as hazardous. Learn about any hazardous properties of the chemicals you are using (Safety data sheet, see section 3.9) and take the necessary precautions.

Never taste any chemicals and avoid smelling any gases produced. If smelling is necessary to identify a substance, do so with caution. Substances with foul or toxic vapours should always be handled in a vapour hood (cf. section 5.7). Keep an eye on the function of the vapour hood. If you suspect that the vapour hood is not working properly, report it to your supervisor or, for example, your research group laboratory technician.

Avoiding touching chemicals with bare hands (cf. section 5.1). Toxic substances can also be absorbed through the skin. Use a lab spoon/spatula. Wash your hands if any chemicals splatter onto your skin.

3.14.3.1 Labels and caps

Do not change the caps of reagents. Ensure that all reagent bottles you are using are properly labelled. If a substance is hazardous (see section 3.3), mark the bottle with, for example, a separate warning label (Figure 3 or Figure 4). Never use a reagent whose label is illegible.

3.14.3.2 Taking chemicals from storage bottles

Solvents are taken from a tap into a beaker in suitable amounts. If the bottle does not have a tap at its base, the solvent is poured from the bottle. There is no need to use your own pipette. Solid substances are poured into, for example, a watchglass or onto paper in the required amount. You may not use your own spatula.

Every effort should be made to use only the required amount of chemicals in order to both preserve the environment and save on chemical costs. If, however, any chemicals are left over, they may not be poured back into the storage bottle.

3.14.3.3 Concentrated acids and bases

Any acids or bases that splatter onto the worktable must be wiped up immediately. Larger quantities of acids or bases must first be neutralised.

Dilution of acids: Always pour the concentrated acid being diluted into water. Pouring water into concentrated acid causes a highly exothermic reaction and poses a splash hazard. Particularly when diluting sulphuric acid, this rule must be followed.

Diluting sodium or potassium hydroxide also causes a highly exothermic reaction, so they should be diluted in an adequately sized, heat-resistant container.

3.14.3.4 Liquefied and solidified gases

Nitrogen is a commonly used liquefied gas in laboratories, but other liquefied gases are also used, such as helium in NMR equipment. The handling of liquefied gases always requires special precautions, due to their extremely low temperatures: the boiling point of liquid nitrogen is -196°C. Always use protective equipment (gloves, aprons, footwear; see section 5) and containers that can withstand extremely low temperatures. Direct contact with the skin results in severe frostbite injuries.

Also ensure that there is adequate ventilation. When boiling, liquefied gas produces a large quantity of gas. One litre of liquid nitrogen can produce approximately 700 litres of nitrogen gas, thus reducing the oxygen concentration in the room to a point below critical levels (cf. section 3.12.2.1 and 7.5). The figure below (Figure 11) shows a portable gas detector, which warns when the oxygen concentration falls too far, and containers suitable for the storage of liquefied gases (cryogenic or cryotanks).

Figure 11 Portable gas detector and two types of cryotanks

The surface of uninsulated containers holding liquefied gas is cold enough to cause air condensation, thus forming droplets. Condensed air can contain as much as 50% oxygen, which promotes the ignition of flammable substances. The resulting fire can be extremely intense. In other words, avoid bringing flammable materials into contact with the condensed air.

Dry ice
Dry ice is a solid form of carbon dioxide. Its temperature is -79°C. Always use the appropriate protective gloves when handling dry ice (see section 5.1). Direct contact with the skin results in severe frostbite injuries. Dry ice should also never be put into the mouth.

3.14.3.5 Peroxides

Peroxides can form in some solvents, such as diethyl ether, during their storage. A peroxidic ether can explode when heated or evaporating. The danger of peroxides forming decreases if the ether is kept in a dark bottle and stored in a cool place, sheltered from sunlight. If this type of solvent is to be evaporated or heated, steps must be taken to see whether the solvent contains any peroxides, using, for example, an oxidised potassium iodide solution. The solutions are not mixed together, but rather form two separate phases: the upper phase is ether and the lower phase is an iodine solution. If the solvent contains peroxides, the reagent in the lower phase turns brown or, when using starch, blue. When conducting the test, a blank test of the reagents should also be done. Before heating or evaporating a solvent, peroxides are removed with active charcoal, by washing with an iron sulphate solution or pouring the solvent through a column of aluminium oxide.

3.15 Storage of chemicals

The use, transfer and storage of hazardous chemicals is regulated in a separate act, the *Act on the Safe Handling and Storage of Dangerous Chemicals and Explosives* (390/2005). The Act specifies the following:

- The holder of a dangerous chemical shall exercise care and caution in its storage.
- Dangerous chemicals shall be stored in containers fully compliant with applicable requirements in areas reserved specifically for them. Furthermore, the holder of a chemical shall ensure that no unauthorised personnel take possession of it. In a storage area for dangerous chemicals, attention should be given to making the appropriate arrangements and ventilation as well as ensuring that the chemical can be recovered or rendered harmless in the event of an accident.
- Chemicals that react with one another shall be stored separately, if their reactions result in fire, substantial exothermic reactions, the production of hazardous gases or the formation of unstable substances.
- The storage quantities and locations of dangerous chemicals shall be such that they do not pose any threat.

3.16 List of chemicals

As stated in the *Government Decree on Chemical Agents at Work* (715/2001): "... employer shall keep an updated list of the chemicals, itemised by their trade names, which are used in the workplace. The list must reveal the classification data of each chemical and which of the chemicals have available safety data sheets." (section 3.9). The safety data sheets and the list of the chemicals used in the workplace shall be accessible for the employees in the workplace. The safety data sheets and the list or copies of those shall be provided to the occupational safety and health representative of the workers at the workplace in an appropriate manner."

3.17 Instructions regarding chemicals that may potentially cause accidents (OVA instructions)

The Instructions regarding chemicals that may potentially cause accidents (OVA instructions) were drafted by the Finnish Institute of Occupational Health and are intended for use as a source of chemical safety information for emergency rescue services, environmental protection authorities and anyone interested in chemical hazards. There are OVA instructions for 93 substances, including abstracts for each to provide a brief, concise overview of key information. These abstracts can be found on the Finnish Institute of Occupational Health website (see section 8.1).

4 OTHER AREAS OF OCCUPATIONAL SAFETY

4.1 Workshop safety

Workshop functions are regulated by, for example, the Occupational Safety and Health Act (738/2002) and *Government decree on the safety of machinery* (400/2008).

A risk assessment is conducted for all machines and equipment (cf. section 1.8). Assessments are conducted on new machines before they are taken into use. Machines and equipment, which require special professional skills, may only be used by personnel who have received training for them. A list of large machine supervisors and personnel authorised to use the machines must be posted on the workshop wall. Large machines are, for example, circular saws, lathes, welding equipment, routers and drill presses.

Whenever beginning work, it must be ensured that all safety and protective equipment are in place. As stated in the Occupational Safety and Health Act (738/2002): "Safety devices or guards installed in machinery, work equipment or other device or a building shall not be removed or disconnected without a special reason. If an employee, owing to the work task, temporarily has to remove a safety device or guard, he or she must restore or reconnect it as soon as possible." Disconnecting safety equipment must always be discussed with the workshop supervisor.

4.2 Hot work

Hot work is any work that generates sparks or uses an open flame or other source of high temperature and poses a risk of fire. Hot work includes gas and arc welding, flame and arc cutting, disc cutting, metal grinding, work involving a Bunsen burner or other open flame and work involving hot air blowing. Hot work is primarily performed at a hot work site approved by fire protection authorities that is marked by the sign shown below (Figure 12). The hot work site must always have adequate portable fire extinguishing equipment. Flammable waste generated by hot work must be kept in metal waste containers with lids. Flammable goods that are not part of the work being performed must not be found in the worksite. Flammable liquids must not be stored or handled in or around the hot work site. When performing hot work, a company must always have a hot work supervision plan. Hot work supervision plans must be included in the educational emergency response plan (cf. section 1.7).

Figure 12 Hot work site sign and hot work card.

4.2.1 Temporary hot work site

A hot work site is temporary when it does not meet the requirements set for a permanent hot work site, and work may be performed there only if it is not possible to perform work in the permanent hot work site. A written hot work permit compliant with the supervision plan must be obtained whenever performing hot work in a temporary hot work site. In addition to this, personnel performing hot work must hold a valid hot work card (Figure 12). A temporary hot work site must have the portable fire extinguishing equipment specified in the hot work permit; this equipment must be at least equivalent as that in a permanent hot work site. After finishing hot work, hot work supervision must be continued for the period of time specified in the hot work permit. All fire alarms disconnected during the hot work must be reconnected immediately when the work has been completed and the Emergency Response Centre must be notified of the reconnection. Establishment of a temporary hot work site must comply with the SFS 5900 standard (*Hot work fire safety*). The standard in question also includes guidelines for personnel whose task it is to supervise, monitor and perform hot work.

4.3 Radiation safety

4.3.1 Ionising radiation

Typical sources of ionising radiation include x-ray radiation, cosmic radiation, and radiation from radioactive substances, which is further divided into three key types: alpha, beta and gamma radiation. Use of ionising radiation requires a permit. This requires a safety permit specified in the *Radiation Act* (592/1991) and *Radiation Decree* (1512/1991). Permits are issued by the Radiation and Nuclear Safety Authority (STUK). Prior to making a permit decision, the applicant must demonstrate that the place of use, radiation sources and protective equipment comply with safety requirements. The place of use must be staffed with a safety supervisor and qualified personnel.

The radiation protection for places where radiation equipment and radioactive substances are used must be designed and constructed in such a way that the use of radiation will not pose any danger to employees or other personnel. When planning protection, the number and type of uses of the radiation equipment or source as well as the use of the surrounding facilities must be taken into consideration. When designing places of use, attention must also be given to the fact that radiation equipment and radioactive substances must, under no circumstances, fall into the hands of unauthorised personnel.

The supervisor oversees the safety of radiation operations in co-operation with the Radiation and Nuclear Safety Authority and is responsible for ensuring that the operations meet requirements and inspection obligations specified in the Radiation Act.

4.3.1.1 Maximum values for radiation exposure

The Radiation Decree (1512/1991) specifies the following, among others, concerning maximum values for radiation exposure:

- "The effective dose caused to a worker by radiation work shall not exceed an average of 20 millisieverts (mSv) per year reckoned over a period of five years, nor 50 mSv in any one year. The annual equivalent dose in the lens of the eye shall not exceed 150 mSv, nor shall the annual equivalent dose at any point on the hands, feet or skin exceed 500 mSv.

- The effective dose to a young person of no less than 16 but no more than 18 years of age who is involved in the use of radiation sources in the course of vocational training shall not exceed 6 mSv per year. The annual equivalent dose in the lens of the eye shall not exceed 50 mSv, nor shall the annual equivalent dose at any point on the hands, feet or skin exceed 150 mSv.
- The foetus shall be protected in the same way as any member of the public. When a woman has announced her pregnancy, her work shall be arranged so that the equivalent dose of the foetus is as low as reasonably achievable, nor shall it exceed 1 mSv for at least the remainder of the pregnancy. When a woman has announced that she is breastfeeding an infant, she shall not be kept in work involving a risk of significant intake of radioactive substances."

4.3.2 Non-ionising radiation

Low-energy electromagnetic fields are part of our living environment. The most well-known of these fields occurring in nature is the magnetic field generated by the Earth and the sun. Human-made fields include the radiofrequency fields of mobile phones and low-frequency fields generated by the use of mains power. Exposure to non-ionising radiation is regulated in the Ministry of Social Affairs and Health *Decree on the limitation of public exposure to non-ionising radiation* (294/2002). This decree sets the public exposure limit for non-ionising radiation

- maximum values for electrical and magnetic fields over 100 kHz
- maximum values for laser radiation
- maximum values for ultraviolet radiation

In addition to this, recommended values are given for electrical and magnetic fields below 100 kHz. The maximum value or recommendation for electrical and magnetic fields does not guarantee that they will not interfere with the function of life support devices, such as a pacemaker.

When a monitor, magnetic stirrer or other machine is live (i.e. it is plugged into a mains outlet), there will be an electric field in and around the machine. When the machine is turned on and electrical current flows into it, a magnetic field will also form around the machine. The strength of both the electrical and magnetic field drops off rapidly with distance from the machine.

An electric field is formed by differences in voltage and its strength is measured in volts per metre (V/m). The higher the voltage, the stronger the electric field. Electric fields are strongest in the immediate vicinity of high-voltage power transmission equipment and high-power industrial equipment. The electric fields generated by home appliances and small machines are insignificant.

The magnitude of a magnetic field is expressed as a magnetic flux density, whose unit of measurement is the Tesla (T). As a rule, magnetic fields have a more significant impact on the health than electric fields. A television picture or computer screen can also be affected by a magnetic field. The source of a magnetic field might be a main distribution board or, for example, a magnetic stirrer.

4.3.2.1 Laser safety

A laser is a device that emits coherent light. In coherent light, the phases of all electromagnetic waves (wavelength 180 nm - 1 mm) are identical. A laser beam travels a great distance in the air, because it does not spread out and scatter like an ordinary beam of light. The hazardous aspect of a laser beam is that a laser can focus a large amount of energy on a very small spot. For example, the powerful beam of cutting lasers used in surgical procedures and industry burns and vaporises tissue or other material. This is why a powerful laser beam can cause irreparable damage if it accidently strikes an eye or skin. Laser safety and maximum values for laser radiation exposure are regulated by the *Government decision on laser equipment and their inspection* (291/2008) and SFS-EN standard 60825 (*Safety of laser products*).

Safety classification

Laser safety classes are specified in Government decision 291/2008 and SFS-EN standard 60825, so that the higher the class number, the more hazardous the laser is.

- Class 1 (enclosed machining laser)
  - the power of the laser beam in a laser product is so weak that it does not pose a risk under any circumstances, or the laser product is built in such a way that the laser beam only travels inside the product, without escaping. The laser encased inside the laser product may, however, be so powerful that it belongs to a higher safety class. This is the case with, for example, CD players. The user instructions for these kinds of devices includes a warning, stating that the protective casing must not be opened.
- Class 2
  - the laser produces only visible light and their power is relatively low. As a rule, the blink reflex will protect the eye. However, staring at a beam from a laser in this class can damage the eye. Many laser pointers and lasers used in schools for educational purposes belong to this class.
- Class 1M and 2M
  - the laser product beam either has a large divergence or it is a single direction laser with a relatively wide beam at the aperture. Looking at Class 1M and 2M laser beams only poses a hazard when using magnifying optics, such as binoculars or a magnifying glass.
- Class 3R
  - lasers are slightly more powerful than Class 1 and 2 laser products. Direct beam exposure or a beam reflected from a smooth surface can cause permanent eye damage. This class includes the most powerful laser pointers permitted in Finland as well as professional-grade surveying lasers.
- Class 3B
  - direct beam exposure and beams reflected from a mirror are always hazardous to the eyes.
- Class 4 (unenclosed machining laser)
  - the laser beam is so powerful that it can cause a burn injury instantaneously. The eye can be damaged even from diffuse exposure. A high-power laser beam can cause wood or fabric to ignite. Class 4 lasers are used in, for example, hospitals and industry as cutting lasers as well as for special light effects in entertainment.

