UMEÅ UNIVERSITY

INSTRUCTIONS FOR GASES, FLAMMABLE PRODUCTS AND PRESSURISED EQUIPMENT

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1. Description

These instructions specify how gases, flammable products and pressurised equipment must be handled. The rules supplement or clarify the statutory requirements. The instructions also describe responsibilities and roles concerning flammable products, as the organsation includes functions outside ordinary delegation. In addition to the University's adaptation based on statutory requirements, specific requirements resulting from classification plans and the University's safety levels are also highlighted.

2. Background

As an operator, the University is responsible for ensuring that gases, flammable products and pressurised equipment are handled safely. Gas and flammable products must always be handled with special care to avoid accidents resulting from fire and explosion. Requirements from public authorities govern what safe handling entails, and relevant persons within the organisation must know and comply with the protective and safety requirements for handling.

The statutory requirements, for example, state that persons who handle gases, flammable products and pressurised equipment must have good knowledge of any potential risks that a certain handling might entail and take measures to minimise these. A section on risk assessments thus follows below. There is also the general requirement that action plans must be drawn up for handling potential accidents, fires, spills and explosions. These must also be implemented by the relevant organisation. Individual organisations may also be required to have separate permits or to report their operations to a supervisory authority. However, the University has a collective permit for flammable products. In this permit, which is time-limited, it must be stated, for example, which person or persons are designated according to the delegation as flammable products managers.

Current statutory requirements for these areas can be found in the Swedish Work Environment Authority's regulations on Chemical Occupational Safety and Health Risks, and on the Use and Control of Pressurised Equipment; Gases; Pressure Equipment; Simple Pressure Vessels; and Overpressure and Suppression Testing, and in the Swedish Civil Contingencies Agency's (MSB) statutory requirements on Flammable and Explosive Products. In laboratory operations, the EU's Reach Regulation (on the registration, evaluation, authorisation and restriction of chemicals, etc.) and CLP Regulation (on the classification, labelling and packaging of chemical substances and mixtures) set further requirements on, for example, registration, labelling and safety data sheet information. The chemicals registration system KLARA is used for this purpose.

The following terms are used in the instructions:

Handling: manufacturing, processing, treatment, packaging, storage, transport, use, care, recycling, destruction, marketing, maintenance, transfer and similar procedures. Handling large quantities of flammable products requires a permit and that a manager is appointed and reported to the supervisory authority.

Flammable products:

a. **Flammable gases –** gases that can ignite in air at 20 °C and atmospheric pressure.
b. **Flammable liquids –** liquids that have a flashpoint of no more than 100 °C.
c. **Fire-reactive products** – other substances, mixtures and objects specified in

regulations from the Swedish Civil Contingencies Agency (MSB).

Pressurised equipment: cisterns, vacuum containers, pressure containers or pipelines. Examples include autoclaves and reactors.

3. Roles and responsibilities

The handling of gases, flammable products and pressurised equipment must be carried out in accordance with the line organisation, which is clarified in the Vice-Chancellor's decision-making and delegation procedure for Umeå University and in subsequent further delegations. A central coordinator for the physical work environment and a central chemicals expert can assist with advice and support in the field. The coordinator for the physical work environment also administers changes in and renewals of the University's collective permit for flammable products. In addition to the line organisation, there must also be one or more managers appointed for flammable products. See Section 3.1. There is also a gas manager for the central gas distribution system who must participate in any changes in the central gas system. If multiple organisations share premises, a coordinator must be appointed. In Region Västerbotten's premises, the Region's rules and procedures apply for the handling of gases, flammable products and pressurised equipment.

Relevant employees must know and apply the rules and local procedures prescribed and know the properties of the gases, liquids, aerosols or solid objects handled.

