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ISSA AISS IVSS

Safety of Liquefied Gas Installations

(Propane and Butane)

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International Section on the Prevention of Occupational Risks in the Chemical Industry of the International Social Security Association (ISSA).

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Safety of Liquefied Gas Installations

Propane and Butane

Compendium for industrial practice

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Preface

The International Social Security Association (ISSA) has set itself the task of using professionally oriented sections to publicize by means of information exchange, publications and colloquia the risks such as industrial accidents and occupational diseases recognised in the field of social security and to offer suggestions for their prevention.

The committee of the "Chemistry" section of the ISSA has set up an "Explosion Protection" working party to promote the international exchange of information among experts and to develop jointly solutions to specific problems. By this means, the working party aims to contribute to a high and, among industrial countries, comparable standard of technology in the field of explosion protection. It is ready and willing to pass on its knowledge to countries less well developed industrially.

This compendium has been compiled in close cooperation with the "Machine Protection" section and should allow project engineers, plant managers, safety experts, etc. with no specialized knowledge of the liquefied gas field to assess whether hazards due to liquefied gas can arise in their own plant or in the construction, equipping and erection of liquefied gas installations. The compendium is not intended to solve the question of whether protective measures are necessary and feasible as the widely different national regulations preclude any reliable generalizations. Rather, it concentrates on identifying the problems and formulating solutions to meet the protection aims.

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Contents

Definition of terms

What is understood by the term liquefied gas?

For the purposes of this booklet, **LPG** or **L**iquefied **P**etroleum **G**as is understood to mean the flammable gases propane and butane and their mixtures, which can be liquefied under pressure.
The expression "liquid gas" is sometimes found in colloquial usage, but is a contradiction in terms. According to our physical laws, material at specified temperatures and pressures can be either in the solid, liquid or gaseous state. However, as low-boiling hydrocarbons in a pressure container are present in the liquid – and also in the gaseous – phase, the expression "liquid gas" can occasionally be found for this two-phase system.

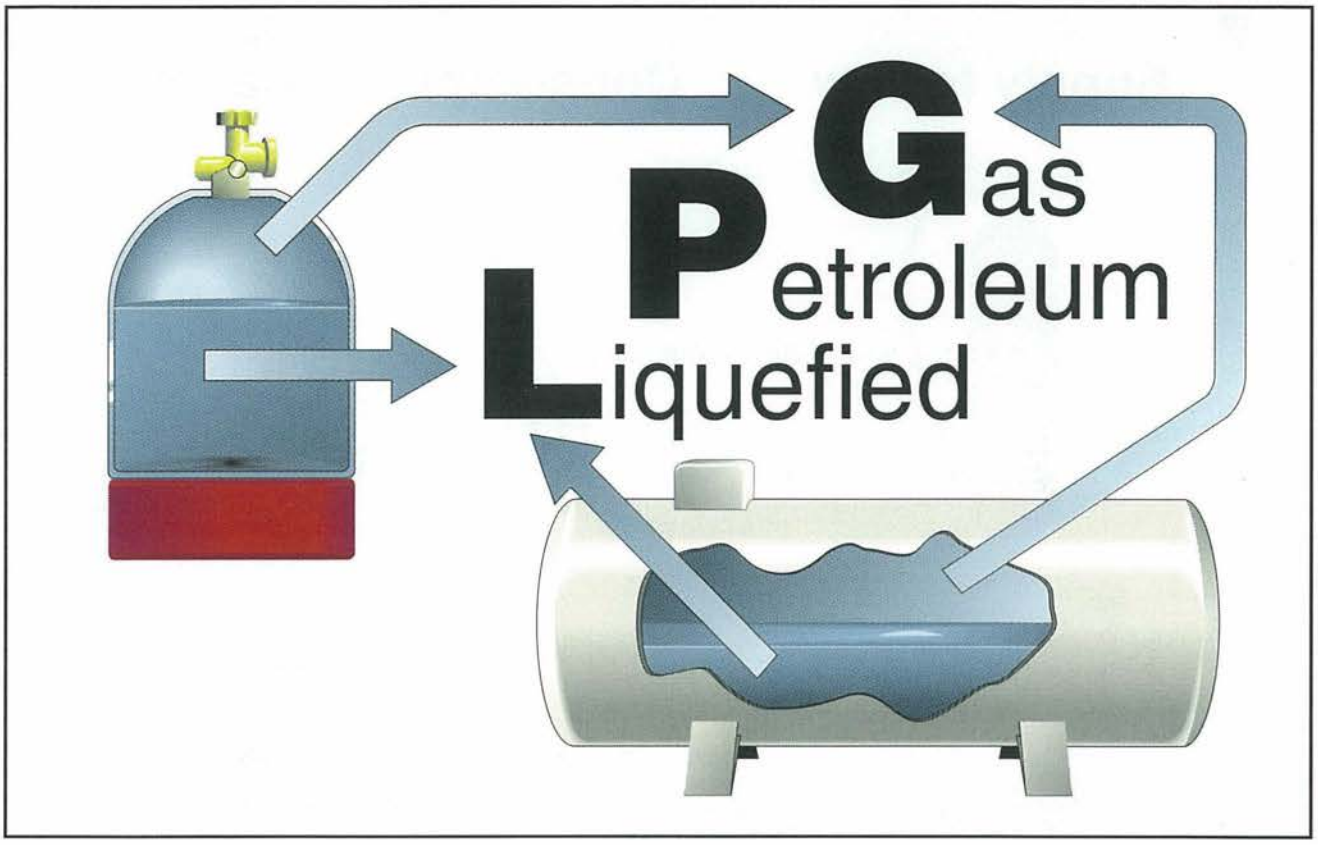


Fig. 1: Two phases of liquefied gas

What is understood by liquefied gas installations?

In this booklet, liquefied gas installations are understood to mean the entire interconnected supply and consumption equipment, especially for the use of liquefied gas as a combustion and power gas (this also includes devices with disposable containers).