Hazards
Lasers operating in the visible-light and near infrared wavelength ranges can cause permanent damage to the retina. The most important safety requirement is, of course, that the laser beam never be pointed at people.

Primary hazards:

- Eye exposure (see section 5.2)
- The laser beam must be isolated to prevent eye exposure (acrylic guards, protective casings, beam carrier shielding).
- If a laser poses a direct or indirect radiation hazard, use protective eyewear.
- Avoid looking directly at a beam.
- Skin exposure

Secondary hazards:

- Fire and explosions
- The work piece can ignite during processing.
- Sparks can start fires in the flue gas exhaust (inadequate cleaning).
- Refrigerant leaks can cause explosions at the laser end.
- The cutting dust produced when cutting titanium is an explosive substance.
- A reflected beam can heat liquid or gas containers located near the laser.
- Chemical hazards
- Refrigerants can cause burns on the skin.
- Poisoning caused by vapours produced
- From active laser (gain) media:
- Of the optical components, ZnSe focusing lenses are used on, for example, CO_2 lasers. If these lenses should break, the ZnSe dust is extremely toxic when inhaled (cf. section 3.2.1).
- Vapours produced during laser processing can be extremely hazardous. For example, Be, Cd and Co vapours have proven to be carcinogenic in even the smallest doses (cf. section 3.4).
- Oxygen displacement caused by the gasification of liquefied nitrogen refrigerant (cf. section 3.14.3.4).
- Electrical hazards
- Laser excitement sources generate extremely high voltages, e.g. DC-excited CO_2 lasers – 20,000 V.

Safety guidelines
SFS-EN standard 60825 and Government decision 291/2008 specify, among others, the following safety guidelines for laser use:

- Possible reflections from each work piece must be determined.
- The laser operating area must be shielded.
- Access to the laser work area is only permitted for personnel wearing the proper eye protection and safety apparel.
- The laser equipment and doors leading to its operating area should be marked with the warning signs shown here (Figure 13).

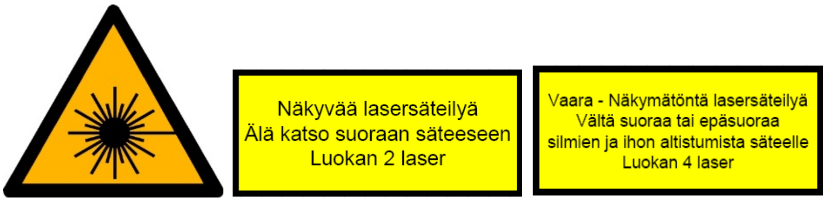


Figure 13 Laser safety warning signs

4.3.2.2 Ultraviolet radiation safety

As stated in the Ministry of Social Affairs and Health Decree 294/2002: "The radiation exposure caused by ultraviolet radiation (UVR) appliances shall be limited below a level where a short-term exposure does not cause acute harmful health effects and the adverse chronic health effects are minimized."

The decree also states that:

- "The effective radiant exposure of ultraviolet radiation to the skin in 24 hours shall not exceed 50 J/m^2 in the wavelength band 180 - 400 nm."
- "The effective radiant exposure of ultraviolet radiation to the eye in 24 hours shall not exceed 30 J/m^2 in the wavelength band 180 - 400 nm and the radiant exposure shall not exceed 10 kJ/m^2 in the wavelength band 315 - 400 nm."

4.4 Electrical safety

As stated in the *Electrical Safety Act* (410/1996): "For the purpose of ensuring the safe use of electrical equipment or electrical installations and of preventing the harmful effects of electromagnetic interference resulting from the use of electricity, and for the purpose of securing the position of a person who has suffered damage caused by the electric current or magnetic field of electrical equipment or an electrical installation, this Act shall lay down the requirements concerning electrical equipment and electrical installations, the manner in which conformity with these requirements is demonstrated and monitored, work in the electricity sector and its supervision and the liability for damages of the possessor of electrical equipment or electrical installations."

Key safety requirements for electrical installations are laid out in the *Decision of the Ministry of Trade and Industry on Safety of Electrical Installations* (1193/1999). Regulations concerning electrical work are laid out in the *Decision of the Ministry of Trade and Industry on Electrical Works* (516/1996), as follows: "Electrical work refers to the repair and servicing of electrical equipment and the construction, repair and servicing of electrical installations. Electrical work is not considered to include the demolition of electrical equipment and installations if the equipment or installation in question has been reliably and duly de-energized."

"Work related to the repair and servicing of electrical equipment, and work related to the construction, repair, servicing and use of electrical installations shall be authorised on the following conditions:

- a sufficiently qualified natural person is appointed to direct the work (supervisor); No supervisor is required for one-time work (...) or for work that may cause only a minor risk or interference referred to in Section 5 (of the Electrical Safety Act 410/1996);

- a natural person independently carrying out and supervising work possesses sufficient qualifications or otherwise has sufficient professional skills; and
- premises and tools necessary for carrying out the work are used, and the provisions and regulations on electrical safety are observed."

In accordance with applicable electrical safety regulations, all power grid parts and components must be intact, and any faulty equipment shall be immediately disconnected from the grid. Professionals specialising in workshop electrical work and authorised third-party service providers are to be used in the construction and repair of equipment that uses electricity.

The supervision of electrical products is based on the Electrical Safety Act (410/1996) and other attendant regulatory provisions. In accordance with the above legislation, the manufacturer is responsible for ensuring the safety of its product, while the authority in question is responsible for overseeing the general safety and conformity of products on the market. The Finnish Safety and Chemicals Agency (Tukes) is responsible for the supervision of electrical products. By marking its product with a CE marking (see Figure 14) the manufacturer or importer assures that its product fulfils the appliche requirements of applicable EU legislation.

Electrical equipment intended for use in explosive atmospheres (cf. section 3.11) must comply with ATEX Directive 1994/9/EC (Decision of the Ministry of Trade and Industry on equipment and protective systems intended for explosive atmospheres 918/1996) requirements.

4.5 Refrigeration equipment safety

Refrigeration equipment is generally based on vapor compression, which cools measuring equipment or indoor air as well as coolers and freezers. Refrigeration equipment can suffer from malfunctions, where the equipment refrigerant or a water-glycol mixture (i.e. anti-freeze) can leak into the environment and cause an environmental hazard.

Glycol-based refrigerant is hazardous waste, as specified in the *Waste Act* (646/2011) (see section 6.3), which is flushed out of the cooling system for recovery, labelled and taken to the nearest hazardous waste collection point. Flushing a single cooling system can yield approximately 30-60 litres of glycol waste. If multiple systems are being flushed, there will be more waste. In such cases, a service provider is hired to take the glycol waste away.

In refrigeration equipment and their design, it must be taken into consideration that, according to the Government Decree on the maintenance of equipment containing ozone-depleting substances and certain hydrofluorocarbons and qualifications required of persons carrying out maintenance and waste management (1187/2001), all refrigeration equipment containing more than 3 kg of CFC or HCFC refrigerants (R22, R12, R502, R134a, R404A, R407C and R410A) must be inspected for leaks at least once a year. The owner or holder of the refrigeration equipment is responsible for inspections, which may only be conducted by an authorised refrigeration professional. Using an electronic leak detector, the equipment compressors, condensers and evaporators are checked for leaks. In addition to this, the entire circulation system must be inspection if any refrigerant has been added to the equipment. Regional Environment Centres, municipal environmental protection authorities and health inspectors oversee the conducting of leak inspections.

As specified in Decrees 1187/2001 and 1239/2003 (Government Decree on the maintenance of equipment containing ozone-depleting substances and certain hydrofluorocarbons and qualifications required of persons carrying out maintenance and waste management), maintenance and inspection records on refrigeration equipment. These records contain all maintenance procedures performed, particularly the addition of refrigerant. Refrigerant is circulated inside the refrigeration equipment, and is not consumed or lost in any way. If any refrigerant must be added, there is a leak in the equipment that needs to be located and repaired immediately. A maintenance tag, which lists when the last statutory inspection was conducted and the deadline for the next inspection, must be affixed to the refrigeration equipment. The tag is filled out and affixed by the refrigeration maintenance service provider.

Refrigeration installation and maintenance work may only be performed by a service provider which has received a Finnish Safety and Chemicals Agency (Tukes) qualification certificate. The Tukes Qualification Register can be found on the Tukes website (see section 8.1). The client ordering the work to be performed must always ensure that the name of the refrigeration work service provider is on the Tukes Qualification Register. If it is not, the service provider is guilty of violating *the Finnish criminal Code* (39/1889). A Tukes qualification certificate is an indication of the service provider's professional expertise.

4.5.1 Cooler and freezer safety

Many educational institutions have coolers and freezers. Working in these areas does not differ from normal laboratory work aside from the fact that the room temperature must be taken into consideration with regard to clothing. The equipment and supplies being used must also be able to withstand the cold. Chemicals and samples stored in coolers and freezers must be properly marked (see section 3.7).

4.6 Cleanroom safety

A cleanroom is a separate, closed area, whose environmental conditions, such as the volume of air impurities, particle sizes, temperature and pressure, are precisely controlled. Personnel working in a cleanroom and the materials being handled there must be brought into the room through vestibules. When entering a cleanroom, all personnel must wear cleanroom suits.

The cleanroom systems protect people and products from impurities, eliminating either organic or inorganic contaminants as well as hazards in the work and production areas. The goal is to eliminate the contaminants and their sources, preventing them from spreading into the environment, and to reduce the volume of contaminants in the work areas.

The pressure inside a cleanroom is higher than that outside. The cleanroom pressure is increased by means of laminar air conditioning and filter systems. A HEPA filter, which removes a minimum of 99.97% of particles 0.3 microns in size or, if more efficient filtration is needed, a ULPA filter, which removes 99.999% of particles 0.1 - 0.2 microns in size are typically used to condition make-up air in the cleanroom. The particle volume is limited to the desired level of cleanroom purity.

Humans constantly release particles and the microbes they carry. Epithelial skin cells regenerate approximately twice a week and the dead cells are shed from the surface of the skin by flaking. Approximately 10 million dead skin cell particles are shed every day. These particles are spread into the environment also through the mouth and nose by speaking, breathing, coughing and sneezing as well as from the clothes being worn. The table below (Table 5) shows how many particles are released from humans.

Table 5 Particles released from humans.

Particles released from humans no./min.	Normal clothing	Laboratory wear	Cleanroom suits
Sitting still	448 000	142 000	14 920
Sitting, small movements	4 450 000	462 000	48 600
Standing, moving about	2 240 000	390 000	31 700
Brisk walking	5 380 000	1 285 000	157 000

Cleanrooms are classified in accordance with different standards, for example, by the volume of air impurities. The tables below list the SFS-EN ISO 14644-1 standard *(Cleanrooms and associated controlled environments. Part 1: Classification of air cleanliness*), which was ratified on 14 February 2000 (Table 6) and **G**ood **M**anufacturing **P**ractice (GMP) particle limits used in the pharmaceuticals industry (Table 7).

Table 6 Cleanroom classification according to the SFS-EN ISO 14644-1 standard.

ISO Class no.	Maximum permitted number of particles (particles/m^3 of air) equal to or greater than the sizes specified below					
	0.1 µm	0.2 µm	0.3 µm	0.5 µm	1 µm	5 µm
ISO 1	10	2				
ISO 2	100	24	10	4		
ISO 3	1,000	237	102	35	5	
ISO 4	10,000	2,370	1,020	352	83	
ISO 5	100,000	23,700	10,200	3,520	832	29
ISO 6	1,000,000	237,000	102,000	35,200	8,320	293
ISO 7				352,000	83,200	2,930
ISO 8				3,520,000	832,000	293,000
ISO 9				35,200,000	8,320,000	239,000

Table 7 GMP limits for particle quantities

Grade	At rest		In operation	
	Maximum permitted number of particles/m³			
	≥ 0.5 µm	≥ 5 µm	≥ 0.5 µm	≥ 5 µm
A	3 500	0	3 500	0
B	3 500	0	350 000	2 000
C	350 000	2 000	3 500 000	20 000
D	3 500 000	20 000	Not defined	Not defined

4.6.1 Clothing

Although machines, materials and facilities can be fully sterilised, protecting people is far more difficult. People carry with them enormous quantities of particles, spreading them around the environment. This is why users play a crucial role in the function of a cleanroom. By wearing the proper clothing and acting in the right manner, the user can substantially reduce the risks they pose to cleanroom functions.

Cleanroom clothing is subject to extremely stringent requirements compared to other work and protective wear. Because a working person is the most problematic particle source in the cleanroom, the primary purpose of the cleanroom suit is to keep released particles inside the suit. In addition to particles from the person, no particles must be released from the suit material itself. Cleanroom suits are chosen based on the desired level of purity and protection.

4.6.2 Hygiene

Work being performed in the cleanroom is primarily done with the hands. This is why keeping the hands clean and gloves clean and intact play a key role in cleanrooms. Washing with ordinary soap and water will easily remove all unwanted microbes and particles that have joined your own microbe content from the environment. It will also remove part of the skin's own microbe content. Immediately after washing, however, there is an explosive growth in bacteria - around two hours later, the skin is once again releasing large quantities of bacteria. Using a disinfectant will slow down the bacterial growth, thus decreasing the number of particles being released significantly. Even when wearing protective gloves, bacteria can still enter the cleanroom through microscopic holes forming in the gloves.

The use of make-up is not recommended in a clean roo, because make-up produces an enormous amount of particles, whereas unscented moisturising lotions have been found to reduce the number of particles being released from the skin.

Working in a cleanroom while coughing or sniffling/sneezing is to be avoided, because coughing and sneezing release massive amounts of particles in droplets. As they descend, these droplets dry quickly, thus effectively spreading the particles into the environment.

4.6.3 General work instructions

Because people are the worst cleanroom contaminators, cleanrooms need certain "rules of play" to ensure that people know how to work there. In addition to clothing, the amount of movement affects the volume of particles entering the cleanroom. The more people move, the more particles are released. In order to minimise the ingress of particles into the cleanroom, it is important to keep movements as calm and slow as possible. In order to achieve the best result, proper working practices must be taught comprehensively.

Below are guidelines for working in a cleanroom:

- Never open both vestibule doors simultaneously
- Clothing for different cleanrooms should never be worn/stored in the same room
- Never bring non-sterile items into a cleanroom
- Always use calm, slow movements when working in a cleanroom
- Use gloves whenever working with equipment and samples
- Follow all dress guidelines
- Never wear make-up or jewellery
- Never touch your bare skin

5 PERSONAL PROTECTIVE EQUIPMENT

Always use the necessary personal protective equipment when performing any work. As stated in the Occupational Safety and Health Act (738/2002): "Employers shall acquire and provide for use by employees [and students] appropriate personal protective equipment in compliance with requirements separately provided by statute if the risk of injury or illness cannot be avoided or adequately reduced by measures focused on the work or working conditions." (cf. section 1.8). Personal protective equipment includes protective gloves, footwear, coats and helmets as well as hearing, face and respiratory protectors.