3.1 Special information regarding flammable products

The head of department/similar at a department that handles flammable products is responsible for:

- Ensuring that handling complies with the awarded permit for flammable products, the University's safety levels (Section 4.3.2 below) and other applicable statutory requirements.
- Ensuring that gases and flammable products are registered and inventoried annually in the University's chemical registration system, KLARA.
- Appointing manager(s) for the handling of flammable products in their operational area using the form "Delegation of tasks – Manager for the handling of flammable products".
- Ensuring that managers for the handling of flammable products receive the training and the authorisations required to perform their duties.
- Ensuring that other employees receive the training necessary for the handling.
- Verifying that risk assessments are carried out by the person leading a phase of work involving the handling of a flammable product.
- Verifying that self-inspection procedures are in place.
- Ensuring that an action plan is prepared for measures to be taken in the event of a fire, explosion or emission.
- Ensuring that adequate damage control measures are taken.

The flammable products manager is responsible for:

- Preparing local instructions for the work with flammable products within the department.
- Preparing instructions for operations and maintenance of the facility.
- Serving as the organisation's knowledge support in the application of the rules.
- Providing support in accident and near-miss reporting.

- Handling the department's contacts with licensing authorities and supervisory authorities.
- Monitoring that the commissioning of new operations (facility) comply with applicable regulations and local procedures/instructions.
- Participating in fire safety inspections.
- Carrying out regular self-inspections of the handling of flammable products.
- Monitoring that the quantities of flammable products handled within the department/similar correspond to what is stated in the applicable permit.
- Ensuring that measures are taken in the event of non-conformances. Necessary measures may be of an organisational or technical nature, to ensure that the handling is satisfactory and safe.
- Stopping work with flammable products at the department/similar that could pose a risk to life and health.
- Reporting to the head of department and to the fire safety coordinator if non-conformances require rectification measures.

Group leaders/operative managers directing various work stages involving the handling of flammable products, such as researchers, supervisors, heads of academic disciplines, etc. are responsible, through further delegation, for ensuring that:

- The safety regulations are followed during ongoing stages of work and that persons engaged in operations with flammable products are informed of the risks that could be associated with the operations and that they have the requisite knowledge.
- Chemical residues generated in the operations are handled in accordance with applicable statutory requirements and the University's internal regulations.
- A risk assessment is performed, in consultation with the manager for the handling of flammable products.

Central coordinator for physical work environment

- Responsible for ensuring that the University has a current collective permit for flammable products on Campus Umeå premises.
- Coordinates supervisory visits and any reports submitted to the supervisory authority.
- Can assist with advice and support on handling.

Central chemicals expert

- Can assist with advice and support on handling.

4. Risk assessment

Before starting any new handling of gases and/or flammable products or pressurised equipment, a risk assessment must be performed. An analysis of the risks for accidents that could cause serious personal injury or damage to the environment must also be carried out. In the risk assessment, risks associated with the work stages to be performed must be evaluated and assessed. The risk assessment must be documented and preventative measures taken to reduce/eliminate the risks, and this must form the basis for the handling procedures that will be in force. If there is a risk for serious personal injury or damage to the environment, the statutory requirements specifically state that the organisation must maintain or pay for preparedness regarding staff and property and otherwise take the necessary measures to prevent or limit such damage and injury.

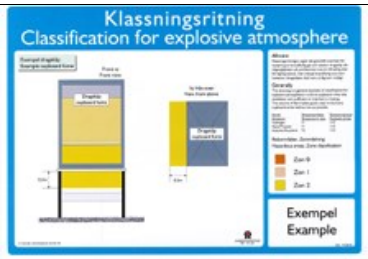
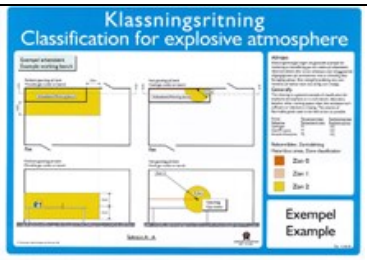
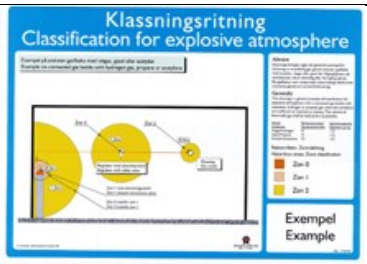
5. Classification plans