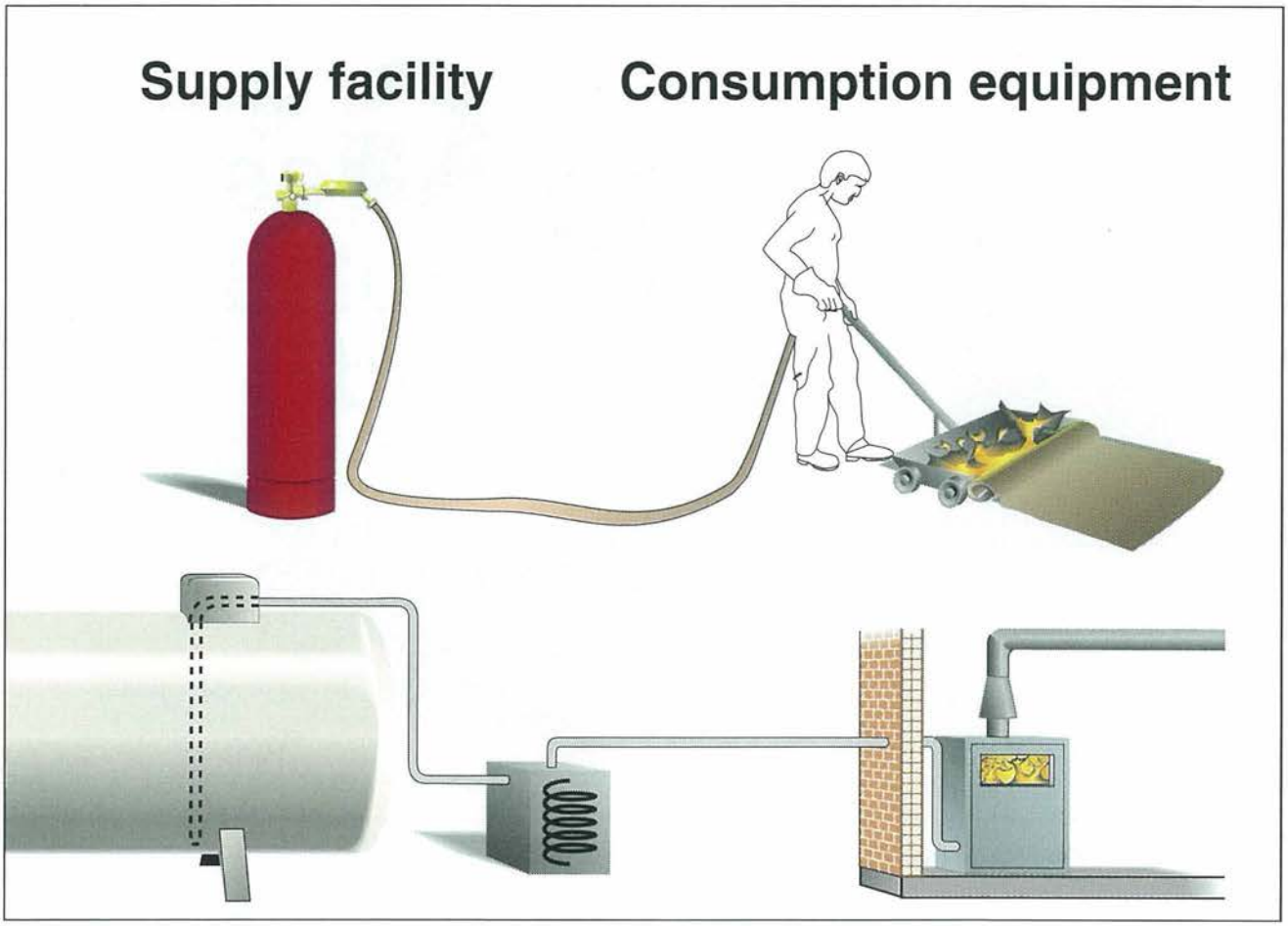


Fig. 2: Supply facilities and consumption equipment

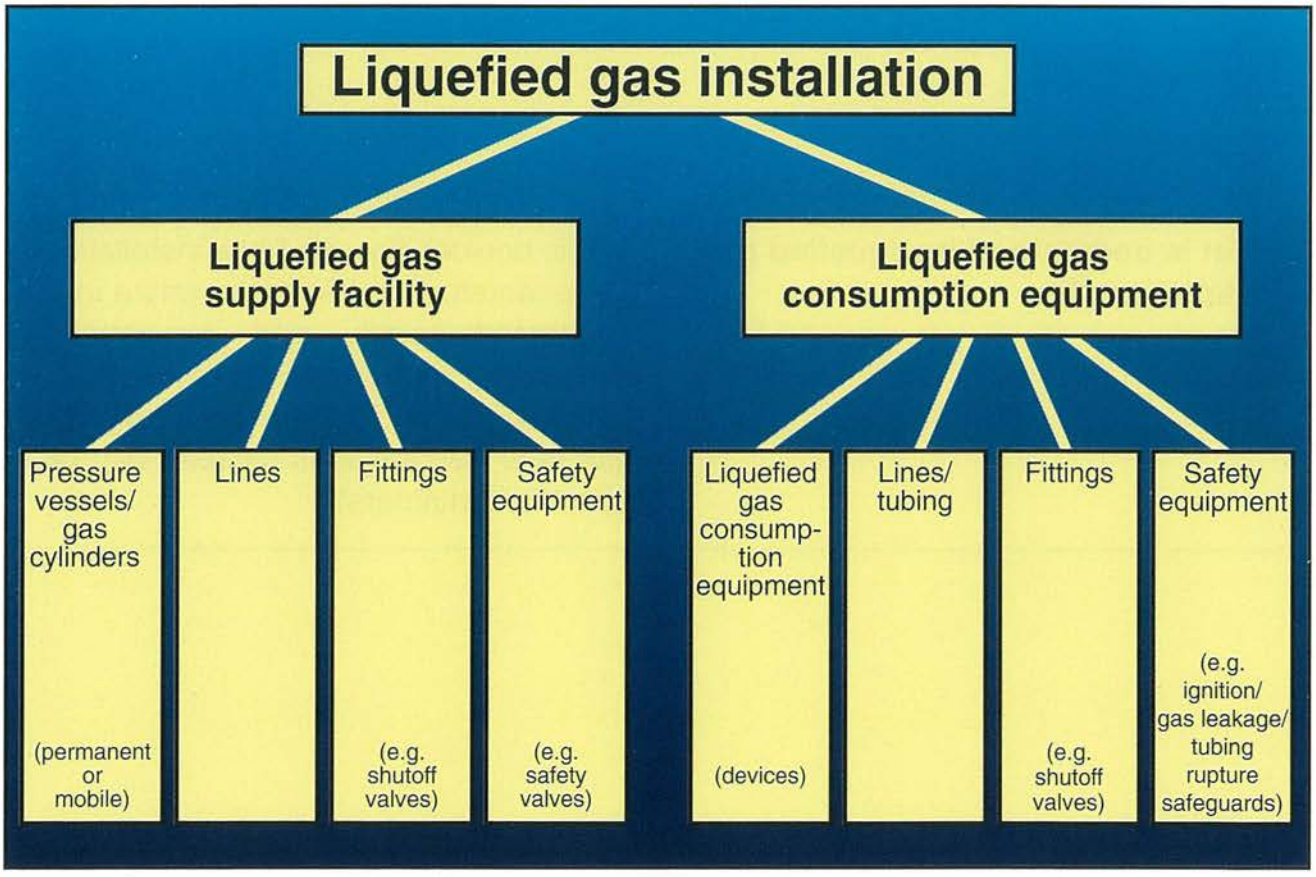


Fig. 3: Components of liquefied gas installations

What are supply facilities?

Supply facilities include – as far as this booklet is concerned – the containers (e.g. tanks, batteries of cylinders or bottles and their equipment parts) and the associated pipelines used to supply consumption equipment.

Fig. 4: Liquefied gas supply facilities

What is consumption equipment?

Consumption equipment includes – within the scope of this booklet – the consumption appliances (devices) with their equipment parts and the associated pipework.

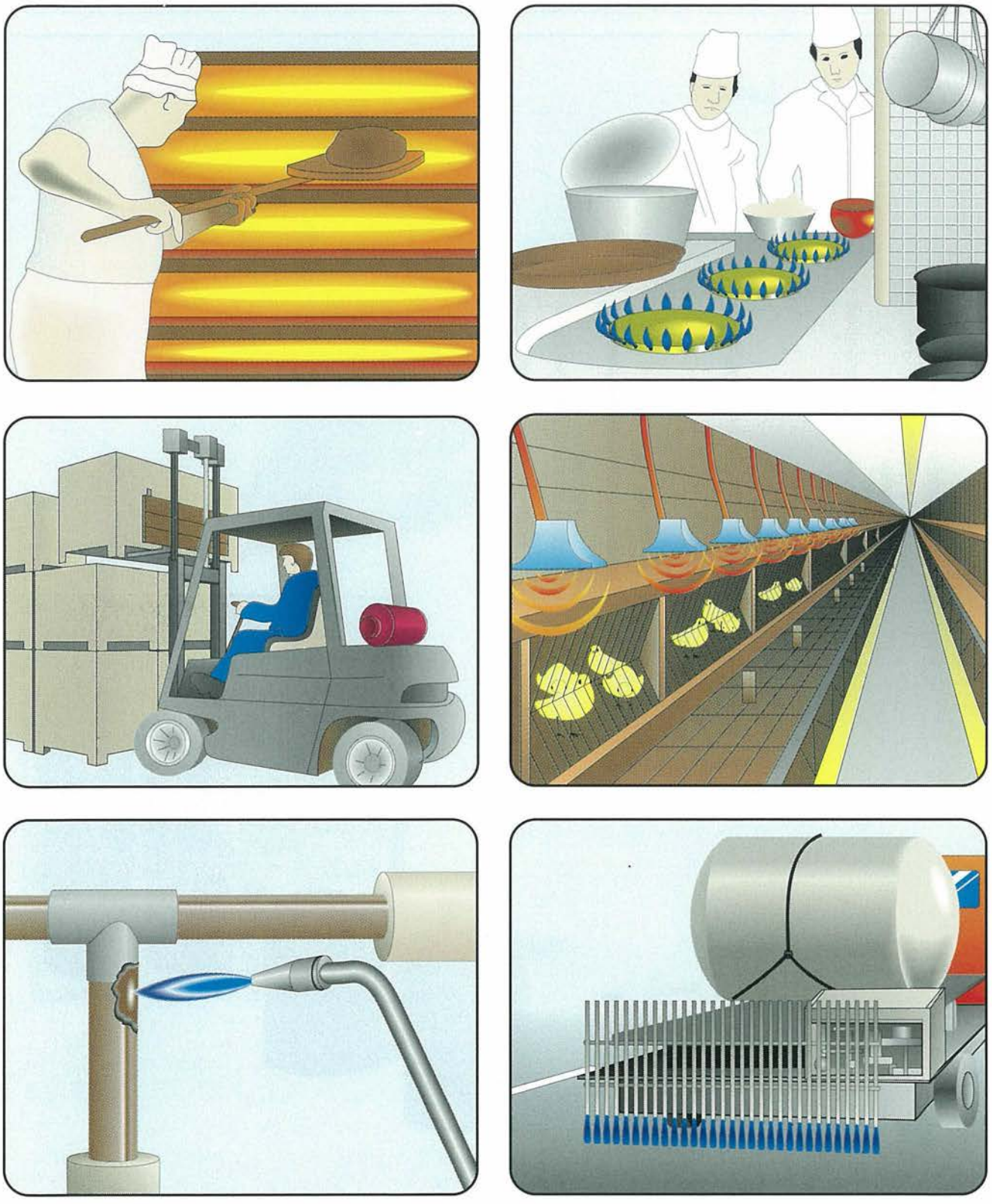


Fig. 5: Liquefied gas consumption equipment

Properties and risks

What are the important properties of liquefied gas?

Proper and safe use of the liquefied gas energy source presupposes a knowledge of the most important chemical and physical properties. The properties of liquefied gas relevant for safety can be summarized as follows:

- Liquefied gas is a flammable gas which can form explosible mixtures with air or oxygen in the gas phase (Fig. 6).
- From the densities of propane, butane and air, it follows that liquefied gas in the gaseous state is approximately twice as heavy as air and hence sinks to the floor and like a liquid can flow to the lowest point, e.g. to lower-lying rooms (Fig. 7).

  For this reason, liquefied gas installations may be set up below ground level only under certain conditions.
- Liquefied gas is colorless and hence invisible.
- As pure liquefied gas has no smell, a small amount of an odorous substance is added to it to ensure easy detection of any escaping gas.
- Liquefied gas can pass over from the gaseous to the liquid state at a relatively low pressure.
- Liquefied gas exhibits special behavior with regard to its volume:

- Thermal expansion of the liquefied gas (compared with other liquids, e.g. water) is extremely high.
- The volume increase on vaporization is also considerable: 1 kg propane has a volume of around 2 liters in the liquid phase.