As stated in the Occupational Safety and Health Act (738/2002): "Employees **shall use and care for the personal protective equipment and other equipment the employer has provided for them**." Personal protective equipment is regulated by, among others, *Government decision on Personal Protective Equipment* (1406/1993) and *Government decision on the selection and use of personal protective equipment at work* (1407/1993).Also, as stated in the Occupational Safety and Health Act (738/2002): "Employees shall in their work wear such appropriate clothing that does not cause a risk of injury." The personal protective equipment used must meet European Union requirements and, therefore, must bear a CE marking (Figure 14). Cleanroom work demands special attention concerning the use of personal protective equipment and clothing. The requirements for cleanroom clothing are outlined in section 4.6.1.

5.1 Hand protection

Protective gloves must be used whenever handling poisons, solvents and corrosive, sensitising, carcinogenic and infectious substances. When choosing gloves, it should be kept in mind that each glove material provides protection only for specific substances. It is therefore crucial that the user choose the right glove material. If you use the wrong gloves, they may be permeated by chemicals, which are absorbed through the skin as the hands sweat. The result may be worse than if the user had not worn gloves at all.

Determine which glove is the right choice for each substance. Typical glove materials are natural rubber, PVC, nitrile, neoprene and butyl rubber. Glove durability, permeability and other properties are regulated by, among others, the following standards: SFS-EN 420 (*Protective gloves. General requirements and test methods*), SFS-EN 374 (*Protective gloves against chemicals and micro-organisms*), SFS-EN 388 (*Protective gloves against mechanical risks*), SFS-EN 407 (*Protective gloves against thermal risks*) and SFS-EN 511 (*Protective gloves against cold*). Gloves are marked with pictograms compliant with the SFS-EN 420 standard (Figure 14). These pictograms indicate "what the glove can withstand".

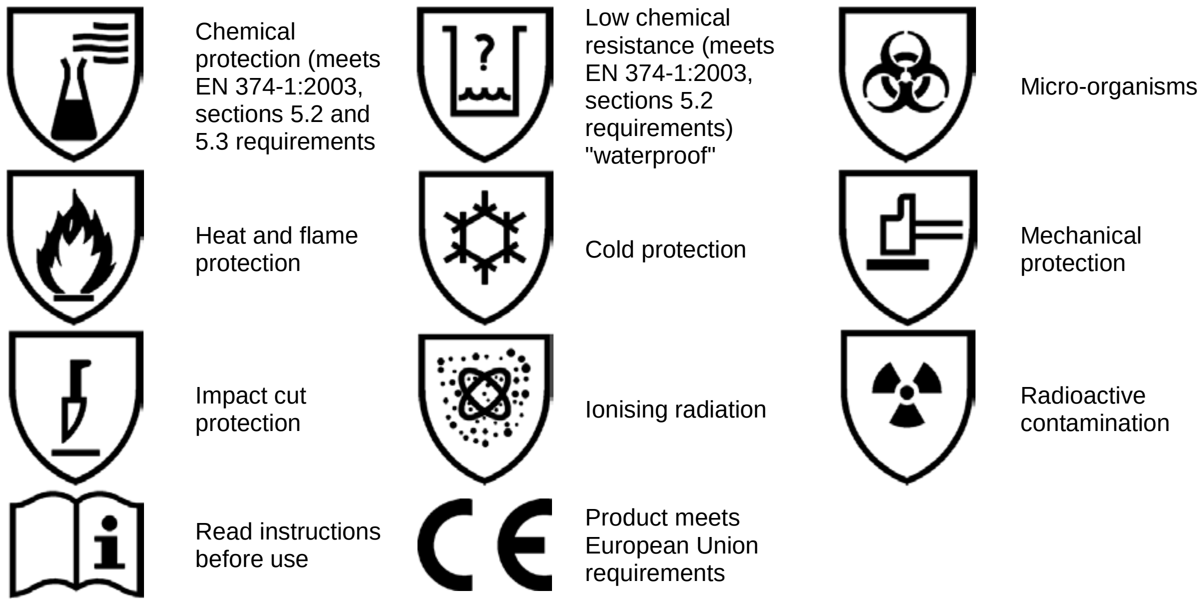


Figure 14   SFS-EN 420-compliant glove test pictograms.

Chemical protection is only provided by SFS-EN 374-compliant gloves with a chemical permeability performance level of at least 2 with three standard defined chemicals. These standard defined chemicals and their code letters are listed in the table below (Table 8). The code letters of standard defined chemicals are marked on the glove or glove packaging together with the test pictogram (Figure 14).

Table 8 SFS-EN 374 standard defined chemicals.

Code letter	Chemical	CAS number	Category
A	Methanol	67-56-1	Primary alcohol
B	Acetone	67-64-1	Ketone
C	Acetonitrile	75-05-8	Nitrile compound
D	Dichloromethane	75-09-2	Chlorinated paraffin
E	Carbon bisulphide	75-15-0	Sulphur containing organic compound
F	Toluene	108-88-3	Aromatic hydrocarbon
G	Diethylamine	109-89-7	Amine
H	Tetrahydrofuran	109-99-9	Heterocyclic and ethereal compound
I	Ethyl acetate	141-78-6	Ester
J	n-Heptan	143-85-5	Saturated hydrocarbon
K	Sodium hydroxide 40%	1310-73-2	Inorganic base
L	Sulphuric acid 96%	7664-93-9	Inorganic mineral acid

Gloves may also be marked with CE XXXX, in which XXXX is the four-digit code of the notified body. The glove or glove package must bear a CE marking (Figure 14) as well as the manufacturer's contact information, glove name, size, test standard and, if necessary test marking (Figure 14). The manufacturer must also provide a chemical resistance table with breakthrough times. The figure below (Figure 15) shows examples of various gloves. Hands and arms should also be protected when working near a UV table.

Figure 15 Chemical-resistant lab gloves, cryogenic gloves for handling liquefied gases and workshop gloves.

5.2 Eye and face protection

When performing work in which there is a risk of chemicals splattering or hazardous radiation being reflected into the face or eyes, eye protection must be worn. Depending on the use, there are many different types of eye protection available. The best protection is provided by eyewear with side, top and bottom shields. Normal eyeglasses provide insufficient protection from splattering, and many eye protectors can be worn over eyeglasses. It is also possible to use prescription eye protectors. In some cases, there is also a need to use a face protector, if there is any risk of, for example, strong chemical reactions, chemical splattering when opening a pressurised container, projectiles or even cracking of a container (e.g. vacuum distillation). UV eye protection must be used when the work requires looking at UV light, such as a UV bulb in a spectrophotometer. The figure below (Figure 16) shows some typical eye and face protectors.

Figure 16 Eye and face protectors

The material and function of laser eye protection depends on the power, wavelength and type of the laser being used. The eye protector should be marked with the protected wavelengths and their level of protection (Figure 17).

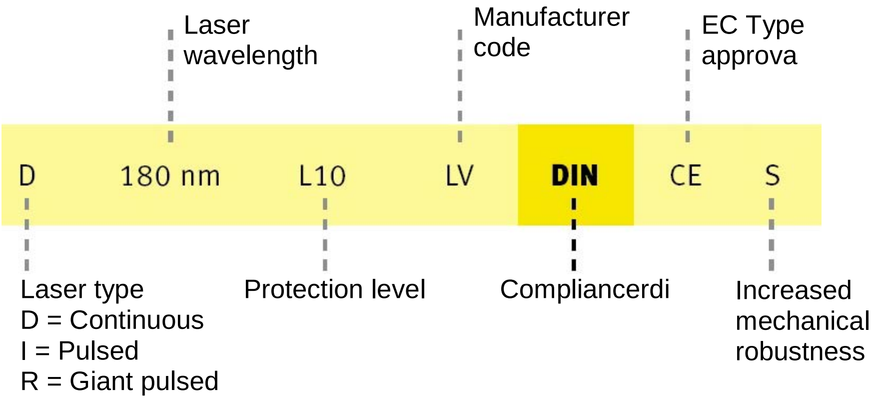


Figure 17 Markings on laser eye protection.

5.3 Respiratory protection

Work, in which gases hazardous to the health are produced or in which dust is formed, must be performed in a vapour hood or, if this is not possible, local exhaust ventilation must be used (see section 5.7). If it is not possible to use a vapour hood or local exhaust ventilation, a respiratory protector (Figure 18) must be used, while ensuring the necessary room ventilation. Respiratory protectors come in a variety of models with a variety of filters, depending on the work being performed. Paper facemasks are only used to protect against inhaling dust and they come in two protection classes:

- P1 for coarse dust
- P2 for fine dust

Half and full face-piece respirators use filters for both extremely fine dust (such as micro-organisms and radioactive particles - P3) and for different chemicals, or combinations of the two.

Below are some chemical filters for protection against: (Filter type code letters and colours shown in parentheses)

- organic gases and vapours, such as toluene and xylene, with a boiling point of higher than 65°C (A, Brown);
- organic gases and vapours, such as acetone and diethyl ether, with a boiling point lower than 65°C (AX, Brown-White);
- inorganic gases and vapours, such as chlorine, hydrogen sulphide and hydrogen cyanide (B, Grey)
- acidic gases and vapours, such as sulphur dioxide and hydrogen chloride (E, Yellow)
- ammonia and organic ammonia derivatives, such as ethylamine (K, Green)
- combinations of the above (e.g. ABEK).

Many adhesives, paints and lacquers contain organic hydrocarbon solvents. It must also be kept in mind that the respirators in question only provide protection up to a certain concentration and are divided into three different categories based on the level of filtration protection they offer. Filters also decline in performance over time. A rule of thumb to follow is that, if you can smell the chemical through a chemical filter, it has to be replaced.

Figure 18 Dust mask and gas respirators: full and half-face piece.

5.4 Hearing protection

If the noise level exceeds 80 dB while performing work, the employer must supply its employees with hearing protectors and make arrangements for hearing examinations. Hearing protectors include ear muffs, which are intended for long-term use, and disposable ear plugs, which are inserted into the ear canal (Figure 19).

Figure 19 Ear muffs and disposable ear plugs

5.5 Other body protection

If there is any possibility of splatter or projectiles striking the clothes or skin, safety clothing should be worn. For example, a lab coat or apron, pants and closed shoes (or sandals with socks) must be worn when performing laboratory work. A work coat and pants are worn when performing workshop tasks. When choosing a lab coat, its material and model are taken into consideration. The safest material to use is cotton. Synthetic materials can react with chemicals or static electricity can cause sparks. Care must also be taken to ensure that the sleeves and hem of the coat do not pose any safety risks. Long hair must also be kept tied back.

If an assignment involves lifting heavy objects or, in general, there is a risk of crushing the feet (such as in a machine room), safety shoes with, for example, a hardened toe cap, must be worn. If there is any risk of objects falling on the head at work or the workplace, a helmet must be worn. The use of helmets is stated on a separate sign at the site in question. The figure below (Figure 20) shows examples of protective clothing and equipment.

Figure 20 Lab coat, cryogenic apron, workshop jacket, safety shoe and safety helmet.

5.6 Gas detection system

Gas detectors can be used in areas where asphyxiant or toxic gases are used. Gas detectors can be either portable (fFigure 11) or fixed systems (cf. section 7.11). When a system detects excessively high gas concentrations or, correspondingly, excessively low oxygen concentrations, it triggers an alarm. Gas detectors can also issue a false alarm, if, for example, the gas sensor baseline has risen to alarm levels.

5.7 Vapour hood and local exhaust ventilation

When laboratory work produces toxic or unpleasant gases and dust, it should be performed in a vapour hood or, if the equipment and work cannot be moved into a vapour hood, local exhaust ventilation (Figure 21), which uses suction to remove gases and vapours, must be used. Always ensure that the vapour hood or local exhaust ventilation is working properly before and while using them.

Figure 21 Vapour hood and local exhaust ventilation

5.8 Chemical safety storage cabinets

There are also various chemical safety storage cabinets available on the market. These cabinets are designed for the safe storage of chemicals in, for example, laboratory facilities. This negates the need for a separate, approved chemical storage area. The cabinets are equipped with ventilation couplings, thus allowing for connection to the building ventilation system. There are, for example, fire safety storage cabinets for storing solvents or acid/base cabinets for storing corrosive chemicals. Fire safety storage cabinet doors and fire dampers for ventilation ducts close automatically in the event of a fire. Fire safety storage cabinets are divided into different classes, according to the duration of a fire: 15, 30, 60 and 90-minute cabinets. This number of minutes indicates how long the cabinet will withstand a fire, as specified in SFS-EN 14470 (*Fire safety storage cabinets*). The figure below (Figure 22) shows a few examples of chemical safety cabinets.

Figure 22 Fire safety, acid/base and gas cylinder storage cabinet.

5.9 Radiation protection for radioactive substances

Compared to ionising radiation, the ability of low-energy electromagnetic radiation, such as radio waves, to penetrate matter is minimal, because ionising radiation is easily absorbed into matter due to its high energy.

Alpha radiation can be blocked by a sheet of paper or fabric – it cannot even penetrate human skin. Alpha radiation is only dangerous if a radioactive substance emitting it enters the body by, for example, inhaling. Beta particles are more penetrative and can pass through, for example, the skin. Substances emitting beta radiation are hazardous to the skin or when entering the body. Aluminium foil or a sheet of glass can block beta radiation.

Gamma radiation can generally penetrate any matter. Upon colliding with a layer of matter, it does not stop entirely – it is merely dampened. In the case of gamma radiation, a commonly used term is "half-value layer" (or half thickness), which is the thickness of any particular material necessary to reduce the intensity of gamma radiation to one-half its original value. For example, the half-layer value of concrete is a few centimetres. The half-layer value depends on the energy of gamma radiation and the elemental composition and density of the medium. Because the damping effect increases exponentially, two times the half-layer value will dampen the radiation to a quarter of its original value. Therefore, a metre of concrete will be enough to dampen even the most powerful gamma radiation almost entirely. If the energy of the gamma radiation is low, a layer of lead approximately 1 millimetre thick will be enough to dampen it. Concrete, steel and lead are commonly used to protect against gamma radiation.

6 WASTE PROCESSING

6.1 Fundamental principles of the Waste Act

The goal of the *Waste Act* (646/2011), *Government Decree on Waste* (179/2012), *Environmental Protection Act* (86/2000) and *Environmental Protection Decree* (169/2000) is to support sustainable development by promoting the sensible use of natural resources as well as by preventing and eliminating the hazards and risks that waste pose to health and the environment. Acting in accordance with the spirit of the legislation involves preventing or at least reducing the generation of waste as well as ensuring that the waste does not cause significant harm or difficulty to waste management, or pose any hazards or risks to health or the environment. Any waste generated should, in the first place, be reused and, in the second place, be recycled. If recycling is not possible, the waste must be used in another way, such as a source of energy. If no use can be found, the waste must be finally disposed of without any form of recovery.