In the Swedish Civil Contingencies Agency's regulations on explosive environments in the handling of gases and liquids, there is a requirement for *classification plans* to be prepared of risk areas containing explosive environments, i.e., areas in which the open handling of flammable gases and liquids entails the risk of a flammable gas/air mixture forming. These risk areas must be divided into zones and are part of an overall risk assessment. Each classification plan therefore has the primary function of stating in which zones (0–2) flammable gas mixtures could occur and where ignition sources through electrical equipment etc. must therefore be avoided. If electrical equipment does occur in classified areas, this must usually be explosion-proof. Another decisive factor in the scope of the classification is the design of ventilation in connection with the handling. For the availability of the ventilation to be considered good, and thereby involving reduced classification requirements, separate ventilation equipped with backup power and backup ventilation is usually required. If these functions do not exist, interlocking can be used, which involves automatic disconnection of electrical equipment if the ventilation flow becomes too low or ceases altogether.

Zone 0 – Risk area in which an explosive gas mixture occurs continuously or for long periods of time.
Zone 1 – Risk area in which an explosive gas mixture is expected to occur during normal handling.
Zone 2 – Risk area in which an explosive gas mixture is not expected to occur during normal handling, and even if it does occur, it is only rarely and briefly.

In laboratory premises within the University, the ventilation has high operational safety but there is no backup power or backup ventilation. Interlocked power sockets must therefore always be used for the equipment in areas in which zones may occur if the ventilation's function is reduced or ceases. If interlocked power sockets are not available in a zone, only equipment with the correct ATEX classification may be placed within the zone.

To support this risk assessment, there are three general classification plans that apply for laboratories with normal handling of flammable products. These show the zone that occurs when the ventilation is insufficient during the handling of flammable gas or solvents such as methanol or ethanol. For laboratories with a handling of flammable products that deviates from normal handling, specific classification plans have been drawn up. General classification plans must be posted near the laboratory premises. These can be downloaded from the intranet.

Fume cupboards		Inside the fume cupboard and 0.5 m outside and under the opening, Zone 2 requirements apply.
Workbenches, laboratory counters or other surface that is not enclosed.		Generally, Zone 2 applies within a distance of 0.5 m laterally, over and under the counter for the handling of loose gas cylinders. Fixed power sockets are classified as Zone 2 within a radius of 0.5 m around the socket.
Connected gas cylinder with flammable gas, e.g., hydrogen, ethane or acetylene		The area within a radius of 0.5 m around the connection valve is classified as Zone 1. The area within a radius of 1.5 m outside Zone 1 is classified as Zone 2. The area around a regulator with safety valve is classified as Zone 2. For power sockets, the area within a radius of 0.5 m around the outlet of the socket is classified as Zone 2.

6. The University's safety levels for gas handling

If gas is needed, the following order applies:

1. Gas from the central distribution system should be used in the first instance. This system also forms the basis of the safety system for flammable gas. The gases in the central distribution system contain a maximum pressure of about 10.5 bar, except for liquefied petroleum gas (LPG), which gives just under 0.5 bar, and instrument air, which gives up to about 6.5 bar.

   The quality (purity) of the gases in the central gas system is as follows:

Helium	instrument 5.0 Alphagaz 1
Argon	Instrument 5.0 Alphagaz 1
Nitrogen	4.6 (O2 < 1.6 ppm. H2O < 2 ppm.)
Oxygen	Industrial quality
Carbon dioxide	Industrial quality
Hydrogen	5.0 Alphagaz 1
LPG	Standard quality
Instrument air	Oil-free and filtered, dew point approx. -50–55 °C

2. If the central distribution system does not meet the requirements for type of gas, pressure or purity, the need can be met through the purchase and secure storage of a separate gas cylinder.
3. When using toxic gases, a warning system with gas sensors must be used.