  Under the same conditions, 1 kg propane in the gaseous phase has a volume of approx. 500 liters at standard temperature and pressure (Fig. 10).

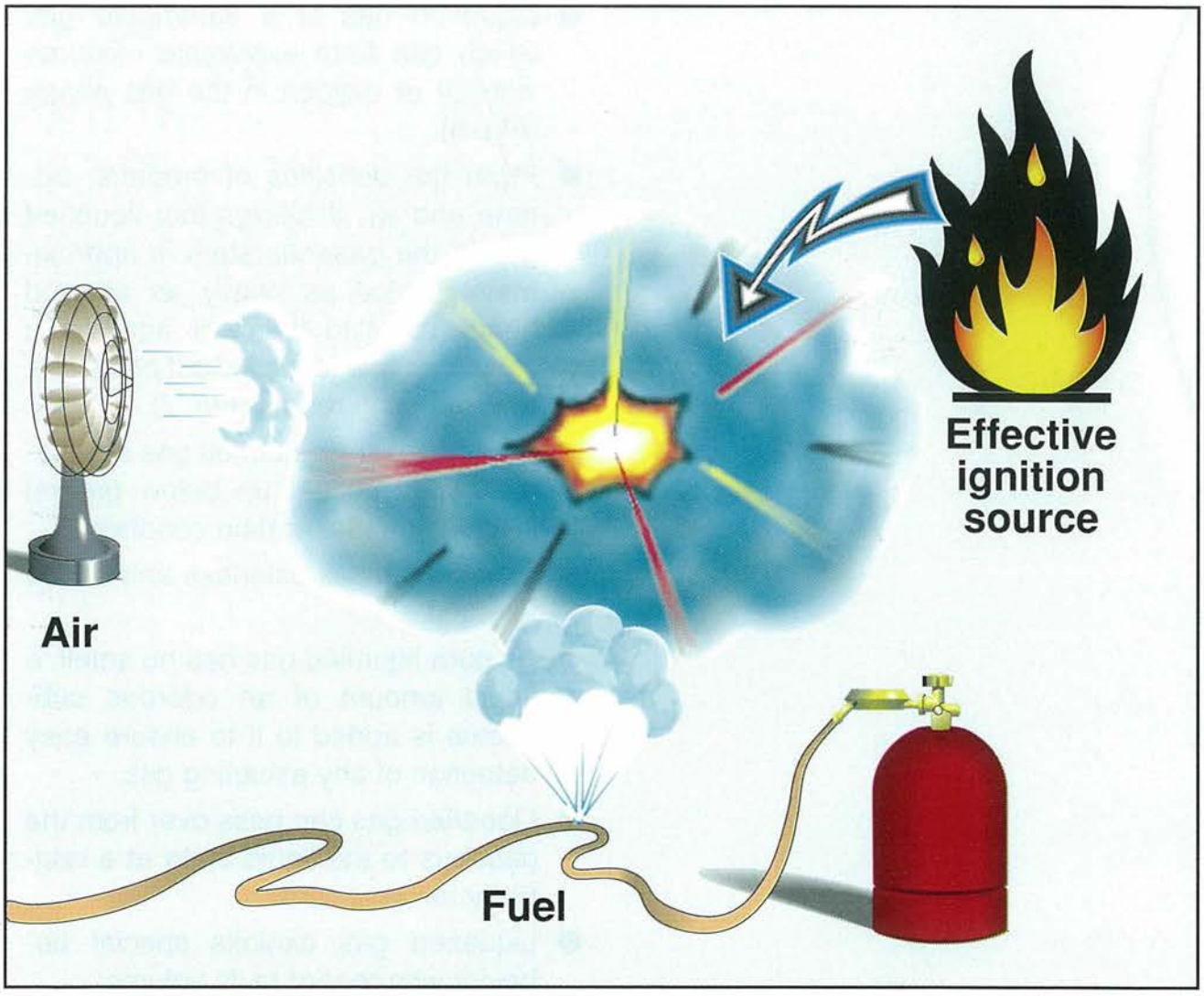


Fig. 6: Prerequisites for the occurrence of liquefied gas explosions

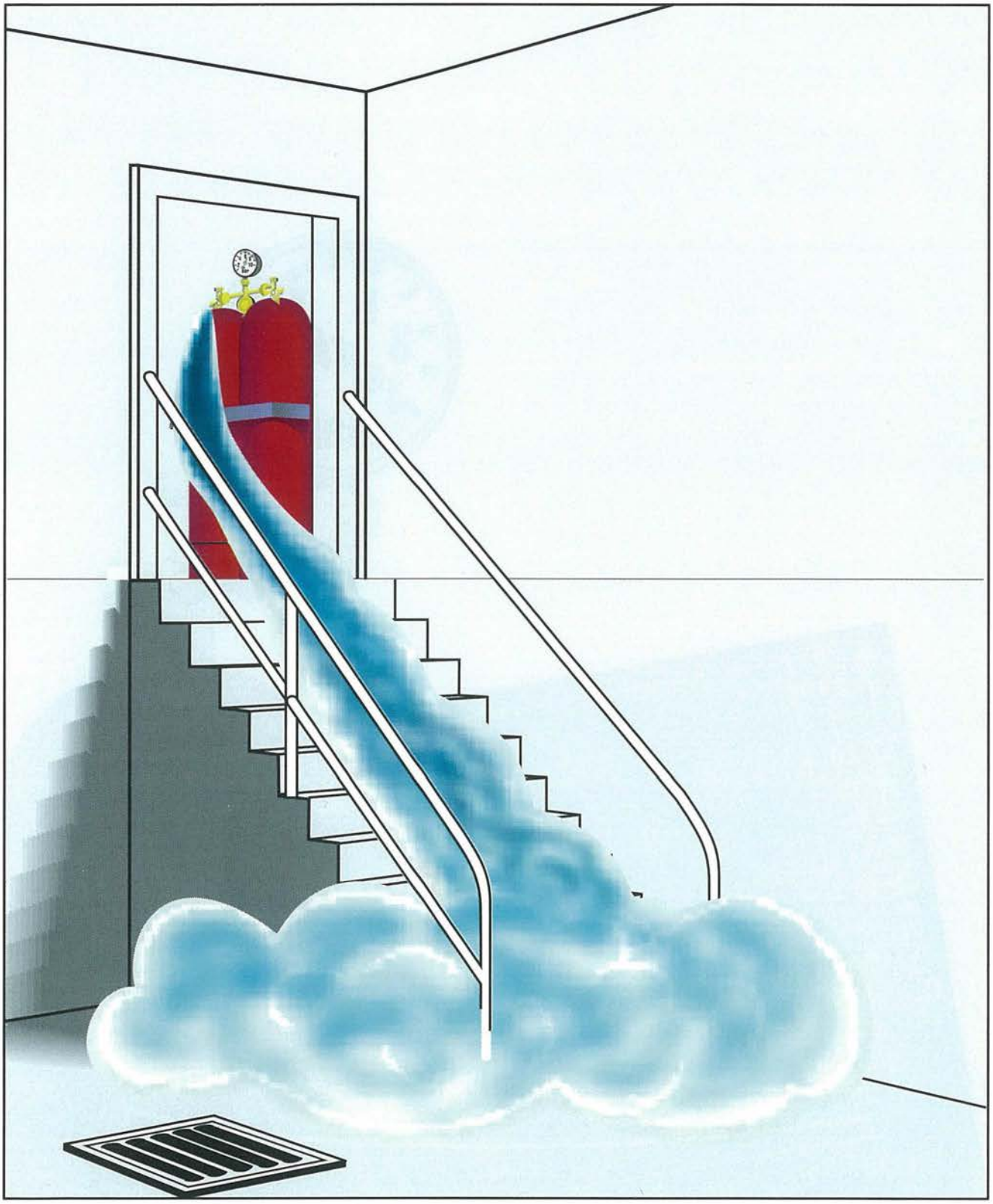


Fig. 7: The spreading of liquefied gas

Liquefied gases (propane and butane) are invisible, odoriferous, easily ignitable gases that are heavier than air.