The Act defines *waste* as: "...any substance or object which the holder discards, intends to discard or is required to discard." The Act defines *hazardous waste* as: "...any waste with properties that render it flammable or explosive, infectious, or hazardous to human health or the environment in other ways, or with other corresponding properties (hazardous properties)..." Annex 4 of the Government Decree on Waste (179/2012) contains the "*List of the Most Common Wastes and Hazardous Wastes.*"

The general obligations of producers are the **obligation to obtain and provide information and the obligation to exercise caution**. The properties of both the chemicals to be used and the waste generated must be known and the wastes must be disposed of properly. Wastes must also be packaged and marked so that their transport and processing can be done safely. As stated in section 119 of the Waste Act (646/2011), producers must keep a record: "...on the type, quality, quantity, origin and place of delivery of waste generated, collected, transported, handled or treated..." "Bookkeeping information shall be stored in written or electronic format for six years."

In order to make it possible to reuse the waste generated, various types of waste must be collected separately. Particularly where the collection of hazardous waste is concerned, the waste must absolutely be collected separately in order to allow the reuse of other waste. Hazardous waste may only be delivered to an approved consignee. The waste producer's responsibility for arranging waste management does not end until after the properly packaged and marked waste has been received by a consignee referred to in the Waste Act. Another requirement is that the correct information on the waste has been duly provided. If the waste is delivered to a consignee other than the one referred to in the Waste Act, both the new and previous holder of the waste will be responsible for waste management. The waste holder must draft a *shipping document* on, for example, the hazardous waste to be transferred or delivered to the waste consignee. As stated in the Act: "The shipping document shall contain information, necessary to monitoring and supervision, on the type, quality, quantity, origin, delivery site and date, and waste carrier." The shipping document must accompany the waste shipment. Shipping documents are retained for three years.

Section 6.4 presents examples of how the wastes can be sorted for recycling. The possibilities for recycling depend a great deal on the location of the educational institution. For more detailed information, contact the local waste management service provider.

6.2 Wastes entering the sewerage system

Obligations for monitoring wastewater pollutants entering the sewerage system are specified in Regulation (EC) No 166/2006 of the European Parliament and of the Council of 18 January 2006 *(concerning the establishment of a European Pollutant Release and Transfer Register and amending Council Directives 91/689/EEC and 96/61/EC*), Ministry of the Environment Environmental Protection Decree (169/2000), and *Government Decree on Substances Dangerous and Harmful to the Aquatic Environment* (1022/2006).These decrees specify, among others, substances which require a permit for disposal into the sewerage system or which are entirely prohibited from doing so. In accordance with these decrees, the local water works sets, for example, the permissible limits for wastewater pollutants. If these limits are exceeded, an "industrial wastewater agreement" must be drawn up with the local water works. The industrial wastewater agreement must be made with a local water treatment plant and it must include the permit terms and conditions for wastewater entering the sewerage system.

In order to guarantee the proper operation of the treatment plant and reuse of the plant sludge, each party is obligated to ensure that not just anything is discharged into the sewerage system. As a rule, no wastes other than harmless, water-soluble liquids with a pH of 6-11 are to be discharged into the sewerage system. If necessary, consult the building manager for more information and permission to dispose of larger quantities of wastewater into the sewerage system.

The general supply conditions of the municipal water services state what may or may not be discharged into the sewerage system. The following materials must not be disposed of in the sewage system:

- objects, textiles, metals, sand, soil, glass, rubber, plastics, grease, oil or other such residential or industrial wastes, which may cause clogging of the sewer or hinder the processing of sewage, or substances which, when reacting with the sewage, may cause clogging, corrosion or a significant rise in the sewage temperature
- poisons or substances that produce toxic gases, acids or substances that may corrode the sewerage system structures
- other hazardous or toxic substances that are harmful to the sewerage system or receiving waters, or substances that interfere with the sewerage system or water treatment plant operations or threaten the health of employees.

Other ordinances may also be issued and, for example, Helsinki Region Environmental Services Authority (HSY) policy guidelines (1 January 2010) specify the following limits and ordinances:

- pH must be 6.0-11.0
- Extremely flammable, highly flammable and water-insoluble solvents (e.g. diethyl ether, petroleum ether, cyclohexane) may not be discharged into the sewerage system.
- Chlorinated hydrocarbon solvents (e.g. tri- and tetrachloroethylene, dichloromethane, chloroform, carbon tetrachloride) may not be discharged into the sewerage system.
- Wastewater entering the sewerage system may contain no more than 3 mg/l of highly flammable, flammable and toxic water-insoluble solvents as well as benzene hydrocarbons (monocyclic aromatic hydrocarbons), such as benzene, toluene, ethyl benzene, xylene (BTEX) compounds.

Wastewater may not be diluted to achieve set limits. The set limits also apply to individual wastewater batches.

6.2.1 What problems can wastewater cause for a sewerage system?

Under the Government decision on the treatment of wastewater for discharge into waters from a public sewer and certain industrial sectors and wastewaters from industry for discharge into a public sewer (365/1994), all wastewater being discharged into public sewers and municipal wastewater treatment plants must be appropriately pretreated. Pretreatment is done in order to:

- protect the health of sewerage system and water treatment plant employees
- prevent damage to the sewerage network, water treatment plants and related equipment

- facilitate operation of the wastewater and sludge treatment processes
- prevent the harm caused by water treatment plant emissions entering the environment or fulfil regulatory requirements concerning receiving waters
- ensure the safe and environmentally acceptable placement of sludge.

For example, HSY's wastewater treatment plant in Suomenoja is a biochemical treatment plant, which began denitrogenation in 1998. The sludge formed at the plant is decomposed and the resulting methane gas is recovered and used in the facility's own power plant .

6.2.2 What to do in the event of an accidental emission

Any abnormal emissions into the sewerage system must be reported to the local wastewater treatment plant immediately.

6.3 Hazardous waste

Educational institutions must appoint a hazardous waste supervisor, who is responsible for the proper post-processing of hazardous waste at the institution.

As stated in the Waste Act (646/2011): "Hazardous waste shall not be diluted, or in other ways mixed with waste different in type or quality, or with other substances."

6.4 Waste sorting

6.4.1 Chemical waste

When chemicals are used, for example, in reactions or washing, they become contaminated. They are then no longer considered pure chemicals and must always be collected and sorted as follows:

1. Organic waste
    - Hydrocarbons, aldehydes, alcohols, ethers, esters and ketones ($C_xH_yO_z$) together
    - Nitrogen-based solvents
    - Chlorinated solvents
2. Inorganic
    - Solids
    - Solutions
3. Acids
4. Bases
5. Cyanides (nitriles): Nitrile + acid $\Rightarrow$ HCN, i.e. ensure that nitriles do not come into contact with acids
6. Mercury and its compounds
7. Iodine and its compounds
8. Bromine and its compounds
9. Oxidising substances
10. Cell cultures and microbiological waste

- Wastes are autoclaved before post-processing.
- Cell cultures to which toxins have been added are processed as hazardous waste, according to the poison and concentration.
- Cell cultures with no added microbes are mixed waste.
- Cell culture growth media which do not contain hazardous waste can be poured into the sewerage system.

In addition to these, asbestos, gas respirator filters and oils are collected. Combining wastes that will react with one another is prohibited.

Always know what substances your are using so you will know what kinds of wastes are being produced. Make every effort to use as little of the substance as possible, in order to minimise the amount of waste and, in turn, protect the environment. Package all hazardous waste in accordance with the *Government decision on problem waste information to be provided and the packaging and labelling of problem wastes* (659/1993), so that they do not pose a risk during transport (Figure 23), i.e. use chemical-resistant containers and approved packaging (Figure 24), and label the waste with clear, easy-to-read markings (Figure 25).

Figure 23   Packaging hazardous wastes

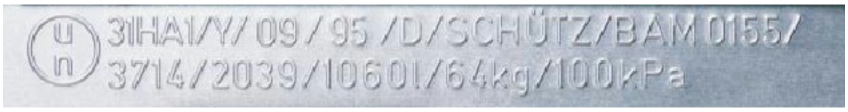
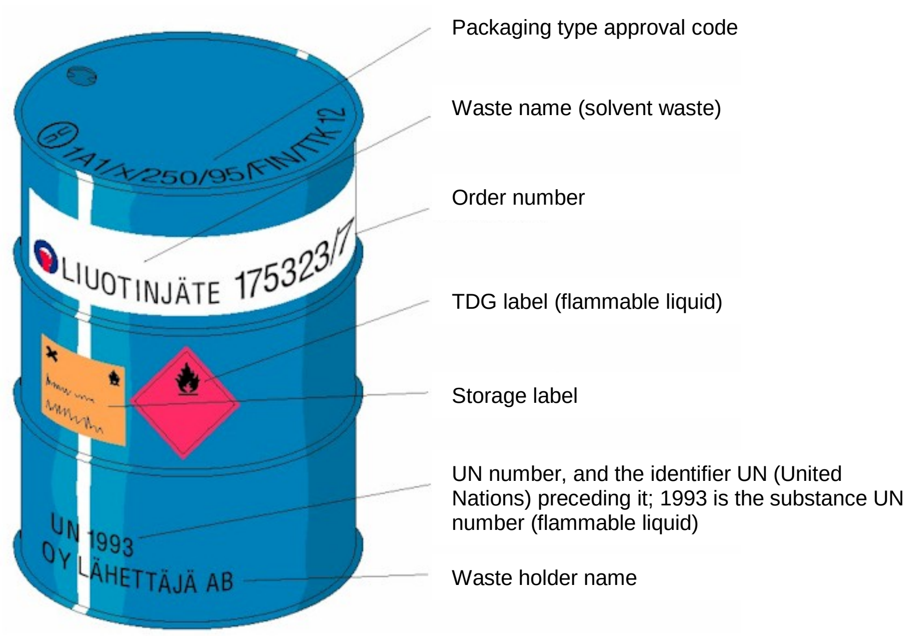


Figure 24   Type approval marking for chemical packaging.



Packaging type approval code

Waste name (solvent waste)

Order number

TDG label (flammable liquid)

Storage label

UN number, and the identifier UN (United Nations) preceding it; 1993 is the substance UN number (flammable liquid)

Waste holder name

Figure 25 Marking hazardous waste

6.4.2 Glass waste

Broken glass is collected in specifically designated receptacles. Remove all chemical residues, caps, plastics and metals from the glass before placing them in the receptacle. The figure below (Figure 26) is an example of a glass collection receptacle.

Glass waste is sorted as follows:

Laboratory glass

- borosilicate glass, such as Duran®, Pyrex®, aluminium silicate glass, quartz glass and lead glass
- beakers, flasks and heat-resistant test tubes
- generally, glassware with ground-glass joints
- also coloured thermal glass

Clear glass

- soda-lime glass
- glass pipettes
- non heat-resistant test tubes
- drinking bottles
- glass jars

Coloured glass

- chemical bottles
- no laboratory glass

Figure 26 Glass waste collection receptacles

Ceramic products (e.g. crucibles and Büchner funnels) are to be disposed of with mixed waste.

6.4.3 Waste electrical and electronic equipment (WEEE)

Waste electric and electronic equipment (WEEE) may not be placed in ordinary waste receptacles - it is collected separately. The educational institution's technical or equivalent personnel is in charge of collecting WEEE and sending it for recycling.

6.4.4 Waste paper

Office and domestic recyclable paper (periodicals, flyers) are generally collected in offices (cardboard cartons) or receptacles found in corridors. There is no need to remove staples. Envelopes and adhesive paper (e.g. “Post-it Notes") are to be disposed of with energy waste (cf. section 6.4.6).

6.4.5 Recyclable cardboard

Cardboard packaging and kraft paper are collected separately. A cardboard baler, for example, can be acquired for this purpose.

6.4.6 Energy waste

Waste that can be reused as energy, such as packaging plastics (no PVC), styrofoam, cardboard packaging and "Post-It Notes", are to be collected in energy waste receptacles.

6.4.7 PVC waste

PVC (polyvinyl chloride) waste, such as vinyl gloves, is collected with mixed waste.

6.4.8 Biodegradable waste

Biodegradable waste, such as used coffee grounds, teabags, fruit rinds and food leftovers, is collected in a biodegradable waste receptacle.

6.4.9 Metal waste

Metal waste is collected in separate collection receptacles.

6.4.10 Batteries and accumulators

Dead batteries and accumulators are sent to, for example, an electrical workshop. Small accumulators, batteries and button cells are to placed in, for example, a recycling box as shown below (Figure 27) (http://www.paristokierratys.fi).

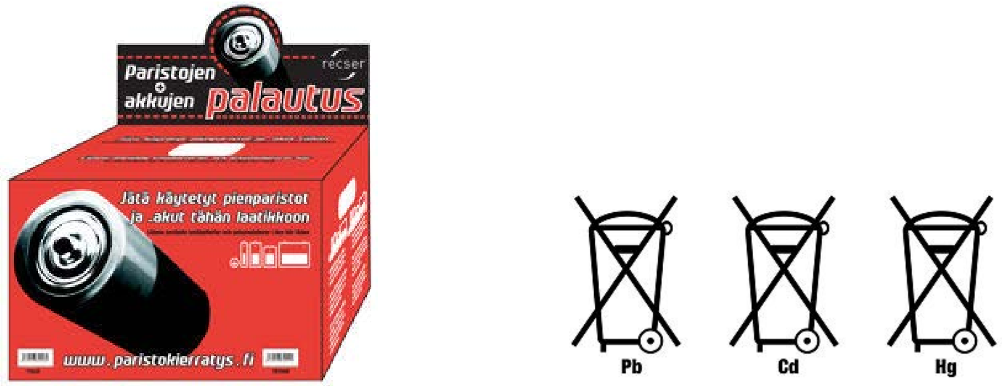


Figure 27 Collection box for batteries and accumulators, and symbols for accumulators and batteries containing heavy metals.

Accumulators and batteries containing heavy metals are marked with the symbols shown above (Figure 27), these must not be disposed of with ordinary waste.

6.4.11 Printer toner/ink cartridges

Used toner/ink cartridges are to be sent for recycling. Inkjet printer cartridges may be disposed of with mixed waste.

6.4.12 Fluorescent bulbs and energy-saver bulbs

Custodians are generally responsible for changing light bulbs and sending burned out bulbs for recycling.

6.4.13 Special and risk waste

Special waste or risk waste comprehends wastes that pose a hazard to the user or environment, without being hazardous waste due to their toxicity or other quality. Special or risk waste includes infectious, biological, sharp (capable of cutting and puncturing), radioactive, tissue sample or equivalent wastes and various other types of waste. Special waste requires special measures for final disposal.

Sharp wastes (such as disposable hypodermic needles, knives) are considered special waste because they pose a hazard to the user in the form of puncture wounds and cuts. Disposable needles and knives are to be bent, rendering them useless, and packaged in sealed containers, such as a heavy-duty plastic jug or canister. Needles can also be cut using special cutters and disposable hypodermic needles can be rendered useless by cutting off the tip. The collection container can be placed in with mixed waste if it is not considered risk waste.

6.4.14 Other waste

Waste that cannot be recycled and, in turn, reused, is placed in with mixed waste.

7 WHAT TO DO IN THE EVENT OF AN ACCIDENT

Speed is crucial in administering first aid. This is why all personnel must learn where all the necessary equipment and supplies are located. In the event of an accident, first aid must be administered immediately and, if necessary, assistance should be sought by calling the general emergency number **112**. All accidents and "close calls" are to be reported to the occupational safety representative, using the form found in Appendix 2. The figure below (Figure 28) shows safety signs.