4. In premises where gases are handled that can affect the atmosphere so that it becomes harmful to health, such as carbon dioxide, nitrogen and oxygen, a gas warning system should be considered. The risk assessment forms the basis for this assessment.

For hydrogen, LPG, helium, argon, carbon dioxide, oxygen and nitrogen, there is a monitoring system that registers gas use. The system also monitors that the use of the flammable gases hydrogen and LPG do not exceed maximum permitted instantaneous flows. If the maximum flows are exceeded, the supply is automatically stopped for the entire building or building section in which excessive instantaneous flow was measured.

If the central ventilation systems in the Chemistry, Chemical Biological Centre, Physiology, Natural Sciences and Medical Biology Centre buildings stop, the flammable gas flows in the central distribution system are automatically stopped to the building affected by the ventilation interruption.

The safety system for the distribution of the flammable gases in the central gas network also has a function for safe start of use and safe restart after interruption. The distribution system is sectioned off with key-actuated switches in the laboratories. Restart after interruptions described in the previous paragraph can only be done with a key-actuated switch after the Chem Shop staff have acknowledged the central restart in the monitoring system, which is done after the cause of the fault has been established and, if necessary, rectified.

The distribution of flammable gas to a building can also be interrupted manually by turning the switch in the building's fire control cabinet. Manual valves are also located above false ceilings at the entrances to laboratory floors, preferably from stairwells. Signs show where the shut-off valves are.

To ensure that safety levels and gas qualities are maintained, all adaptations, extensions or other changes to fixed or local gas distribution systems must always be planned and carried out together with the person at the University responsible for gas.

7. Handling of flammable liquids

Operations in which flammable liquids are handled must be adapted and planned so that the risk of fire is limited as far as possible. Handled volumes of flammable liquids must always be kept as low as possible. The following must be particularly considered:

- Loose containers must be approved for the liquid they are used for and designed so that leakage cannot occur.
- In laboratory premises/equivalent, the volumes of flammable liquids taken out must be limited to the need for the day's work, which should be kept to under 10 litres. This volume must be handled in fume cupboards or in a well-ventilated laboratory space and stored in the fume cupboard's ventilated lower compartment with an air exchange of at least 10 times an hour, and where unauthorised co-storage can be prevented.
- A maximum of 50 litres in total may be stored/handled within a fire cell. As there are often multiple laboratories within a fire cell, volumes exceeding the daily use of a maximum of 10 litres in laboratory premises must be stored in fireproof Type G90 cabinets, type approved in accordance with SS-EN14470-1. These cabinets are considered self-contained fire cells and may therefore not contain more than 50 litres per cabinet.
  Unauthorised co-storage must be avoided, and the cabinets must be ventilated to the outside air with at least 10 air exchanges per hour. Note that collected volumes/residues must also be

calculated into the total volume, which is why these should be transferred regularly to the Hazardous Waste Building.
- Flammable liquids must not be stored together with flammable gas, toxic substances, acids, bases or easily ignitable products. Refrigeration and freezer storage may only be carried out in cabinets adapted for this and with suitable ATEX classification for this purpose.
- Places in which spills or leakage of flammable liquids could occur must be designed so that the liquid can be taken care of safely. There are no formal requirements, however, for containment for laboratory operations and similar. Rags or other items that have been used to wipe up flammable liquids must be given particular attention and placed in non-flammable containers.

8. Handling of gases, including flammable gases

Gas from the central distribution system should be used in the first instance. Gas cylinders are pressurised devices that pose a significant risk during transport and in the event of improper handling and fire. There are also specific risks associated with flammable and toxic gases. Efforts should therefore be made to keep the number of gas cylinders in the building as low as possible, and to use the smallest gas cylinders possible.

Gas cylinder handling with gas that is not flammable and/or toxic requires access to approved storage facilities, as gas cylinders (with gas that is not flammable and/or toxic) may only be used *temporarily* in laboratories or other well-ventilated, non-public premises. *Temporarily* refers to the time the gas is actually used.