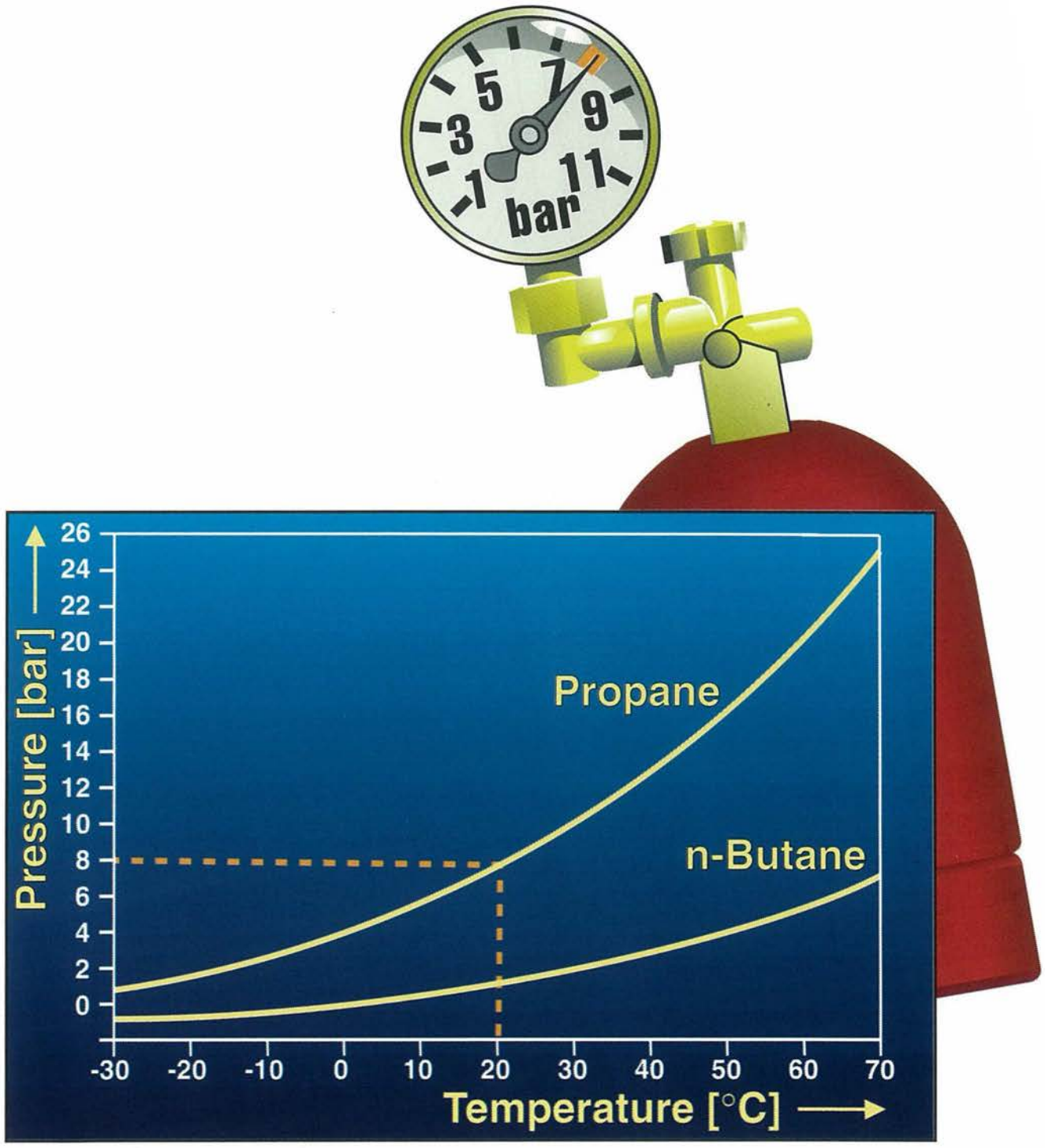


Fig. 8: Vapor pressure curves of propane and butane

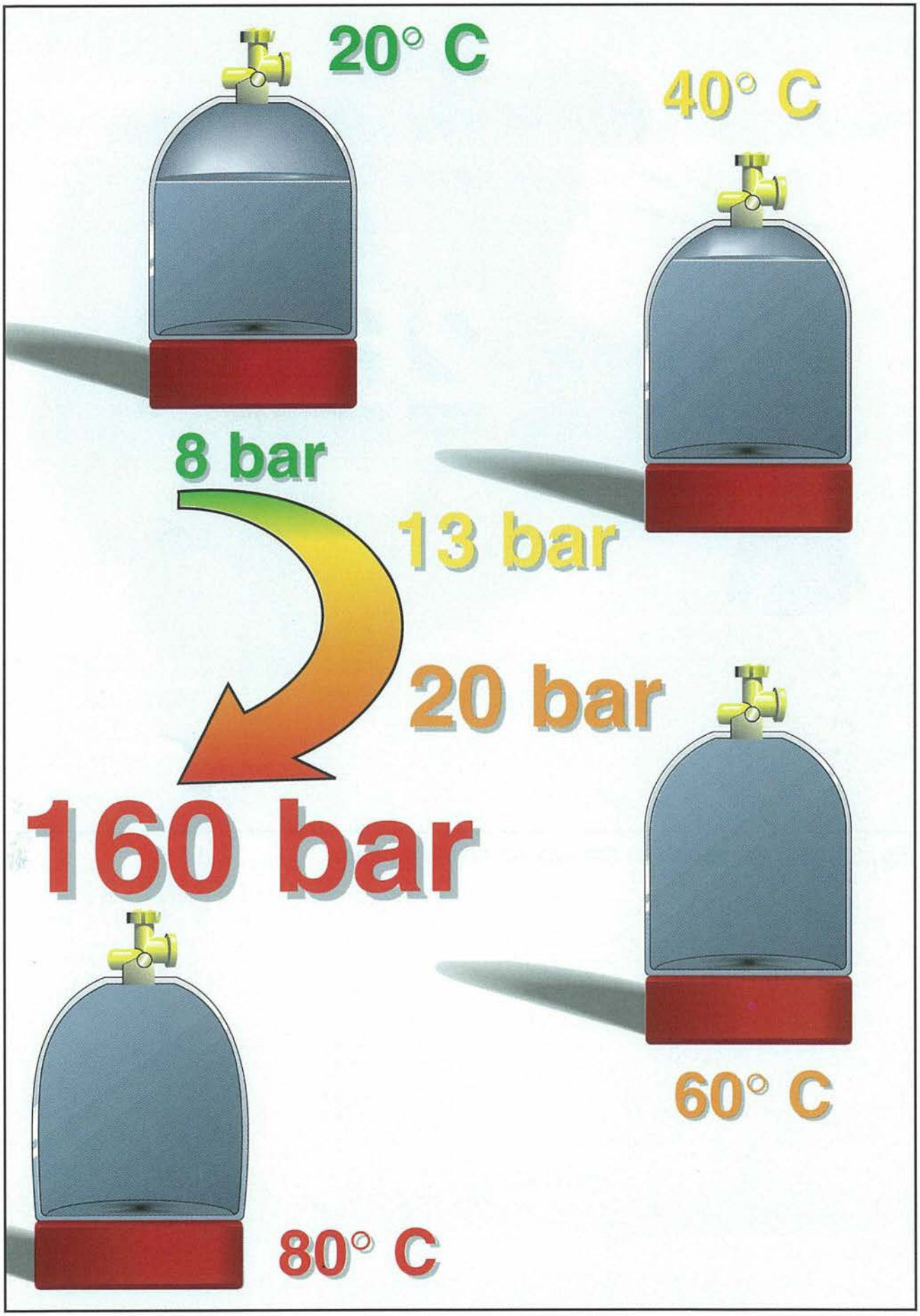


Fig. 9: Volume increase of liquid propane with increasing temperature

Fig. 10: Volume increase in the vaporization of propane

What risks exist in the storage and use of liquefied gas?

Uncontrolled escape of liquefied gas in the liquid or gaseous state and incomplete combustion are the two main hazard sources in the storage and use of liquefied gas.

The hazards that appear are:

- Explosion and fire hazard.
- Toxicity hazard, especially through carbon monoxide.

In addition, so-called "cold burns" (severe heat abstraction leading to skin burns) and the danger of suffocation must be noted.

Fig. 11: Main hazards in the storage and use of liquefied gas: Explosion and fire hazard, toxicity hazard

When must a fire and explosion hazard be anticipated?

Escaping liquefied gas can be ignited by an effective ignition source. The risk is particularly great when liquefied gas can collect in pockets such as cellars, pits, shafts or ducts.

- The pressure in liquefied gas containers such as tanks or cylinders depends only on the temperature (cf. vapor pressure curves, Fig. 8); thus, e.g. for propane approximately 8 bar at 20°C. Intense heating of the containers (e.g. due to the effects of an external fire or through internal container heating) leads to a massive increase in pressure in the container (see Fig. 9) and under certain circumstances can:
  - cause large quantities of liquefied gas to escape through the safety valve, or
  - lead to rupture of the container, which can have particularly grave consequences.
- With the temperature rise, the volume of the liquid medium also increases. It is thus always necessary to have a gas cushion in the liquefied gas container for safety's sake (Fig. 14).