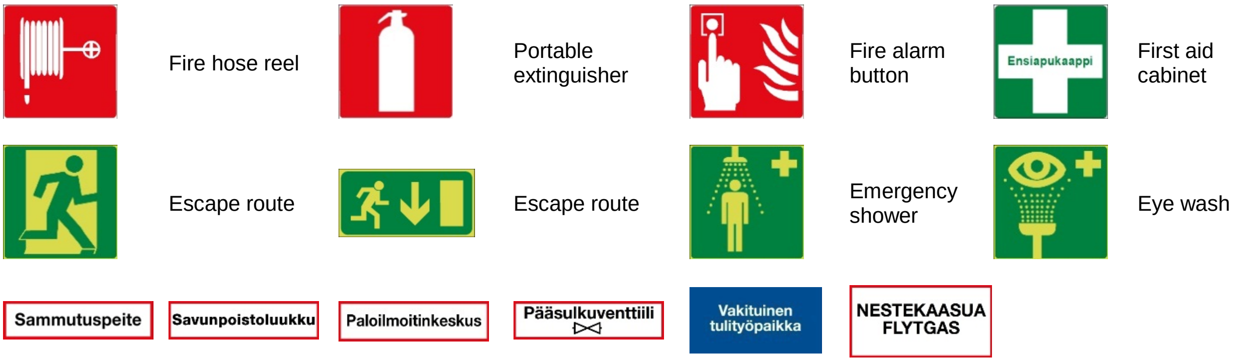


Figure 28 Safety signs.

7.1 Wounds

With the exception of small, surface cuts, all wounds require medical treatment within a few hours: especially when

- there is profuse bleeding
- there may be small pieces of glass, toxic substances, soil or sand in the wound
- the injury is a deep puncture wound or bite.

Regardless of the type of wound, do the following:

- Stop the bleeding.
- Protect the wound area with a dressing.
- Raise and support the injured limb.
- Check the condition of the victim and take them for medical treatment.

Cover small wounds with a bandage. If necessary, clean out the wound with an antiseptic solution. The necessary wound treatment supplies can be found in the first aid cabinets and wound treatment stations, which can be found throughout the building in corridors and rooms. First aid cabinets are marked with safety signs (Figure 28).

7.2 Eye injuries

Speed is absolutely crucial in administering first aid for eye injuries: it is a matter of seconds. If a corrosive or irritant substance gets into the eye, immediately flush out the eye at the nearest faucet or eye wash station (Figure 29) and then gently rinse with water or saline solution from an eye wash bottle (Figure 29) for at least 20-30 minutes. If the victim's eyelids are closed tightly due to pain, open them using the fingers in order to flush out the eyes. After flushing the eyes, the victim must always be taken in for a medical examination. The eye should continue being flushed all the way to the physician's office. Only a physician may remove a contact lense from an injured eye. If there is, for example, glass in the eye, make every effort to keep the eye still. Also cover the unaffected eye to help keep both eyes still. Eye wash stations are marked by safety signs (Figure 28).

Figure 29 Eye wash bottles and eye wash station.

7.3 Corrosive substances on the skin

Remove the contaminated clothing and flush away the substance with a large amount of water. Acids on the skin can be neutralised with a 5% $NaHCO_3$ solution and bases with a 1% acetic acid solution. Finally, rinse the skin with a large amount of water for 20-30 minutes. An eye wash station (Figure 29) can be used to flush the face, while an emergency shower (Figure 33) or regular shower can be used to flush the body. The eye wash station and emergency shower are marked by safety signs (Figure 28).

In accidents involving hydrofluoric acid (HF), wash the skin with water, dry and massage a large amount of 2.5% calcium gluconate gel into the skin. Continue massaging the affected area until the pain subsides and then for another 15 minutes. Take the victim to the hospital immediately.

7.4 Poisoning

For instructions on how to deal with all cases of poisoning, contact the HUCH Poison Information Centre at tel. 09-471977 (Open 24 hours a day). After administering first aid, take the victim for medical treatment. Always send information on or a sample of the substance that caused the poisoning along with the victim.

7.4.1 Poison in the respiratory system

Get the victim into fresh air immediately and have them rest in a semi-sitting position. If the victim is having difficulty breathing or maintaining consciousness, they must be taken to the hospital immediately. If the victim is unconscious, always lay them on their side. If necessary, begin administering Emergency First Response Primary Care (CPR) (see section 7.12).

7.4.1.1 Cyanide poisoning

The signs and symptoms of cyanide poisoning are:

- the scent of bitter almonds
- blushing in the cheeks
- rapid breathing
- dizziness/fainting
- laboured breathing.

Minor exposure:

- Weakness, headache, confusion, nausea, vomiting, rapid pulse

Severe poisoning

- Slow breathing or panting, seizures, unconsciousness

Even in cases of minor exposure, call for an ambulance (112) and explain that cyanide poisoning is involved. Remember that giving mouth-to-mouth resuscitation is also hazardous to the person giving it.

First aid

<u>Respiratory exposure</u>

- Move the victim exposed to hydrogen cyanide into fresh air.
- Call for an ambulance and explain that cyanide poisoning is involved
- If the victim is having difficulty breathing, give them 100% oxygen (mask)
- If it is taking the ambulance a very long time to arrive, break a 0.2 ml ampoule of amyl nitrite into gauze and have the victim inhale Place the gauze under the nose. Allow the victim to breathe continuously for one minute and then take a 30-second break from the amyl nitrite dose. Give 10% oxygen in between doses. Repeat this a total of three times and then break a new ampoule (do not give more than 6 ampoules).
- In minor cases of cyanide poisoning, 100% oxygen and rest are usually an adequate treatment.

<u>Contact with the eyes</u>

- Flush the eyes with running water for 5-10 minutes, keeping the eyes open

<u>Contact with the skin</u>

- Remove the contaminated clothing immediately
- Flush the skin with a large amount of water (shower) and wash with soap for 15 minutes

When assisting the victim, remember to use your personal protective equipment!

7.4.2 Poison in the digestive tract

If the victim has swallowed an acid or base, give them no more than 2 dl of water or milk in order to dilute the corrosive substance. Do not use a neutralising agent. The victim must not be allowed to vomit under any circumstances if they have been seriously injured, they are unconscious, or the situation involves a corrosive substance or organic solvent. Current first aid practices do not otherwise recommend inducing vomiting.

In order to prevent absorption of the toxic substance, activated carbon is administered to the victim. Activated carbon must not be used in cases involving concentrated acids or bases or to victims who are vomiting.

7.5 Lack of oxygen

Victims suffering from a lack of oxygen must be taken to fresh air and, if necessary, given Emergency First Response Primary Care (CPR) (see section 7.12). Remember - do not enter any oxygen-deficient atmosphere without a self-contained breathing apparatus (SCBA). Because blood in the brain only carries oxygen for 10-15 seconds, the victim can quickly lose consciousness.

7.6 Electrical accidents

In the event of an electrical accident, emergency measures must be taken immediately. If a person completes a circuit, the current must first be shut off (e.g. pull the power cord from the mains outlet or cut power at the main circuit breaker). Be careful to avoid getting an electrical shock yourself. If the victim is not breathing, administer Emergency First Response Primary Care (CPR) (see section 7.12). Cover any burns with clean bandages and take the victim for medical treatment.

7.7 Fire

The foundation of building fire safety is general cleanliness and order. Main passageways and areas in front of doors, fire hose reels, portable fire extinguishers and electrical boxes should be kept clear and open. The school facilities are equipped with gas/heat detectors, which alert emergency rescue services when an alarm is triggered. When the automatic fire alarms go off, all personnel inside the building must immediately exit (see section 7.10). In order to prevent the spread of fire, all ventilation equipment must be shut down (Figure 30). Corridor doors must also be kept closed. They must not be "chocked" open if the door is not fitted with closing mechanism, which automatically closes the door in the event of a fire (Figure 30). A fire alarm can also be set off by pressing a fire alarm button (Figure 30) or calling the general emergency number 112.

Figure 30 Fire alarm button, ventilation system "emergency stop" button and fire door control centre.

Some areas (e.g. machine and test halls) have a time switch, which is used to temporarily disable the automatic fire alarm. The time switch may be used when performing work that might set off a false alarm. When the automatic fire alarm has been temporarily disabled, the area in question must be under constant fire surveillance for the entire time that the alarm system is down.

7.7.1 Fire extinguishing

There are three essential components required for a fire: a combustible material, oxygen and a sufficiently high temperature. Eliminating any one of these components eliminates the fire hazard. Fires can be extinguished using a fire blanket, water (e.g. fire hose reel) or a portable fire extinguisher (carbon dioxide or dry chemical extinguisher). Water is best suited for extinguishing fibrous materials, such as wood, paper and fabrics. Water cannot be used to extinguish electrical fires, flammable liquids or oils. Although a CO_2 extinguisher is ideal for extinguishing chemical fires, a dry chemical extinguisher is best for putting out, for example, a sodium fire. A CO_2 extinguisher is best for putting out an analysis equipment fire, so that damage to the equipment can be minimised. Section 5 of the safety data sheet (see section 3.9) specifies what type of extinguisher can be used to put out the chemical in question. When using an extinguisher, keep in mind that the operating time of a portable extinguisher is short (approx. 30 seconds). The extinguisher nozzle must be aimed directly at the source of the fire, i.e. the base of the flame, not the actual flames. Extinguishing agents can produce toxic decay products.

Extinguishers can be found along the educational institution corridors and they are marked with safety signs (Figure 28). When conducting a risk assessment for work areas and work (cf. section 1.8), the need for additional extinguishers must be taken into consideration.

If the work area is equipped with a gas extinguishing system (c. section 7.7.1.5), it will be automatically triggered in the event of a fire. Familiarise yourself thoroughly with the operation of such systems.

7.7.1.1 Portable extinguishers

Weighing no more than 20 kg, a portable extinguisher (Figure 31) is any easily carried and operated fire extinguisher, which produces the necessary pressure for spraying an extinguishing agent. Dry chemical, carbon dioxide (CO_2), pressurised water, foam and wet chemical are the different types of portable extinguishers.

Figure 31 Fire blanket, dry chemical and CO_2 extinguisher.

Portable extinguisher classification
Class A extinguishers are intended for fires involving solid, ordinary combustible materials, such as wood, paper and fabrics. The fire class for Class A extinguishers is determined based on a wood pile extinguishing test. The fire class is listed as a number and the letter A, with the number indicating the length of the test pile in decimetres.

Class B extinguishers are intended for fires involving liquid and liquefying substances. The fire class for Class B extinguishers is determined based on a round tank liquid fire extinguishing test, in which the larger the tank diameter is, the greater the volume of flammable liquid. The fire class is listed as a number and letter B. The number indicates the amount of flammable liquid in litres.

Class C extinguishers are intended for fires involving gaseous substances. There is no separate performance rating for Class C extinguishers.

Extinguisher labels must also state the limitations of use, such as in areas near live electrical current. Depending on the voltage involved, the minimum safe distance might be listed as: "U<=1000 V safe distance 1 m".

Extinguishers imported before 1999
Class A extinguishers are used on fires in ordinary combustible materials, such as wood, paper, fabrics or other materials with similar combustion properties.

Class B extinguishers are primarily intended for fires involving liquids, gases and substances that are liquefied or gasified in heat.

Class A-B extinguishers are intended for fires involving both ordinary combustibles and liquids and gases.

Due to the electrical conductivity of the spray, Class E extinguishers pose no danger to the user, thus making them suitable for fires involving energised electrical equipment.

Extinguishers are also divided into three performance ratings, according to how effectively they have extinguished tank fires of varying sizes in approval tests. Class A extinguishers only have a I rating. Class B and A-B extinguishers have ratings of I, II and III, with I being the lowest.

7.7.1.2 Fire hose reel

A fire hose reel (Figure 32) is an assembly connected to the building water supply, with an approximately 20-30 metre long 25 mm rubber hose. Used by an experienced person, the water output of a fire hose reel is capable of extinguishing a fire approximately 10 square metres in area. The fire hose reel is used by opening a stopcock, pulling the hose toward the fire, opening the hose nozzle and directing the water spray at the fire.

Figure 32 Fire hose reel

7.7.1.3 Fire blanket

A fire blanket (Figure 31) is made of a fireproof fabric. It is usually at least 1.5 m^2 in size. Extinguishing a fire with a fire blanket involves covering the fire with the blanket and smothering the fire. If necessary, other thick fabrics that burn poorly, such as a cotton mat, can also be used in place of a fire blanket. Fire blankets can be used to extinguish, for example, flammable liquid, clothing and waste receptacle fires.

7.7.1.4 Sand

Sand can be used as a smothering extinguishing agent for fires involving, for example, oil, cables and metals.

7.7.1.5 Gas extinguishing system

Extinguisher systems are designed to assist rescue operations by extinguishing and/or limiting fires. One type of system is the gas extinguishing system. Gas extinguishing systems use several different gases, whose purpose is to smother the fire by reducing the oxygen concentration in the area and prevent the fire from starting again (the extinguishing limit is 15% O_2). The most widely used approved extinguishing gases in Finland are carbon dioxide (CO_2) and argon (Ar).

INERGEN Fire Suppression System
One possible gas extinguishing system is the INERGEN (Inert Gas & Nitrogen) Fire Suppression System. In the INERGEN system, the gas composition is 52% nitrogen, 0% oxygen, 40% argon and 8% carbon dioxide. When the system discharges, the oxygen concentration of the area drops to 11.2%.

The system consists of two different detectors:

- flame detector
    - triggers the alarm, but does not activate the system
    - sets off the audible warning alarm
- smoke detector
    - alone, will not activate the system, but sends the information to the Emergency Response Centre.
    - calls the fire department
    - sets off the audible warning alarm

When both the flame and smoke detector are triggered, the system is activated and sends information to the Emergency Response Centre, thus calling the fire department to the scene. When the system is activated, a red indicator light will come on and sirens will sound.

The pressure in an INERGEN cylinder is 200 bar. The system functions as follows:

- discharge begins 10 seconds after the alarm has been triggered
- the pressure in the initial discharge is 50 bar
- during the first minute, the oxygen concentration drops below 14%
- pressure balancing valves open

When the system has been activated, personnel in the area have 10 seconds to leave the area and close the doors. The doors must be closed tightly to keep the gases from entering other areas and weakening the extinguishing capacity.

INERGEN Fire Suppression System – manual activation
There is a yellow "box" outside the area which can be used to manually activate the system. When the button is pressed, the suppression system will be activated after a 10-second delay.

Servicing and disabling/enabling the system must only be done by the maintenance service provider. The system can be disabled when, for example, testing the ventilation system with a smoke airflow indicator.

7.7.2 Clothing on fire

If clothing has caught on fire, the victim must go of be taken to an emergency shower (Figure 33). The flames can also be smothered by, for example, a heavy coat made of tightly-woven material or a fire blanket (Figure 31). Emergency showers are marked by safety signs (Figure 28).