A gas storage facility is a fire-resistant separated room that comprises its own fire cell (at least IE60) and where co-storage with chemicals, flammable liquids, fire-reactive goods or other ignitable materials does not occur. Note that co-storage of certain gases is not permitted.

If there is no special gas storage facility, gas cylinders must be stored in fire-resistant cabinets, type-approved in accordance with SS-EN 14470-2, at least G60 but preferably G90, which means protection against fire for 90 minutes. The gas cabinet must be ventilated to the outside air.

Gas cylinders with flammable gases/and or toxic gases must be permanently stored in gas cabinets (Type G90, EN14470-2) at the laboratory near the fume cupboard in which the gas is used. The gas cabinet must be ventilated to the outside air. For flammable and oxidised gases, the air in the gas cabinet must be replaced at least 10 times per hour. For toxic and very toxic gases, there must be at least 120 air exchanges per hour.
A local gas system with fixed gas piping must be made from a *discharge regulator* inside the gas cylinder to a permanently mounted power socket pedestal in a well-ventilated location near the fume cupboard, if it is not possible to mount the power socket pedestal inside the fume cupboard. Always consider the safety zone for electric equipment and the classification plan that apply for the lab. Zone 2 applies inside gas cabinets with flammable gas.

To maintain the safety level for flammable gas that applies within Umeå University, access to the flammable gas in the local gas system must be controlled via the same sectioned key-actuated switch system used for the central gas system. This means that a *pneumatic valve,* controlled by the central key-actuated switch system, must be installed inside the gas cabinet. Gas cylinders must always be handled carefully and must always be fitted with a fall-protection device during temporary handling. Fall-protection devices must also be used during storage in an approved gas storage facility or during permanent storage at the laboratory in type-approved, fire-resistant gas cabinets. The designated gas

cylinder trolley must be used when relocating gas cylinders. Regulators must be removed and any protective cover securely fitted.

In the event of a fire, temporarily handled gas cylinders must be moved to a safe location. Gas cylinders that are unprotected or in cabinets with a low fire resistance grade could explode if they are exposed to heat/flames, and procedures should be in place for removing them from the premises in the event of a fire. Gas cylinders in type-approved fire-resistant cabinets (Type G90, EN14470-2) or in approved gas storage facilities of at least fire rating EI60 must remain where they are, as these comprise separate fire cells. Check that doors to the approved fire cabinets/fire storage facilities are closed before evacuating.

Equipment that could be exposed to overpressure when connecting to a gas cylinder or the central gas distribution system (pressure regulators, couplings, valves, equipment, etc.) must be designed, assembled and tested accordingly.

When toxic gases are used, a gas warning system must be installed. Sensors must be installed at the workstation and inside the gas cabinet. The gas warning system must be able to be monitored without needing to go into the laboratory. The warning must include sound and light signals.

9. Handling of pressurised equipment

Autoclaves and reactors are examples of pressurised equipment. Depending on the equipment's *chamber size* and *fuse pressure*, these are classified as either Class A or B. However, small tabletop autoclaves may fall outside classification. Class A or B, or no classification, must be determined for each *new* installation (and *new* risk assessment).

An autoclave's *steam generator* must also be taken into consideration. Steam generators with an output greater than 5 kW, which are not of the flow-through type and which have a loop volume of up to 25 litres, are classified as boilers. Additional requirements then apply in accordance with the Swedish Work Environment Authority's regulations on pressurised equipment.

A unit that has Class A or B equipment must make a list of these. A room manager (with contact details provided) must also be appointed for the rooms in which such pressurised equipment is located. The room manager is responsible for ensuring that updated documentation is kept concerning the equipment, as follows:

- CE certification
- Theoretical longevity and lifespan journal
- Testing instructions for its safety equipment
- Operating instructions (including documentation for continuous monitoring, running and periodic maintenance)
- Log of operating cycles completed, monitoring, maintenance, service, etc.
- Procedures for handling non-conformances and outages, and actions to take in unforeseen circumstances
- Risk assessment

Only staff members who have received special training in pressurised equipment of Class A or B may use these. A list must also be kept of these employees.