Fig. 12: Effect of fire on a liquefied gas cylinder

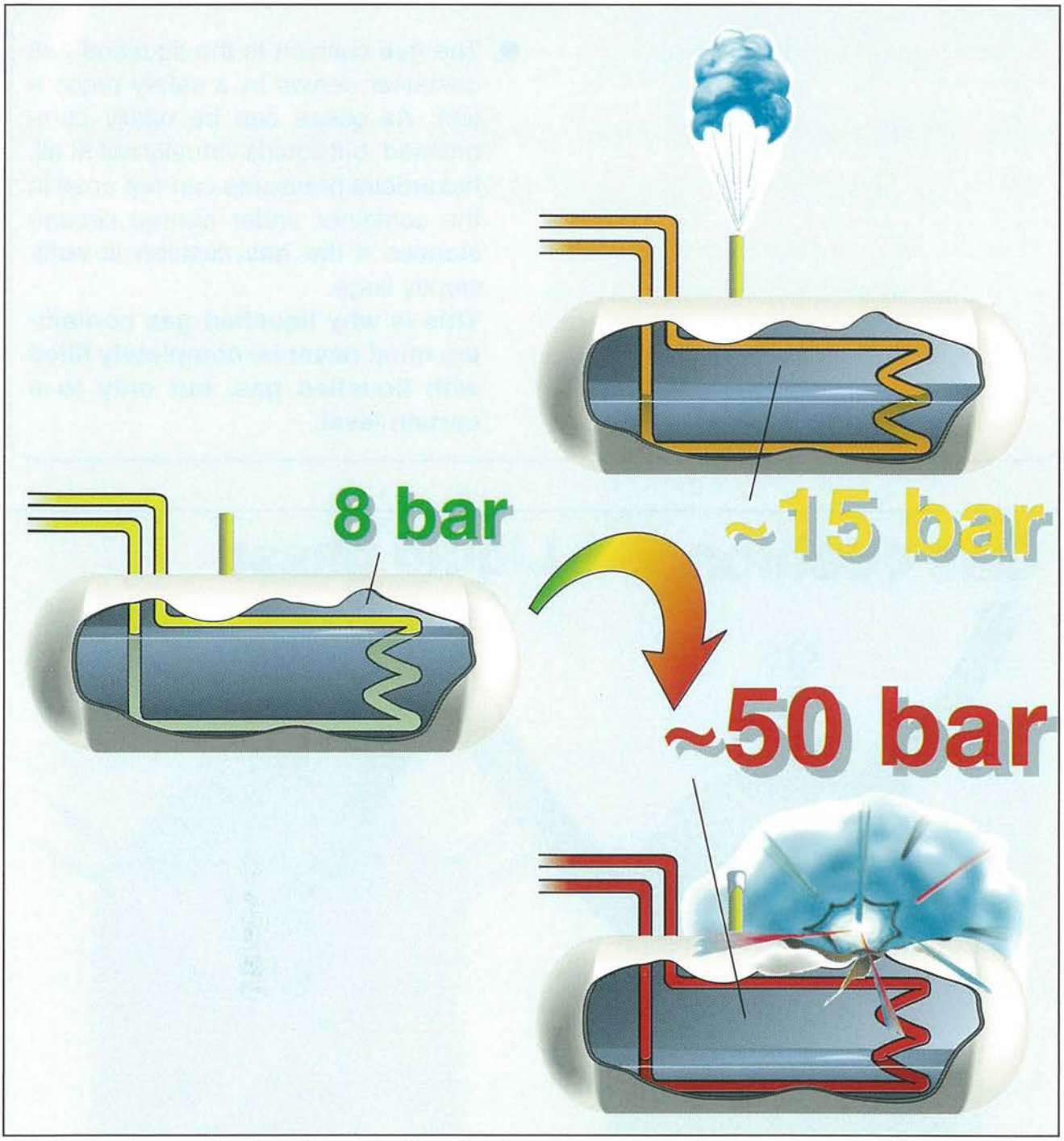


Fig. 13: Excessive heating of a liquefied gas container (e.g. processing facility) through internal heating. Actuation of the safety valve, possible icing up of the safety valve, rupture of the container

- The gas cushion in the liquefied gas container serves as a safety precaution. As gases can be easily compressed, but liquids virtually not at all, hazardous pressures can not arise in the container under normal circumstances if the gas cushion is sufficiently large.
  This is why liquefied gas containers must never be completely filled with liquefied gas, but only to a certain level.

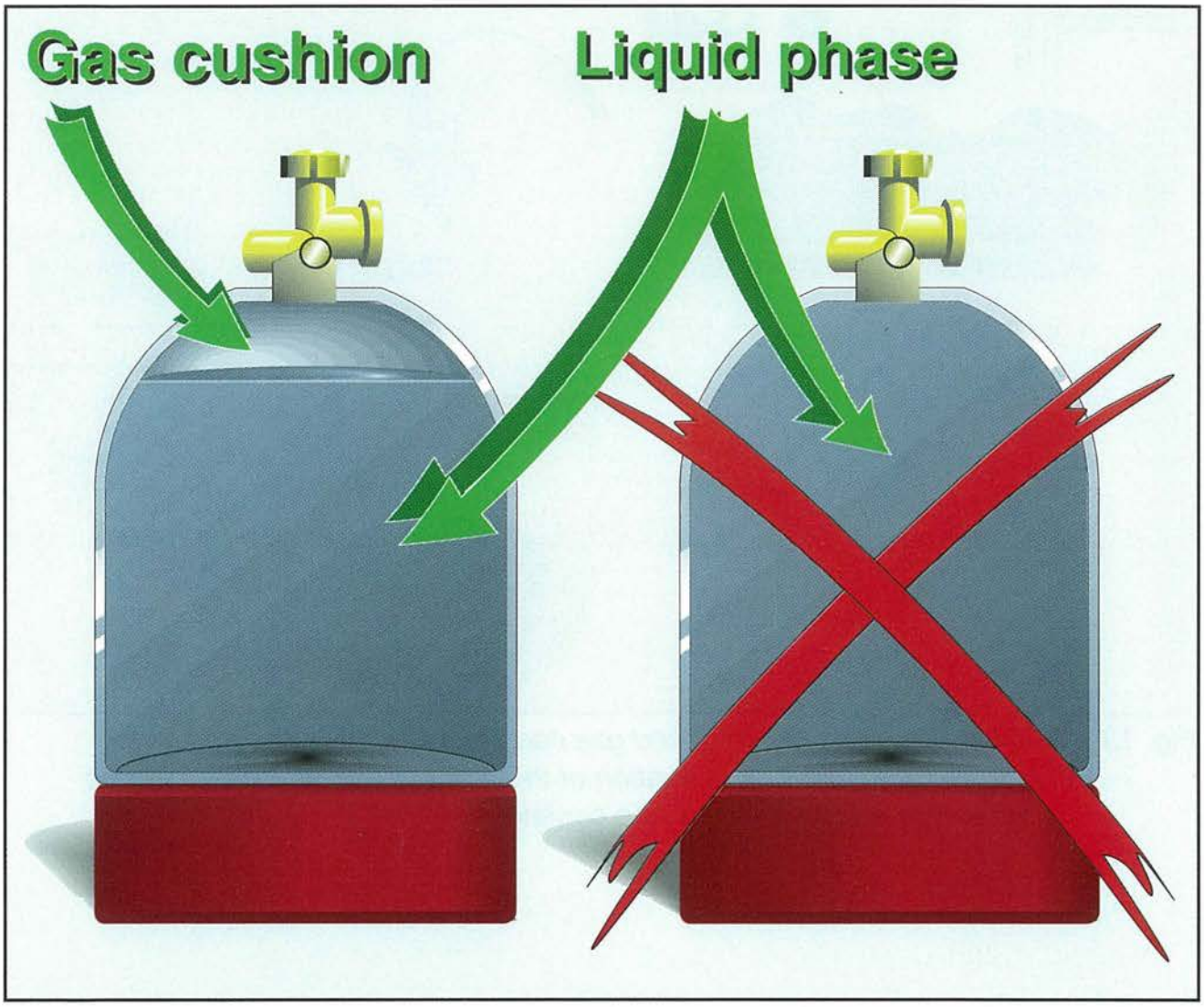


Fig. 14: Gas cushion in liquefied gas containers as a safety measure (fill level in compliance with national regulations)

- The volume of liquefied gas in the liquid phase is highly temperature dependent. A temperature rise of 10°C leads to a pressure rise in a container of 70–80 bar. If part of the installation, e.g. a pipeline is destroyed owing to this pressure rise, a large amount of liquefied gas is abruptly released. The subsequent vaporization leads to a volume increase of around 260 times.
- In consumption equipment (appliances) without an ignition safety feature, unburnt liquefied gas can escape and form explosible mixtures.
- With improper handling of consumption equipment (e.g. transport of consumption devices with a naked flame), a fire can start in fire-hazard situations.