Figure 33 Emergency shower

7.7.3 Fire on work table or in containers

Move any highly combustible objects in close proximity away and smother the flames with, for example, a fire blanket (section 7.7.1.3) or use a portable extinguisher (section 7.7.1.1). Alert other personnel. If you are unable to get the fire under control, attempt to stop its spread and call the fire department.

7.7.4 Gas cylinders

Remove gas cylinders from the area, if it safe to do so. If the cylinders cannot be moved and the fire cannot be extinguished immediately, cool the cylinders with water from a safe location, if at all possible. Clearly mark the cylinders that were involved in the fire and report this to the gas cylinder supplier.

7.8 Burns

There are three types of burns:

1st degree:	skin is red, painful and swollen
2nd degree:	blistering
3rd degree:	skin is a greyish white, brown or charred

Flush the affected area with lukewarm water. Small, superficial burns can be cooled with water for 20-30 minutes. The amount of time needed for cooling is proportional to the extent of the burn (risk of hypothermia). Do not tear away any clothing burned into the skin. Apply a sterile dressing to the affected area if it requires medical attention. Medical treatment is absolutely required in the following cases:

- second degree burn larger than the area of the palm
- 3rd degree burn
- electrical burn
- deep burn on the face or hands
- inhalation of hot fire gases

7.9 Frostbite

Cover frostbite injuries with a clean, dry dressing and seek medical treatment

7.10 Evaculation instructions

In the event of a major accident, such as a large fire or chemical leak, it may be necessary to evacuate the building. The building will also always be evacuated if the automatic fire alarm system is activated. This is why each building must have an emergency evacuation plan as well as a safety organisation, which is supervised by the building's safety manager. The evacuation plan and safety organisations are specified in the emergency response plan (cf. section 1.7), which also contains a list of the building exit doors, mustering points (where all personnel from the affected building gather) and other guidelines and information on the building and other items of import. This plan is intended for all personnel and emergency rescue services.

7.10.1 Safety organisation

Below is a list of tasks to be performed by an example safety organisation in the event of a fire or major accident:

Safety manager

- ensure that the emergency rescue services have been notified
- contacts the deputy safety manager, if necessary
- provides guidance to the emergency rescue services
- sets up a command post and oversees preliminary measures
- relinquishes command to the emergency rescue services

Deputy safety manager

- contacts the safety manager, if necessary
- acts as the safety manager if the appointed safety manager is unavailable
- acts as the safety manager when assisting with preliminary measures
- supervises the mustering point and first aid station
- provides the safety manager with status reports on the mustering point and building

Area supervisor

- ensures the start of preliminary extinguishing
- checks and evacuates personnel from their area
- closes all doors when leaving

Assistant area supervisor

- assists the area supervisor in evacuating the area
- supervises personnel from their area at the mustering point
- provides the deputy safety manager with a status report on the mustering point for their area

First aid personnel

- retrieve first aid supplies (and stretchers)
- set up a first aid station near the mustering point

Personnel

- if necessary, alert the Emergency Response Centre at 112
- if necessary, begin preliminary extinguishing
- report the incident to the area supervisor
- if necessary, assist the area supervisor
- exit the building two-by-two and go to the mustering point
- report key information concerning the fire/accident to the assistant supervisor of their area

7.11 Gas leak: Automatic gas detector

Automatic gas detectors can be installed in areas where toxic or flammable gases are used. Typical detectors of this kind are HC, O_2, H_2 and H_2S. Gas detectors can also be changed along with a change in operations. The detector control unit may feature, for example, indicator lights for various functions:

🟢 Green light: OK Detector on.

🟠 Orange light: Limit 1. Issues a light and audible warning alarm in the affected area as well as a light warning alarm in the general area.

🔴 Red light: Limit 2. Issues a light and audible warning alarm in both the affected and general area.

⚪ White light: Call service

When the system detects excessively high gas concentrations (Limit 1 and Limit 2), it will issue the alarm. Limit 1 is set to give personnel 15 minutes to evacuate the area and Limit 2 is set for less than 15 minutes. Gas lines in the area can also be shut off by pressing the "Emergency stop" button. When the button is pressed, the system shuts off the gas lines and sounds an audible alarm in the affected and general area.

The detector may also issue a false alarm if, for example, the detector baseline rises to alarm levels. The audible warning alarm can be disabled by pressing the "Esc" button on the alarm in question. The alarm will then go into "Service" mode and no longer react to the presence of gases.

When the alarm goes off, exit the area, close the door and shut off the gas lines either by closing the valves or pressing the Emergency stop button. Report the alarm to the person in charge of gas supervision. The figure below (Figure 34) shows what to do in the event of an automatic gas detection alarm.

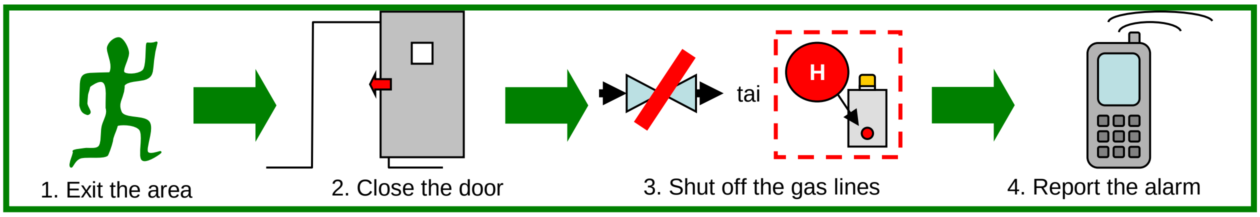


Figure 34 What to do in the event of an automatic gas detection alarm.

When the situation has ended:

- press "Alarm reset" on the touch screen
- determine the cause of the gas leak
- press "MV reset" to open the magnetic valves on the gas lines
- release the Emergency stop button if it was pressed to sound the alarm

7.12 Emergency First Response Primary Care (CPR)

Emergency First Response Primary Care (CPR) involves measures for responding to life-threatening emergencies. Emergency First Response Primary Care (CPR) is used to save a victim's life, prevent their condition from worsening and call professional assistance to the scene. Situations requiring Emergency First Response Primary Care (CPR) are always a matter of minutes – a person who has been seriously injured or taken suddenly ill needs immediate assistance. Begin administering Emergency First Response Primary Care (CPR) immediately at the scene of the incident.

7.12.1 Cardiopulmonary resuscitation (CPR)

1. Check the victim for unresponsiveness:
    - Try to revive the victim by talking to them and shaking them.

2. If the victim does not respond:
    - call for assistance or call the Emergency Response Centre at **112** and
    - follow the instructions given over the phone.

3. Check to see whether the victim is breathing:
    - open the airway by lifting the victim's chin and tilting their head back
    - check to see whether the victim's chest is rising and
    - try to feel and hear air being exhaled from the mouth and nose.

If the victim is breathing, roll them onto their side to make breathing easier, all the while checking their breathing.

If the victim is not breathing

4. begin *chest compressions*:
    - place the heel of one hand in the centre of the chest along the breastbone and the other hand on top
    - with your arms straight, press down on the chest 30 times approximately 4-5 cm, doing around 100 compressions every minute

- NOTE! When administering CPR to a child, start with 5 rescue breaths.

5. Begin *mouth-to-mouth resuscitation*:
    - lift the chin, tilt the head back and pinch the nostrils closed
    - press your mouth over the victim's mouth and slowly blow 2 rescue breaths into the lungs, checking for chest movement all the time.

6. If after properly giving two rescue breaths the victim is still not conscious or breathing normally, continue the chest compressions and mouth-to-mouth resuscitation in the following cycle: 30 compressions followed by 2 rescue breaths. Continue doing this until help arrives or you are no longer able to do so.

Do not stop CPR unless the victim does not show any signs of revival. If the victim begins to breathe, roll them onto their side to make breathing easier, all the while checking their breathing and pulse.

7.13 What to do after an accident

The following guidelines are to be generally observed:

- If necessary, the victim should seek medical attention at an occupational health care station, health centre or other facility that provides medical care.
- The *insurance certificate* (cf. section 1.5) must be sent to the party providing treatment as quickly as possible. The treatment costs can be billed to the accident insurance provider based on this certificate.
    - The form must be signed by either “the accident representative” (laboratory foreman/technician, teacher, work leader) or the supervisor. The insurance certificate can also be submitted later.
    - The certificate also entitles the holder to free medications.
- An *accident/occupational disease report form* must be filled out together with the supervisor, teacher, work leader or occupational safety representative (cf. section 1.5)
    - The report must be submitted as soon as possible after the accident.
    - The personal information included on the form as well as any items and code data related to the accident must be carefully and accurately entered.
    - The form is to be submitted to the educational institution accident representative. They will fill in all other information required on the form.
    - All expenses paid by the insured themselves will be remunerated upon submission of the original receipts for treatment and medications.
    - A medical certificate must be attached to the application or submitted separately.
- If the accident results in a sick leave, a medical certificate must be obtained
- If the accident requires expensive additional examinations and treatment, a promissory note from the accident insurance provider for their payment must be requested in advance.
- In cases of a suspected occupational disease, the *accident/occupational disease report form* must be filled out and submitted, along with all necessary attachments, to the accident insurance provider.

In situations involving accidents and close-calls, the educational institution's own accident report form (Appendix 2), if it has such a form, must also be filled out. The completed form must be submitted to the occupational safety representative (see section 1.3.6) of the building where the accident occurred.

7.14 Recommendations for workplace first aid preparedness

The recommendation below is based on, among others, the Occupational Safety and Health Act (738/2002) and Occupational Health Care Act (1383/2001). In accordance with set guidelines, when there is a specific accident hazard (e.g. irritant, corrosive and toxic substance hazard or a fire, explosion or electrical accident hazard), the following items, at the very least, must be provided for at the workplace:

1. First aid training
    - at least one out of 5 employees per work area or work shift must have completed an FA I course as well as any necessary specialised training
    - the FA II course is recommended for at least some of the employees with first aid training
    - first aid refresher training should be provided every 18 months

2. First aid equipment
    - First aid cabinet, which contains the following items for every 25 employees
        - gauze pads (7.5 cm x 7.5 cm) 15 -20 pcs
        - first aid bandages 2-3 pcs
        - elastic bandages (8-10 cm) 2 pcs
        - tubular mesh bandage (head/limb size) 1 pc
        - adhesive bandage 1-2 rolls
        - slings 2 pcs
        - scissors
        - wound cleansing wipes 8-10 pcs (or wound antiseptic 1 bottle)
        - plasters (various sizes) 20 pcs or a plaster dispenser
        - breathing mask and gloves (or a protection kit, which contains a breathing mask, gloves and a wound cleansing wipe)
    - Portable first aid kit/bag, which contains
        - small first aid bandage 2 pcs
        - large first aid bandage 2 pcs
        - sling 1 pc
        - bandage supply kit 2 pcs
        - gauze bandage 10 x 20 cm 2 pcs
        - gauze bandage 15 x 24 cm 2 pcs
        - elastic bandage 8 cm 1 pc
        - sling 1 pc
        - bandage supply kit 3 pcs
        - burn bandage 55 x 60 cm 1 pc
        - burn bandage 30 x 60 cm 1 pc
        - elastic bandage 10 cm 1 pc
        - sling 2 pcs
        - burn bandages

    - splints (e.g. inflatable splints)
    - thermal blanket
- Stretchers/lightweight stretchers
- Emergency shower and eye wash supplies, if there is any risk of splattering onto the skin on into the eyes
- The location of first aid equipment (cabinets, bags, stretchers, emergency showers, eye wash equipment) must be marked by safety signs (see Figure 28) so that all personnel know where they are
- First aid equipment must be easily accessible (i.e. not locked up)
- First aid equipment should have an appointed supervisor, who looks after the condition and orderliness of the equipment and, if necessary, refills/maintains the supplies
- Emergency phone numbers and instructions on what to do in the event of an accident or illness (e.g. Finnish Red Cross Emergency First Aid Guide and workplace-specific guidelines) must be posted near the first aid equipment.

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8.1 Websites

09.01.2015

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Emergency Response Centre Administration	http://www.112.fi
Finnish Police	http://www.poliisi.fi
REACH Consulting	http://www.reachneuvonta.fi
Ministry of the Interior Rescue Operations	http://www.pelastustoimi.fi
Ministry of Social Affairs and Health National Supervisory Authority for Welfare and Health (Valvira)	http://www.valvira.fi
Finnish Red Cross (-> First aid)	http://www.redcross.fi
Radiation and Nuclear Safety Authority	http://www.stuk.fi
Finnish Safety and Chemicals Agency (Tukes)	http://www.tukes.fi
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8.2 Figures source list

Fig 1 - https://www.osha.gov; Fig 2 - http://www.cirs-reach.com;
Fig 4 - http://www.unece.org; Figs 5 and 22-24 - Ekokem Oy; Figs 6 and 7 - Merck KGaA; Fgs 8, 13 and 28 - www.turvamerkit.fi; Fig 9 TKK Puu; Fig 11 Air Liquide; Fig 12 - www.pelastustoimi.fi; Fig 14 - Standardi SFS-EN 420; Fig 15 - BMA Medical Supplies Direct and Temrex; Figs 16 and 18 - Suojalaite Oy; Fig 17 - Laservision GmbH; Fig 19 - Peltor Oy; Fig, 20 - LABOPlus, Suojalaite Oy and Jalas Oy; Figs 21, 26 and 30-33 - Kimmo Karinen; Fig 22 - Asecos GmbH;
Fig 27 - http://www.paristokierratys.fi; Fig 29 - Suojalaite Oy, Tammed Oy and Kimmo Karinen.

SAFETY DATA SHEET

According to Regulation (EC) No. 1907/2006
Version 5.1 Revision Date 22.05.2013
GENERIC EU MSDS - NO COUNTRY SPECIFIC DATA - NO OEL DATA

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1 Product identifiers

Product name : Methanol

Product Number : 123456
Brand : Chemical
Index-No. : 603-001-00-X
REACH No. : 01-2119433307-44-XXXX
CAS-No. : 67-56-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses : Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company : Firma Oy
Street address 1A1
FI-12345 CITY

Telephone : +358 9 0123 4567
Fax : +358 9 0123 4567
E-mail address : ehs@firma.fi

1.4 Emergency telephone number

Emergency Phone # : Poison Information Centre +358 9 4711

SECTION 2: Hazards identification

2.1 Classification of the substance or mixture

Classification according to Regulation (EC) No 1272/2008
Flammable liquids (Category 2), H225
Acute toxicity, Inhalation (Category 3), H331
Acute toxicity, Dermal (Category 3), H311
Acute toxicity, Oral (Category 3), H301
Specific target organ toxicity - single exposure (Category 1), H370

For the full text of the H-Statements mentioned in this Section, see Section 16.

Classification according to EU Directives 67/548/EEC or 1999/45/EC

F	Highly flammable	R11
T	Toxic	R23/24/25, R39/23/24/25

For the full text of the R-phrases mentioned in this Section, see Section 16.