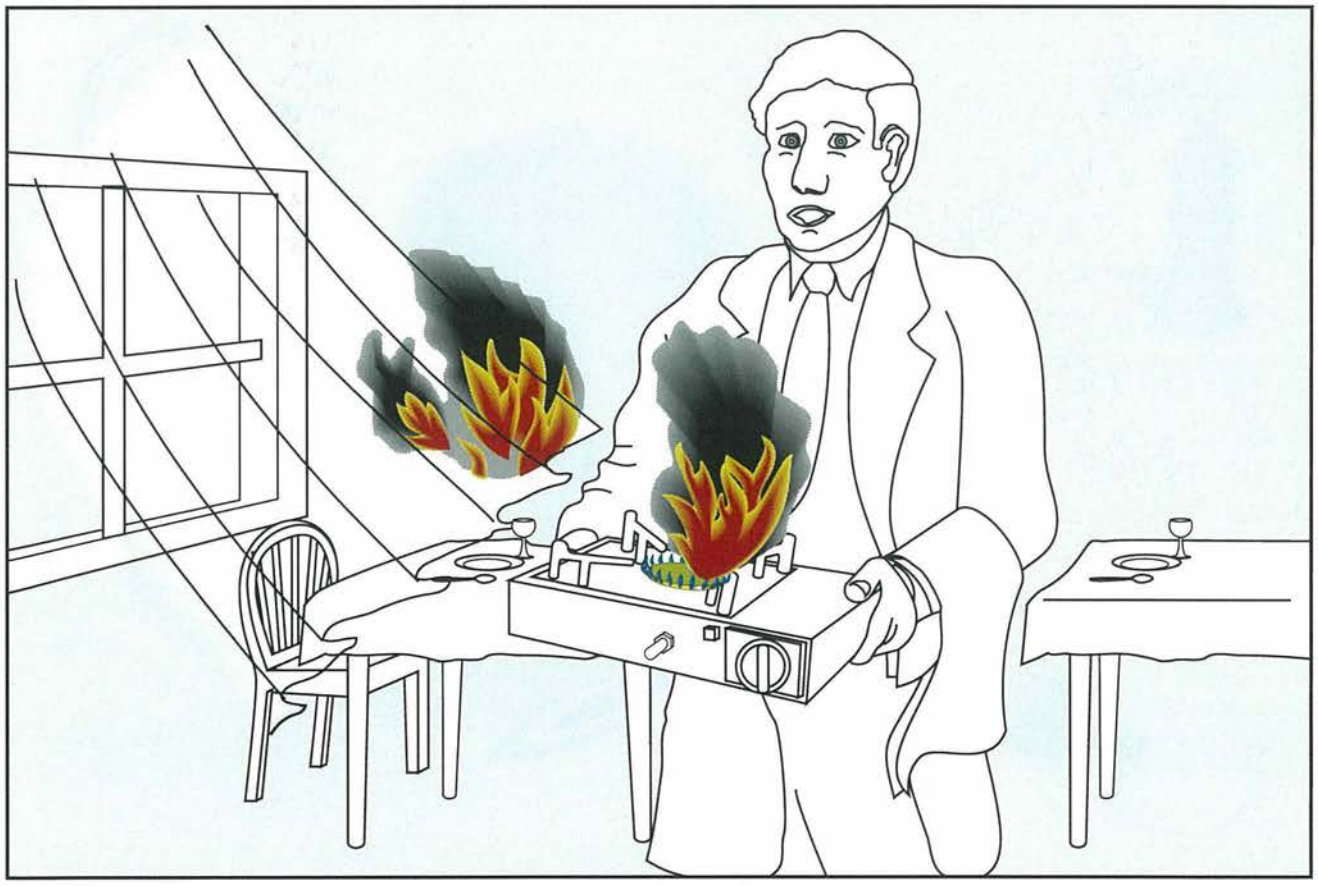


Fig. 15: Improper transport of consumption equipment

How can a toxicity hazard arise?

A toxicity hazard arises in general not through the liquefied gas itself, but through its incomplete combustion. In the combustion of liquefied gas, large quantities of air are necessary (for 1 kg liquefied gas, approximately 12 m^3 air). The hazardous carbon monoxide (CO) can form in dangerous quantities if

- the consumption equipment has an inadequate air supply and no exhaust gas line to the open air is available,
- there is insufficient ventilation and venting in the installation rooms and/or the combustion products are not led off to the open air in a completely hazard-free manner,
- contaminated, wrongly adjusted or faulty consumption equipment is used.

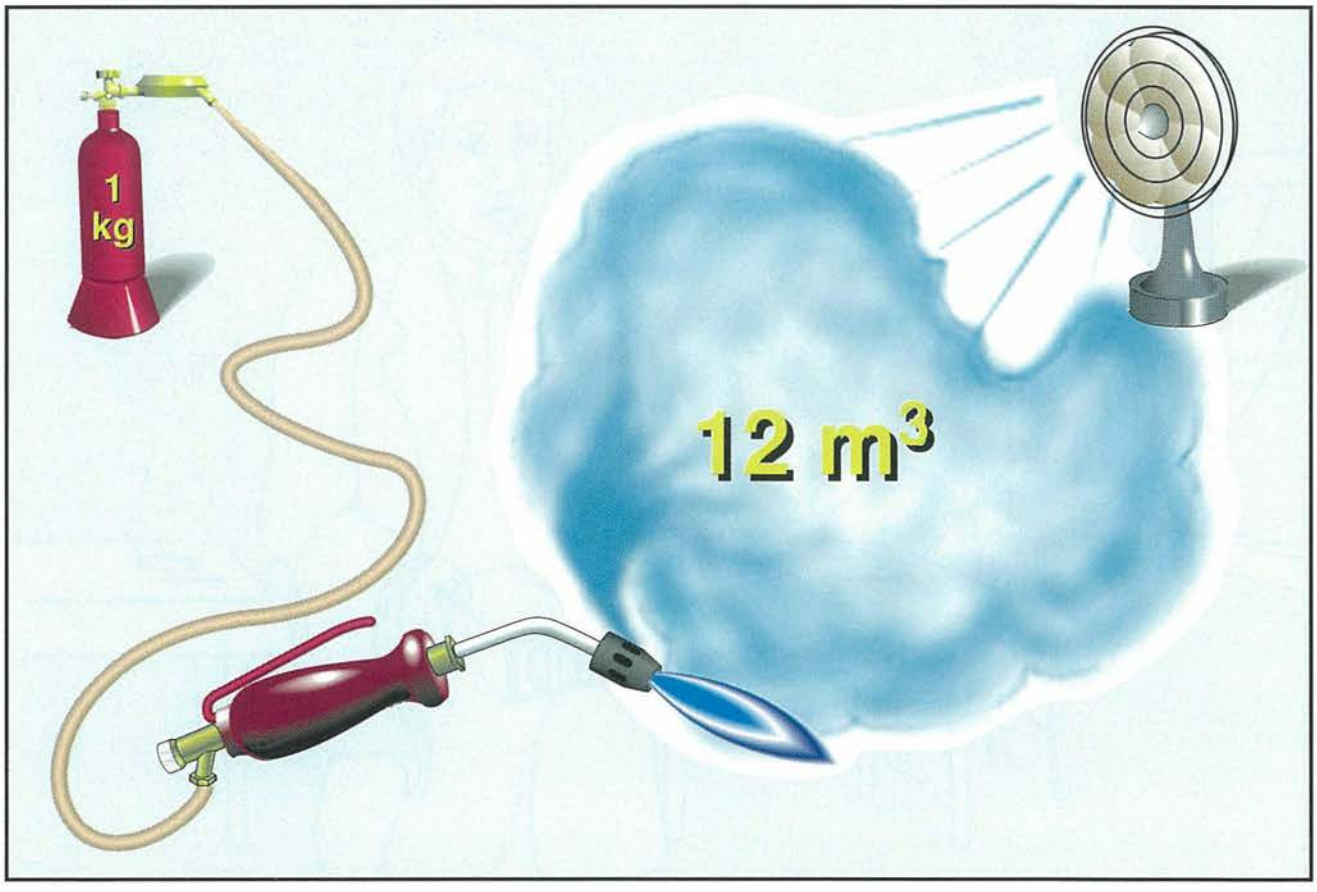


Fig. 16: Air requirements in the combustion of liquefied gas

Fig. 17: Formation of carbon monoxide due to a dirty stove

An explosion hazard through uncontrolled escape of gas and a toxicity hazard through incomplete combustion necessitate proper procedures in the handling of liquefied gas which comply with the *safety regulations*.

Measures for construction, equipping and installation

General

What precautionary measures should be taken with liquefied gas installations regarding leaks and material selection?

Liquefied gas installations must be designed such that they can withstand the expected pressures and stresses and are sufficiently tight with regard to the intended use and the properties of liquefied gas. The materials of liquefied gas installations must be as non-flammable and non-brittle as possible; installation parts that come into contact with liquefied gas must be resistant to it.

What must be particularly observed in the installation of liquefied gas systems?

Liquefied gas system components such as containers, batteries of cylinders, fittings, pipelines or consumption equipment must be installed and/or supplemented by suitable constructional or ventilation measures so that escaping liquefied gas can not flow into underground rooms, ducts, shafts, pits and the like and there accumulate.

What measures must be taken when liquefied gas installations are set up in underground rooms?

In the installation of liquefied gas system components such as containers, pipelines with detachable connections, fittings and gas consumption devices in underground rooms, extensive protection measures complying with national regulations must be implemented, e.g.

- artificial venting of the room,
- gas supply only on effective ventilation (coupling; Fig. 18),
- consumption equipment with ignition safety features (Figs 18 and 32),
- gas leakage safeguards (Fig. 19)
- pressure regulators with leak testing equipment and tubing rupture safeguards (Fig. 20),
- pipe, tubing rupture safeguards (Fig. 21).

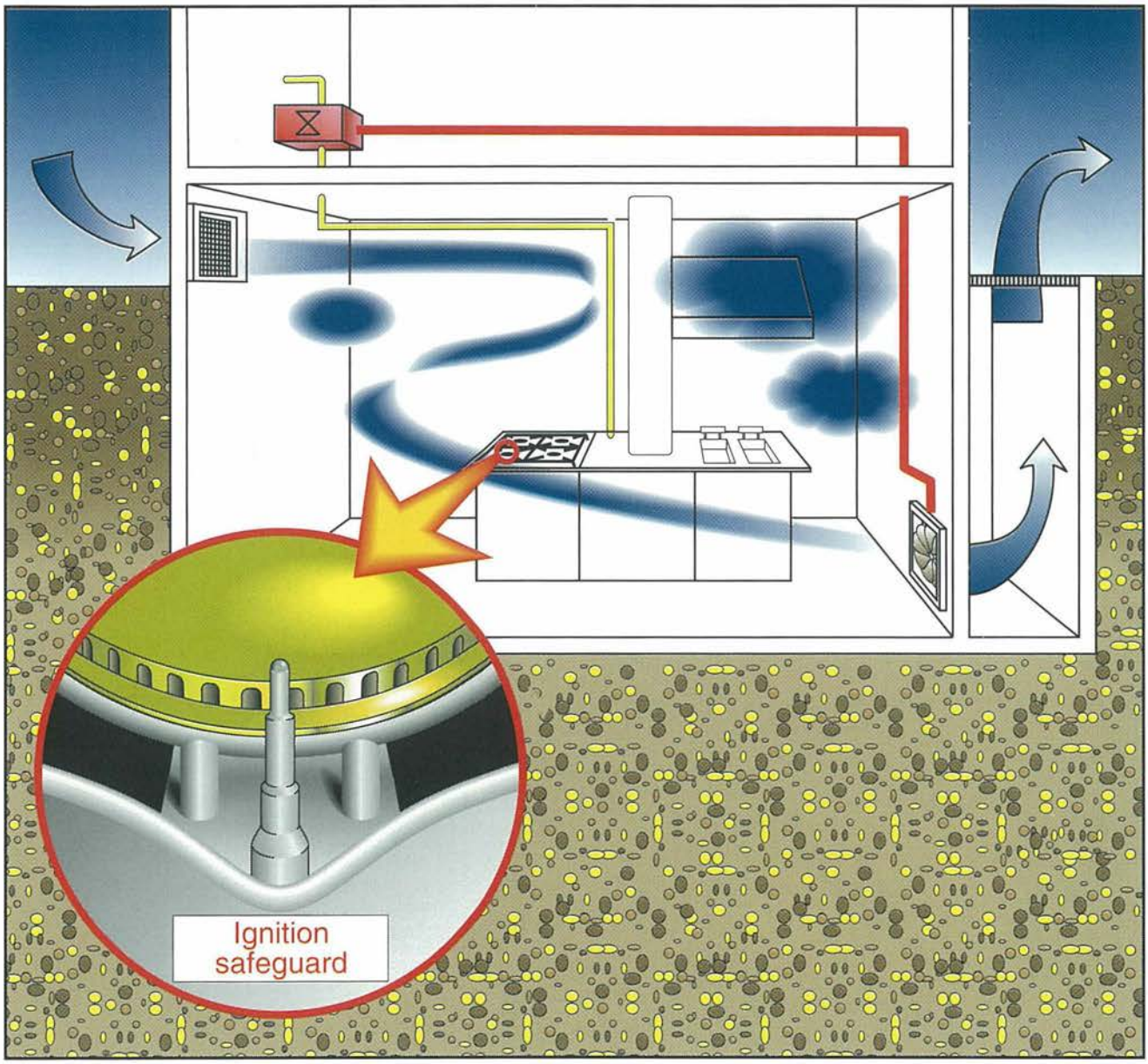


Fig. 18: Coupling of the gas supply of consumption equipment with the ventilation system, e.g. in underground rooms

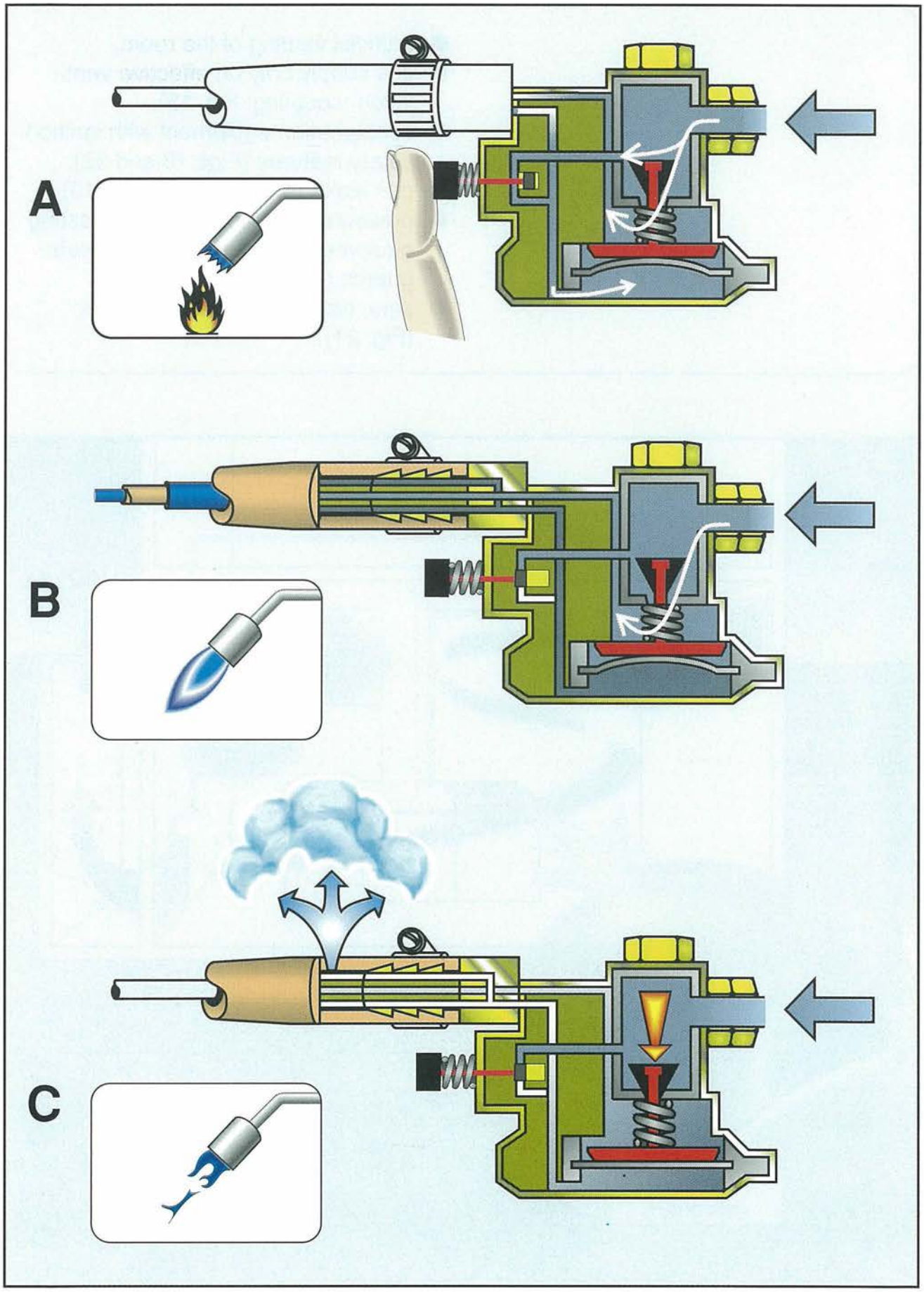


Fig. 19: Operating principle of a gas leakage safeguard (schematic)
A) Ignition, B) Normal operation, C) Gas escape

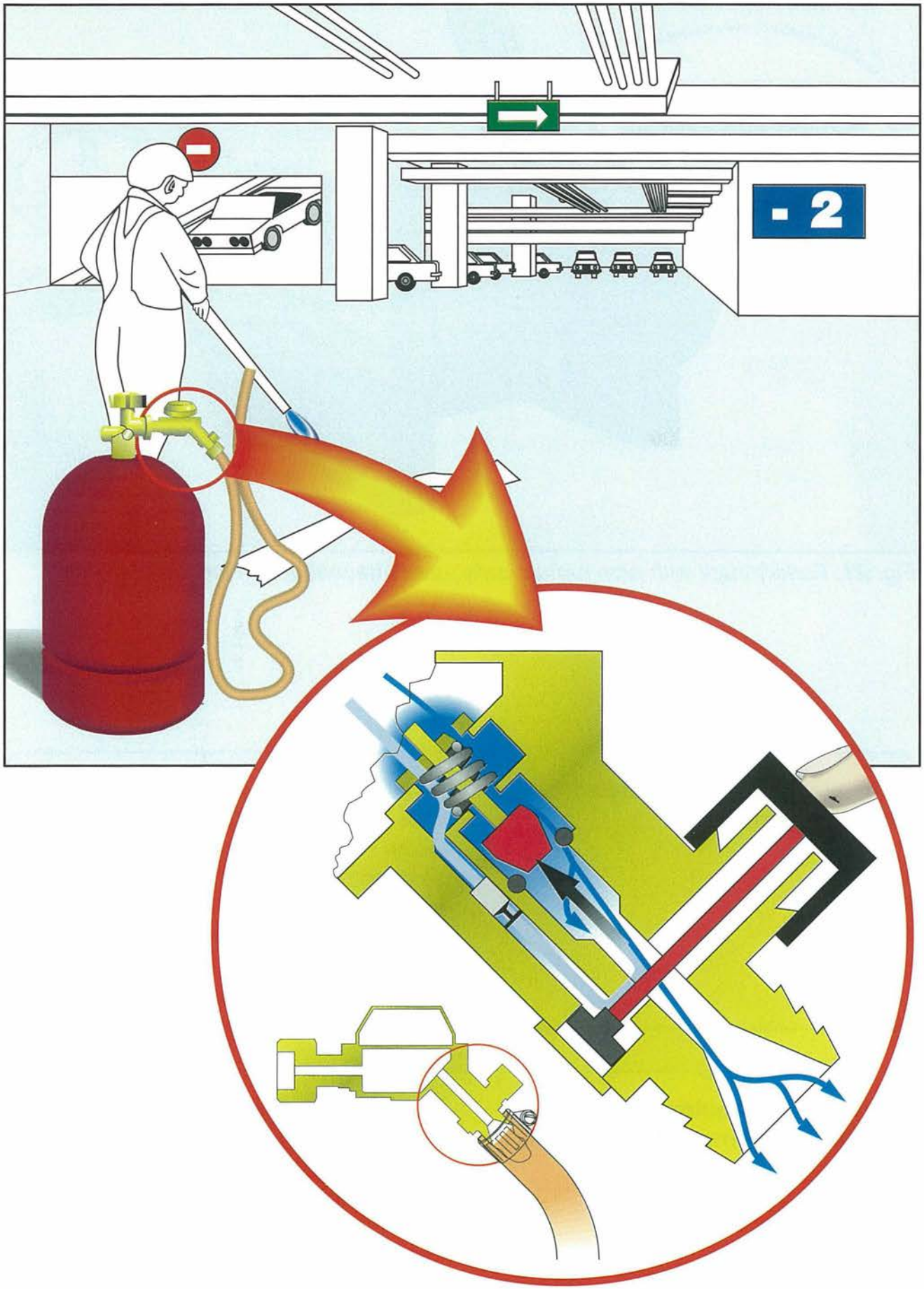


Fig. 20: Use of pressure regulators with leak testing equipment and tubing rupture safeguard in conjunction with consumption equipment in underground rooms