2.2 Label elements

Labelling according Regulation (EC) No 1272/2008

Pictogram

Signal word: Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H301	Toxic if swallowed.
H311	Toxic in contact with skin.
H331	Toxic if inhaled.
H370	Causes damage to organs.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P260	Do not breathe dust/ fume/ gas/ mist/ vapours/ spray.
P280	Wear protective gloves/ protective clothing.
P301 + P310	IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
P311	Call a POISON CENTER or doctor/ physician.
Supplemental Hazard Statements	none

2.3 Other hazards

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT)., This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

SECTION 3: Composition/information on ingredients

3.1 Substances

Synonyms : Methyl alcohol

Formula : CH_4O
Molecular Weight : 32,04 g/mol
CAS-No. : 67-56-1
EC-No. : 200-659-6
Index-No. : 603-001-00-X
Registration number : 01-2119433307-44-XXXX

Hazardous ingredients according to Regulation (EC) No 1272/2008

Component		Classification	Concentration
Methanol			
CAS-No. EC-No. Index-No. Registration number	67-56-1 200-659-6 603-001-00-X 01-2119433307-44-XXXX	Flam. Liq. 2; Acute Tox. 3; STOT SE 1; H225, H301 + H311 + H331, H370	<= 100 %

Hazardous ingredients according to Directive 1999/45/EC

Component		Classification	Concentration
Methanol			
CAS-No. EC-No. Index-No. Registration number	67-56-1 200-659-6 603-001-00-X 01-2119433307-44-XXXX	F, T, R11 - R23/24/25 - R39/23/24/25	<= 100 %

For the full text of the H-Statements and R-Phrases mentioned in this Section, see Section 16

SECTION 4: First aid measures

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

no data available

SECTION 5: Firefighting measures

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture

Carbon oxides

5.3 Advice for firefighters

Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information

Use water spray to cool unopened containers.

SECTION 6: Accidental release measures

6.1 Personal precautions, protective equipment and emergency procedures

Wear respiratory protection. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up

Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections

For disposal see section 13.

SECTION 7: Handling and storage

7.1 Precautions for safe handling

Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Store in cool place. Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

7.3 Specific end use(s)

A part from the uses mentioned in section 1.2 no other specific uses are stipulated

SECTION 8: Exposure controls/personal protection

8.1 Control parameters

Components with workplace control parameters

Derived No Effect Level (DNEL)

Application Area	Exposure routes	Health effect	Value
Workers	Inhalation	Acute local effects	260 mg/m^3
Workers	Inhalation	Acute systemic effects	260 mg/m^3
Workers	Skin contact	Long-term systemic effects	40mg/kg BW/d
Workers	Inhalation	Long-term systemic effects	260 mg/m^3
Workers	Inhalation	Long-term local effects	260 mg/m^3
Consumers	Skin contact	Acute local effects	8mg/kg BW/d
Consumers	Inhalation	Acute local effects	50 mg/m^3
Consumers	Ingestion	Acute local effects	8mg/kg BW/d
Consumers	Inhalation	Acute systemic effects	50 mg/m^3
Consumers	Skin contact	Long-term systemic effects	8mg/kg BW/d
Consumers	Inhalation	Long-term systemic effects	50 mg/m^3
Consumers	Ingestion	Long-term systemic effects	8mg/kg BW/d
Consumers	Inhalation	Long-term local effects	50 mg/m^3
Workers	Skin contact	Acute local effects	40mg/kg BW/d

Predicted No Effect Concentration (PNEC)

Compartment	Value
Soil	23,5 mg/kg
Marine water	15,4 mg/l
Fresh water	154 mg/l
Fresh water sediment	570,4 mg/kg
Onsite sewage treatment plant	100 mg/kg

8.2 Exposure controls

Appropriate engineering controls

Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

Personal protective equipment

Eye/face protection

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

The selected protective gloves have to satisfy the specifications of EU Directive 89/686/EEC and the standard EN 374 derived from it.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0,3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0,4 mm
Break through time: 31 min

Material tested:Camatril® (KCL 730, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

SECTION 9: Physical and chemical properties

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid Colour: colourless
b)	Odour	pungent
c)	Odour Threshold	no data available
d)	pH	no data available
e)	Melting point/freezing point	Melting point/range: -98 °C
f)	Initial boiling point and boiling range	64,7 °C
g)	Flash point	9,7 °C - closed cup
h)	Evapouration rate	no data available
i)	Flammability (solid, gas)	no data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 36 %(V) Lower explosion limit: 6 %(V)
k)	Vapour pressure	130,3 hPa at 20,0 °C 546,6 hPa at 50,0 °C 169,27 hPa at 25,0 °C
l)	Vapour density	1,11
m)	Relative density	0,791 g/mL at 25 °C
n)	Water solubility	completely miscible
o)	Partition coefficient: n-octanol/water	log Pow: -0,77
p)	Auto-ignition temperature	455,0 °C at 1.013 hPa
q)	Decomposition temperature	no data available

r)	Viscosity	no data available
s)	Explosive properties	Not explosive
t)	Oxidizing properties	The substance or mixture is not classified as oxidizing.

9.2 Other safety information

Minimum ignition energy	0,14 mJ
Conductivity	< 1 µS/cm
Relative vapour density	1,11

SECTION 10: Stability and reactivity

10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
no data available

10.4 Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

10.5 Incompatible materials
Acid chlorides, Acid anhydrides, Oxidizing agents, Alkali metals, Reducing agents, Acids

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

SECTION 11: Toxicological information

11.1 Information on toxicological effects

Acute toxicity
LD_{LO} Oral - Human - 143 mg/kg
Remarks: Lungs, Thorax, or Respiration:Dyspnea. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea.

LD_{50} Oral - rat - 1.187 - 2.769 mg/kg

LC_{50} Inhalation - rat - 4 h - 128,2 mg/l

LC_{50} Inhalation - rat - 6 h - 87,6 mg/l

LD_{50} Dermal - rabbit - 17.100 mg/kg

Skin corrosion/irritation
Skin - rabbit
Result: No skin irritation

Serious eye damage/eye irritation
Eyes - rabbit
Result: No eye irritation

Respiratory or skin sensitisation
Maximisation Test - guinea pig
Does not cause skin sensitisation.
(OECD Test Guideline 406)

Germ cell mutagenicity
Ames test
S. typhimurium
Result: negative

in vitro assay
fibroblast
Result: negative
Mutation in mammalian somatic cells.

Mutagenicity (in vivo mammalian bone-marrow cytogenetic test, chromosomal analysis)
mouse - male and female
Result: negative

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

Reproductive toxicity
Damage to fetus not classifiable

Fertility classification not possible from current data.

Specific target organ toxicity - single exposure
Causes damage to organs.

Specific target organ toxicity - repeated exposure
The substance or mixture is not classified as specific target organ toxicant, repeated exposure.

Aspiration hazard
No aspiration toxicity classification

Additional Information
RTECS: PC1400000

Methyl alcohol may be fatal or cause blindness if swallowed.
Effects due to ingestion may include:, Headache, Dizziness, Drowsiness, metabolic acidosis, Coma, Seizures.
Symptoms may be delayed., Damage of the:, Liver, Kidney

SECTION 12: Ecological information

12.1 Toxicity

Toxicity to fish	mortality LC_{50} - Lepomis macrochirus (Bluegill) - 15.400,0 mg/l - 96 h
	NOEC - Oryzias latipes - 7.900 mg/l - 200 h
Toxicity to daphnia and other aquatic invertebrates	EC_{50} - Daphnia magna (Water flea) - > 10.000,00 mg/l - 48 h
Toxicity to algae	Growth inhibition EC_{50} - Scenedesmus capricornutum (fresh water algae) - 22.000,0 mg/l - 96 h

12.2 Persistence and degradability

Biodegradability	aerobic - Exposure time 5 d Result: 72 % - rapidly biodegradable
Biochemical Oxygen Demand (BOD)	600 - 1.120 mg/g
Chemical Oxygen Demand (COD)	1.420 mg/g
Theoretical oxygen demand	1.500 mg/g

12.3 Bioaccumulative potential

Bioaccumulation	Cyprinus carpio (Carp) - 72 d at 20 °C - 5 mg/l Bioconcentration factor (BCF): 1,0

12.4 Mobility in soil

Will not adsorb on soil.

12.5 Results of PBT and vPvB assessment

This substance is not considered to be persistent, bioaccumulating nor toxic (PBT)., This substance is not considered to be very persistent nor very bioaccumulating (vPvB).

12.6 Other adverse effects

Additional ecological information	Avoid release to the environment.
Stability in water	at 19 °C83 - 91 % - 72 h Remarks: Hydrolyses on contact with water.Hydrolyses readily.

SECTION 13: Disposal considerations

13.1 Waste treatment methods

Product

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company.

Contaminated packaging

Dispose of as unused product.

SECTION 14: Transport information

14.1 UN number

ADR/RID: 1230	IMDG: 1230	IATA: 1230

14.2 UN proper shipping name

ADR/RID:	METHANOL
IMDG:	METHANOL
IATA:	Methanol

14.3 Transport hazard class(es)

ADR/RID: 3 (6.1)	IMDG: 3 (6.1)	IATA: 3 (6.1)

14.4 Packaging group

ADR/RID: II	IMDG: II	IATA: II

14.5 Environmental hazards

ADR/RID: no	IMDG Marine pollutant: no	IATA: no

14.6 Special precautions for user

no data available

SECTION 15: Regulatory information

This safety datasheet complies with the requirements of Regulation (EC) No. 1907/2006.

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

no data available

15.2 Chemical Safety Assessment

A Chemical Safety Assessment has been carried out for this substance.

SECTION 16: Other information

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox.	Acute toxicity
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.

H301	Toxic if swallowed.
H301 + H311 + H331	Toxic if swallowed, in contact with skin or if inhaled
H311	Toxic in contact with skin.
H331	Toxic if inhaled.
H370	Causes damage to organs.

Full text of R-phrases referred to under sections 2 and 3

F	Highly flammable
T	Toxic
R11	Highly flammable.
R23/24/25	Toxic by inhalation, in contact with skin and if swallowed.
R39/23/24/25	Toxic: danger of very serious irreversible effects through inhalation, in contact with skin and if swallowed.

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Firma shall not be held liable for any damage resulting from handling or from contact with the above product.

Annex: Exposure scenario

Identified uses:

Use: Used as chemical intermediate

SU 3: Industrial uses: Uses of substances as such or in preparations at industrial sites
SU 3, SU9: Industrial uses: Uses of substances as such or in preparations at industrial sites, Manufacture of fine chemicals
PC19: Intermediate
PROC1: Use in closed process, no likelihood of exposure **PROC2:** Use in closed, continuous process with occasional controlled exposure **PROC3:** Use in closed batch process (synthesis or formulation) **PROC4:** Use in batch and other process (synthesis) where opportunity for exposure arises **PROC8b:** Transfer of substance or preparation (charging/ discharging) from/ to vessels/ large containers at dedicated facilities **PROC15:** Use as laboratory reagent
ERC1, ERC4, ERC6a: Manufacture of substances, Industrial use of processing aids in processes and products, not becoming part of articles, Industrial use resulting in manufacture of another substance (use of intermediates)

Use: Formulation of preparations

SU 3: Industrial uses: Uses of substances as such or in preparations at industrial sites
SU 10: Formulation [mixing] of preparations and/ or re-packaging (excluding alloys)
PROC2: Use in closed, continuous process with occasional controlled exposure **PROC3:** Use in closed batch process (synthesis or formulation) **PROC4:** Use in batch and other process (synthesis) where opportunity for exposure arises **PROC8b:** Transfer of substance or preparation (charging/ discharging) from/ to vessels/ large containers at dedicated facilities **PROC9:** Transfer of substance or preparation into small containers (dedicated filling line, including weighing) **PROC15:** Use as laboratory reagent
ERC2: Formulation of preparations

Use: Industrial use of processing aids in processes and products, not becoming part of articles

SU 3: Industrial uses: Uses of substances as such or in preparations at industrial sites
SU 3, SU9: Industrial uses: Uses of substances as such or in preparations at industrial sites, Manufacture of fine chemicals
PC20: Products such as ph-regulators, flocculants, pre-cipitants, neutralization agents **PC21:** Laboratory chemicals
PROC1: Use in closed process, no likelihood of exposure **PROC2:** Use in closed, continuous process with occasional controlled exposure **PROC3:** Use in closed batch process (synthesis or formulation) **PROC4:** Use in batch and other process (synthesis) where opportunity for exposure arises **PROC8b:** Transfer of substance or preparation (charging/ discharging) from/ to vessels/ large containers at dedicated facilities **PROC9:** Transfer of substance or preparation into small containers (dedicated filling line, including weighing) **PROC10:** Roller application or brushing **PROC15:** Use as laboratory reagent
ERC4, ERC6b: Industrial use of processing aids in processes and products, not becoming part of articles, Industrial use of reactive processing aids

Use: Used as laboratory reagent.

SU 22: Professional uses: Public domain (administration, education, entertainment, services, craftsmen)
SU 3, SU 22, SU24: Industrial uses: Uses of substances as such or in preparations at industrial sites, Professional uses: Public domain (administration, education, entertainment, services, craftsmen), Scientific research and development
PC19: Intermediate **PC20:** Products such as ph-regulators, flocculants, pre-cipitants, neutralization agents **PC21:** Laboratory chemicals

PROC10: Roller application or brushing **PROC15:** Use as laboratory reagent
ERC4, ERC6a, ERC6b: Industrial use of processing aids in processes and products, not becoming part of articles, Industrial use resulting in manufacture of another substance (use of intermediates), Industrial use of reactive processing aids

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1. Short title of Exposure Scenario: Used as chemical intermediate

Main User Groups	: **SU 3**
Sectors of end-use	: **SU 3, SU9**
Chemical product category	: **PC19**
Process categories	: **PROC1, PROC2, PROC3, PROC4, PROC8b, PROC15**
Environmental Release Categories	: **ERC1, ERC4, ERC6a:**

2. Exposure scenario

2.1 Contributing scenario controlling environmental exposure for: ERC1, ERC4, ERC6a

Product characteristics

Concentration of the Substance in Mixture/Article	: Covers the percentage of the substance in the product up to 100 % (unless stated differently).

2.2 Contributing scenario controlling worker exposure for: PROC1, PROC2, PROC3, PROC4, PROC8b, PROC15, PC19

Product characteristics

Concentration of the Substance in Mixture/Article	: Covers the percentage of the substance in the product up to 100 % (unless stated differently).
Physical Form (at time of use)	: High volatile liquid

Frequency and duration of use

Application duration	: > 4 h
Frequency of use	: 220 days/year

Other operational conditions affecting workers exposure

Outdoor / Indoor	: Indoor

Technical conditions and measures

Good work practice required., Use only in area provided with appropriate exhaust ventilation.

Organisational measures to prevent /limit releases, dispersion and exposure

Ensure operatives are trained to minimise exposures.

Conditions and measures related to personal protection, hygiene and health evaluation

Wear suitable gloves tested to EN374., For personal protection see section 8.

3. Exposure estimation and reference to its source

Environment

A chemical safety assessment was performed according REACH Article 14(3), Annex I, sections 3 (Environmental Hazard assessment) and 4 (PBT/vPvB Assessment). As no hazard was identified, an exposure assessment and risk characterisation is not necessary (REACH Annex I section 5.0).

Workers

Contributing Scenario	Exposure Assessment Method	Specific conditions	Value	Level of Exposure	RCR*
PROC1	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	0,01 mg/m^3	0
PROC1	ECETOC TRA	With Local Exhaust Ventilation	Dermal	0,34 mg/kg BW/d	0,009

PROC2	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6,67 mg/m^3	0,026
PROC2	ECETOC TRA	With Local Exhaust Ventilation	Dermal	13,33 mg/kg BW/d	0,333
PROC3	ECETOC TRA	With Local Exhaust Ventilation	Dermal	0,34 mg/kg BW/d	0,009
PROC3	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	13,33 mg/m^3	0,051
PROC4	ECETOC TRA	With Local Exhaust Ventilation	Dermal	6,86 mg/kg BW/d	0,172
PROC4	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	13,33 mg/m^3	0,051
PROC8b	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6 mg/m^3	0,023
PROC8b	ECETOC TRA	With Local Exhaust Ventilation	Dermal	6,86 mg/kg BW/d	0,172
PROC15	ECETOC TRA	With Local Exhaust Ventilation	Dermal	0,34 mg/kg BW/d	0,009
PROC15	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6,67 mg/m^3	0,026

*Risk characterisation ratio

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the Exposure Scenario

Please refer to the following documents: ECHA Guidance on information requirements and chemical safety assessment Part D: Exposure Scenario Building, Part E: Risk Characterisation and Part G: Extending the SDS; VCI/Cefic REACH Practical Guides on Exposure Assessment and Communications in the Supply Chain; CEFIC Guidance Specific Environmental Release Categories (SPERCs).

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1. Short title of Exposure Scenario: Formulation of preparations

Main User Groups : **SU 3**
Sectors of end-use : **SU 10**
Process categories : **PROC2, PROC3, PROC4, PROC8b, PROC9, PROC15**
Environmental Release Categories : **ERC2:**

2. Exposure scenario

2.1 Contributing scenario controlling environmental exposure for: ERC2

Product characteristics

Concentration of the Substance in Mixture/Article : Covers the percentage of the substance in the product up to 100 % (unless stated differently).

2.2 Contributing scenario controlling worker exposure for: PROC2, PROC3, PROC4, PROC8b, PROC9, PROC15

Product characteristics

Concentration of the Substance in Mixture/Article : Covers the percentage of the substance in the product up to 100 % (unless stated differently).
Physical Form (at time of use) : High volatile liquid

Frequency and duration of use

Application duration	: > 4 h
Frequency of use	: 220 days/year

Other operational conditions affecting workers exposure

Outdoor / Indoor : Indoor

Technical conditions and measures

Use only in area provided with appropriate exhaust ventilation., Good work practice required.

Organisational measures to prevent /limit releases, dispersion and exposure

Ensure operatives are trained to minimise exposures.

Conditions and measures related to personal protection, hygiene and health evaluation

Wear suitable gloves tested to EN374., For personal protection see section 8.

3. Exposure estimation and reference to its source

Environment

A chemical safety assessment was performed according REACH Article 14(3), Annex I, sections 3 (Environmental Hazard assessment) and 4 (PBT/vPvB Assessment). As no hazard was identified, an exposure assessment and risk characterisation is not necessary (REACH Annex I section 5.0).

Workers

Contributing Scenario	Exposure Assessment Method	Specific conditions	Value	Level of Exposure	RCR*
PROC2	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6,67 mg/m^3	0,026
PROC2	ECETOC TRA	With Local Exhaust Ventilation	Dermal	13,33 mg/kg BW/d	0,333
PROC3	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	13,33 mg/m^3	0,051
PROC3	ECETOC TRA	With Local Exhaust Ventilation	Dermal	0,34 mg/kg BW/d	0,009
PROC4	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	13,33 mg/m^3	0,051
PROC4	ECETOC TRA	With Local Exhaust Ventilation	Dermal	6,86 mg/kg BW/d	0,172
PROC8b	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6 mg/m^3	0,023
PROC8b	ECETOC TRA	With Local Exhaust Ventilation	Dermal	6,86 mg/kg BW/d	0,172
PROC9	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	26,67 mg/m^3	0,103
PROC9	ECETOC TRA	With Local Exhaust Ventilation	Dermal	6,86 mg/kg BW/d	0,172
PROC15	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6,67 mg/m^3	0,026
PROC15	ECETOC TRA	With Local	Dermal	0,34 mg/kg	0,009

		Exhaust Ventilation		BW/d	

*Risk characterisation ratio

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the Exposure Scenario

Please refer to the following documents: ECHA Guidance on information requirements and chemical safety assessment Part D: Exposure Scenario Building, Part E: Risk Characterisation and Part G: Extending the SDS; VCI/Cefic REACH Practical Guides on Exposure Assessment and Communications in the Supply Chain; CEFIC Guidance Specific Environmental Release Categories (SPERCs).

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1. Short title of Exposure Scenario: Industrial use of processing aids in processes and products, not becoming part of articles

Main User Groups : **SU 3**
Sectors of end-use : **SU 3, SU9**
Chemical product category : **PC20, PC21**
Process categories : **PROC1, PROC2, PROC3, PROC4, PROC8b, PROC9, PROC10, PROC15**
Environmental Release Categories : **ERC4, ERC6b:**

2. Exposure scenario

2.1 Contributing scenario controlling environmental exposure for: ERC4, ERC6b

Product characteristics
Concentration of the Substance in Mixture/Article : Covers the percentage of the substance in the product up to 100 % (unless stated differently).

2.2 Contributing scenario controlling worker exposure for: PROC1, PROC2, PROC3, PROC4, PROC8b, PROC9, PROC10, PROC15, PC20, PC21

Product characteristics
Concentration of the Substance in Mixture/Article : Covers the percentage of the substance in the product up to 100 % (unless stated differently).
Physical Form (at time of use) : High volatile liquid

Frequency and duration of use
Application duration : > 4 h
Frequency of use : 220 days/year

Other operational conditions affecting workers exposure
Outdoor / Indoor : Indoor

Technical conditions and measures
Use only in area provided with appropriate exhaust ventilation., Good work practice required.

Organisational measures to prevent /limit releases, dispersion and exposure
Ensure operatives are trained to minimise exposures.

Conditions and measures related to personal protection, hygiene and health evaluation
Wear suitable gloves tested to EN374., For personal protection see section 8.

3. Exposure estimation and reference to its source

Environment

A chemical safety assessment was performed according REACH Article 14(3), Annex I, sections 3 (Environmental Hazard assessment) and 4 (PBT/vPvB Assessment). As no hazard was identified, an exposure assessment and risk characterisation is not necessary (REACH Annex I section 5.0).

Workers

Contributing Scenario	Exposure Assessment	Specific conditions	Value	Level of Exposure	RCR*

	Method				
PROC1	ECETOC TRA	With Local Exhaust Ventilation	Dermal	0,34 mg/kg BW/d	0,009
PROC1	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	0,01 mg/m^3	0
PROC2	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6,67 mg/m^3	0,026
PROC2	ECETOC TRA	With Local Exhaust Ventilation	Dermal	13,33 mg/kg BW/d	0,333
PROC3	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	13,33 mg/m^3	0,051
PROC3	ECETOC TRA	With Local Exhaust Ventilation	Dermal	0,34 mg/kg BW/d	0,009
PROC4	ECETOC TRA	With Local Exhaust Ventilation	Dermal	6,86 mg/kg BW/d	0,172
PROC4	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	13,33 mg/m^3	0,051
PROC8b	ECETOC TRA	With Local Exhaust Ventilation	Dermal	6,86 mg/kg BW/d	0,172
PROC8b	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6 mg/m^3	0,023
PROC9	ECETOC TRA	With Local Exhaust Ventilation	Dermal	6,86 mg/kg BW/d	0,172
PROC9	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	26,67 mg/m^3	0,103
PROC10	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	53,33 mg/m^3	0,205
PROC10	ECETOC TRA	With Local Exhaust Ventilation	Dermal	21,94 mg/kg BW/d	0,549
PROC15	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6,67 mg/m^3	0,026
PROC15	ECETOC TRA	With Local Exhaust Ventilation	Dermal	0,34 mg/kg BW/d	0,009

*Risk characterisation ratio

4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the Exposure Scenario

Please refer to the following documents: ECHA Guidance on information requirements and chemical safety assessment Part D: Exposure Scenario Building, Part E: Risk Characterisation and Part G: Extending the SDS; VCI/Cefic REACH Practical Guides on Exposure Assessment and Communications in the Supply Chain; CEFIC Guidance Specific Environmental Release Categories (SPERCs).

1. Short title of Exposure Scenario: Used as laboratory reagent.

Main User Groups	:	**SU 22**
Sectors of end-use	:	**SU 3, SU 22, SU24**
Chemical product category	:	**PC19, PC20, PC21**
Process categories	:	**PROC10, PROC15**
Environmental Release Categories	:	**ERC4, ERC6a, ERC6b:**

2. Exposure scenario

2.1 Contributing scenario controlling environmental exposure for: ERC4, ERC6a, ERC6b

Product characteristics

Concentration of the Substance in Mixture/Article : Covers the percentage of the substance in the product up to 100 % (unless stated differently).

2.2 Contributing scenario controlling worker exposure for: PROC10, PROC15, PC19, PC20, PC21

Product characteristics

Concentration of the Substance in Mixture/Article	:	Covers the percentage of the substance in the product up to 100 % (unless stated differently).
Physical Form (at time of use)	:	High volatile liquid

Frequency and duration of use

Application duration	:	> 4 h
Frequency of use	:	220 days/year

Other operational conditions affecting workers exposure

Outdoor / Indoor : Indoor

Technical conditions and measures

Use only in area provided with appropriate exhaust ventilation., Good work practice required.

Organisational measures to prevent /limit releases, dispersion and exposure

Ensure operatives are trained to minimise exposures.

Conditions and measures related to personal protection, hygiene and health evaluation

Wear suitable gloves tested to EN374., For personal protection see section 8.

3. Exposure estimation and reference to its source

Environment

A chemical safety assessment was performed according REACH Article 14(3), Annex I, sections 3 (Environmental Hazard assessment) and 4 (PBT/vPvB Assessment). As no hazard was identified, an exposure assessment and risk characterisation is not necessary (REACH Annex I section 5.0).

Workers

Contributing Scenario	Exposure Assessment Method	Specific conditions	Value	Level of Exposure	RCR*
PROC10	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	53,33 mg/m^3	0,205
PROC10	ECETOC TRA	With Local Exhaust Ventilation	Dermal	21,94 mg/kg BW/d	0,549
PROC15	ECETOC TRA	With Local Exhaust Ventilation	Inhalation	6,67 mg/m^3	0,026
PROC15	ECETOC TRA	With Local Exhaust Ventilation	Dermal	0,34 mg/kg BW/d	0,009

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4. Guidance to Downstream User to evaluate whether he works inside the boundaries set by the Exposure Scenario

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Aalto University
School of Chemical Engineering

APPENDIX 2

☐ Department of Bioproducts and Biosystems
☐ Department of Chemical and Metallurgical Engineering
☐ Department of Chemistry and Materials Science

WORK ACCIDENT REPORT

Fill in the required sections. *May also be completed anonymously

☐ Accident	☐ Close call	Date
Research group	Room	Course
Caused/damaged by*		☐ Personnel ☐ Student ☐ Other
Description of the accident/incident		
Substances/equipment		
Exposure time		
First aid		
Treating physician		
Treatment facility		
Work supervisor		
Report drafted by		Date
Report recipient(s)		Date

Reports are to be submitted to the building occupational safety representative, who will archive the document and, if necessary, send a copy to the Aalto University occupational safety manager. You can find this form also from Inside: https://inside.aalto.fi/display/enchem/Guides+and+instructions

CALL EMERGENCY NUMBER 112 TO REPORT EMERGENCIES

CALL THE EMERGENCY NUMBER, IF YOU CAN.

It is important that the affected person make the call. They have the information that the operator needs to determine what type of assistance should be sent to the scene. Calls made by others might delay the arrival of rescue services.

EXPLAIN WHAT HAPPENED

The Emergency Response Centre operator will ask the caller to provide information on the incident, so that they can send the right kind of assistance to the scene.

PROVIDE THE EXACT ADDRESS AND TOWN OR CITY

The Emergency Response Centre area may have multiple identical addresses in different municipalities. This is why it so important to provide the address and town or city.

ANSWER ALL QUESTIONS ASKED

Each question the operator asks has a purpose. These questions will not delay sending for help. In urgent cases, the operator will alert the appropriate authorities and partners during the call as well as provide them with additional information regarding the incident.

FOLLOW ALL INSTRUCTIONS GIVEN

The operator is fully trained to provide instructions for different situations. It is vital that you follow all instructions given. Carried out properly, the initial response often affects the final outcome of a situation.

DO NOT HANG UP UNTIL TOLD TO DO SO.

Hanging up too soon might delay the arrival of help. Hang up the phone as soon as you are given permission to do so. Keep the line open. The operator or rescue services may need additional information on the situation.

Help the rescue services find their way to the scene. Call back if there is any change in the situation.

WHAT TO DO IN THE EVENT OF A FIRE

RESCUE	those in danger.
EXTINGUISH	the fire or stop it from spreading, using the nearest portable fire extinguisher.
CALL	the Emergency Number at **112**. Alert personnel to seek help or shelter.
LIMIT	the spread of fire by closing doors and windows. The fire will die out from a lack of oxygen.
GUIDE	the fire department/rescue services to the scene.

TELEPHONE NUMBERS:

Emegency Number	**112**
Emergency rescue services, Police	
Poison Information Centre	(09) 471 977
HUCH Eye Clinic	(09) 471 73170 (Operator)
Haartmaninkatu 4, Helsinki	
Finnish Student Health Service (Otaniemi)	046 710 1035
Otakaari 12, Espoo	
Only students Mon-Thu 8:00am-3:00pm, Fri 8:00am-2:00pm	
Employee occupational health care: Terveystalo	030 6000
	(switchboard and appointment)
Terveystalo Aalto University	
Metallimiehenkuja 2, Espoo	
Mon-Thu 8:00am-4:00pm, Fri 8:00am-2:00pm	
Terveystalo Otaniemi	
Sähkömiehentie 3, Espoo	
Laboratory Mon-Thu 07:30-2:30pm, Fri 07:30-1:00pm. Only by appointment	
Terveystalo Tapiola	
Länsituuli 7, Espoo (Shopping center AINOA)	
Mon-Fri 7:30am-9:00pm	
Jorvi Hospital	(09) 4711 (HUS switchboard)
Turuntie 150, Espoo	
Specialised emergency medical care 24h	(09) 471 83400
Espoo Hospital	(09) 816 21 (switchboard)
Karvasmäentie 6, Espoo	
Tapiola Health Centre	(09) 816 3811 (switchboard)
Ahertajantie 2, Espoo	
Telephone Health Service	
- Helsinki	(09) 310 10023
- Espoo, Kauniainen	(09) 87 10023
- Vantaa	(09) 471 67060