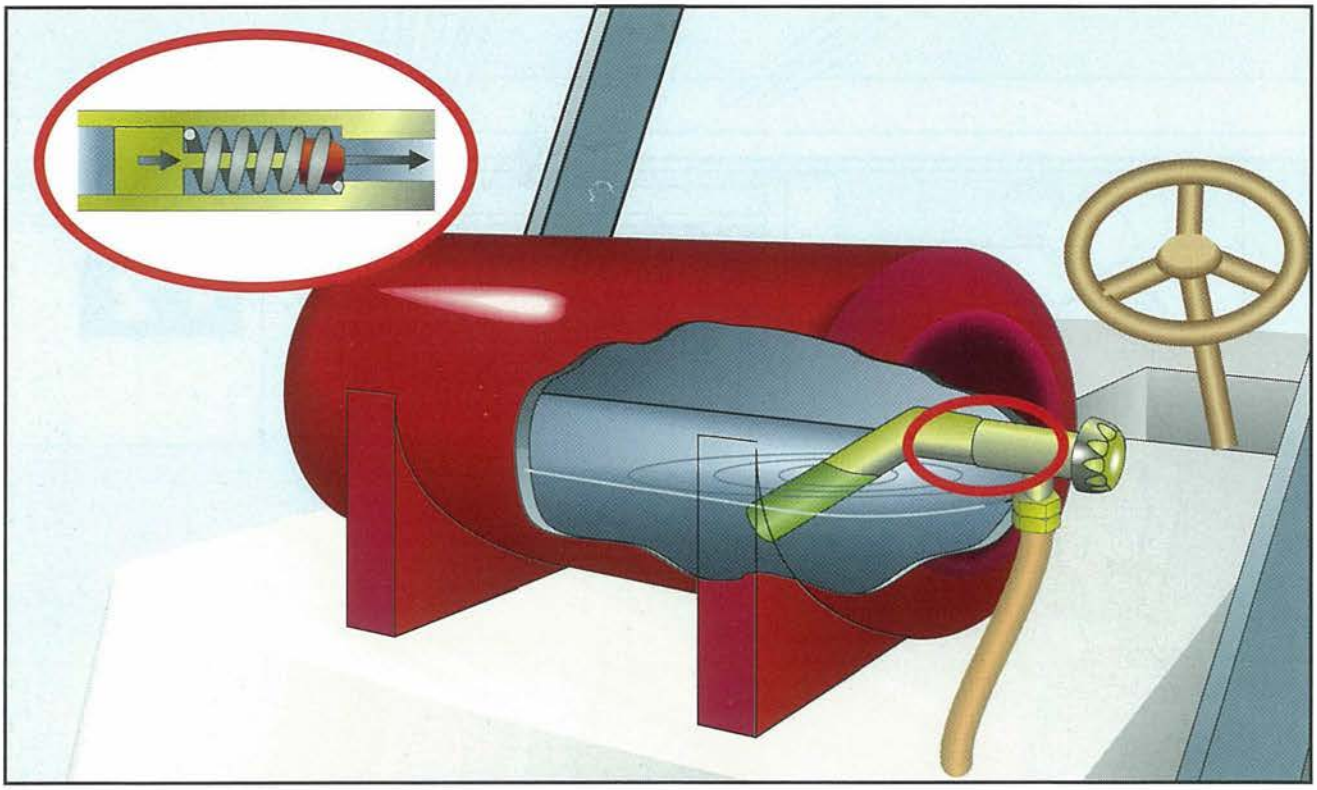


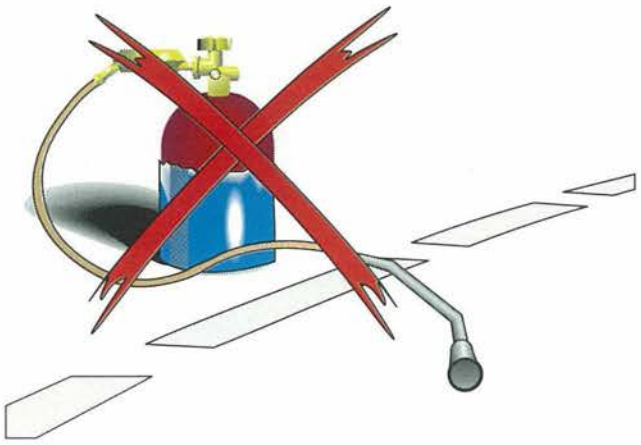
Fig. 21: Forklift truck with pipe rupture safeguard attached to power gas container

When is the use of gas detection systems necessary?

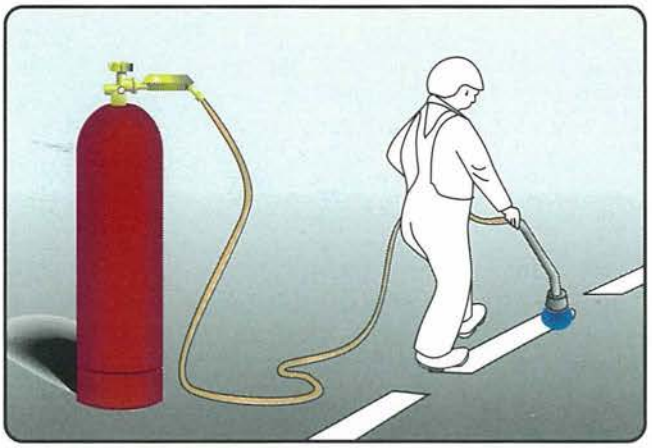
In supply facilities, for example those with extensive storage capacities or in which the absence of leaks can not be assured for any length of time, and consumption equipment not under constant observation (e.g. installed in underground rooms), gas detection systems are required as supporting measures.

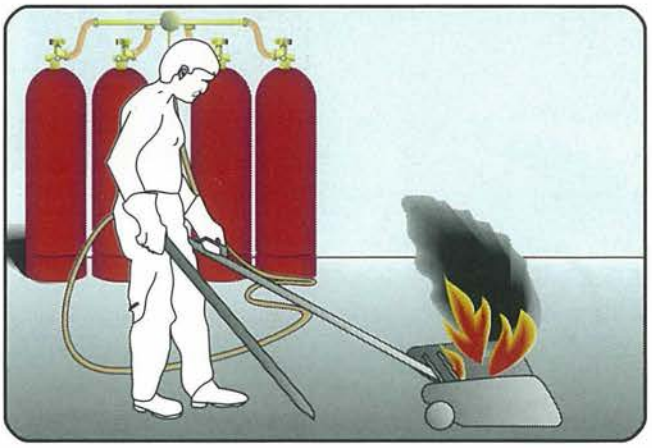
How can the required vaporization efficiency be ensured without risk?

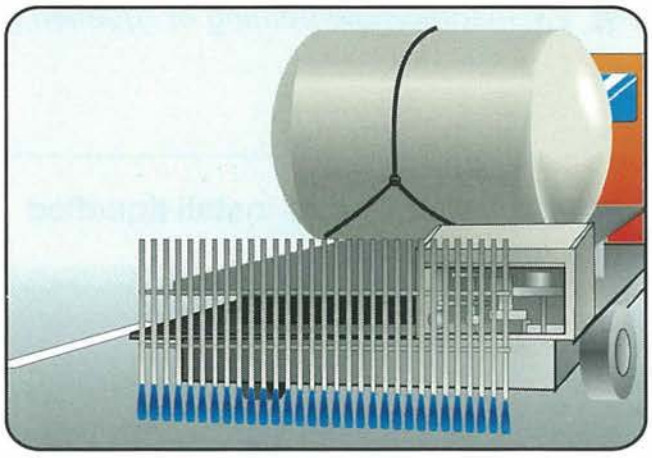
The supply facility must always be designed for the required vaporization efficiency. If need be, a vaporizer must be installed (offtake from the liquid phase). The installation of containers in the immediate vicinity of sources of heat or localized heating, e.g. by a hand torch is not admissible under any circumstances.



Supply facility with insufficient vaporization efficiency







Supply facilities with sufficiently large vaporization efficiency

Fig. 22: Measures for hazard-free assurance of the vaporization efficiency

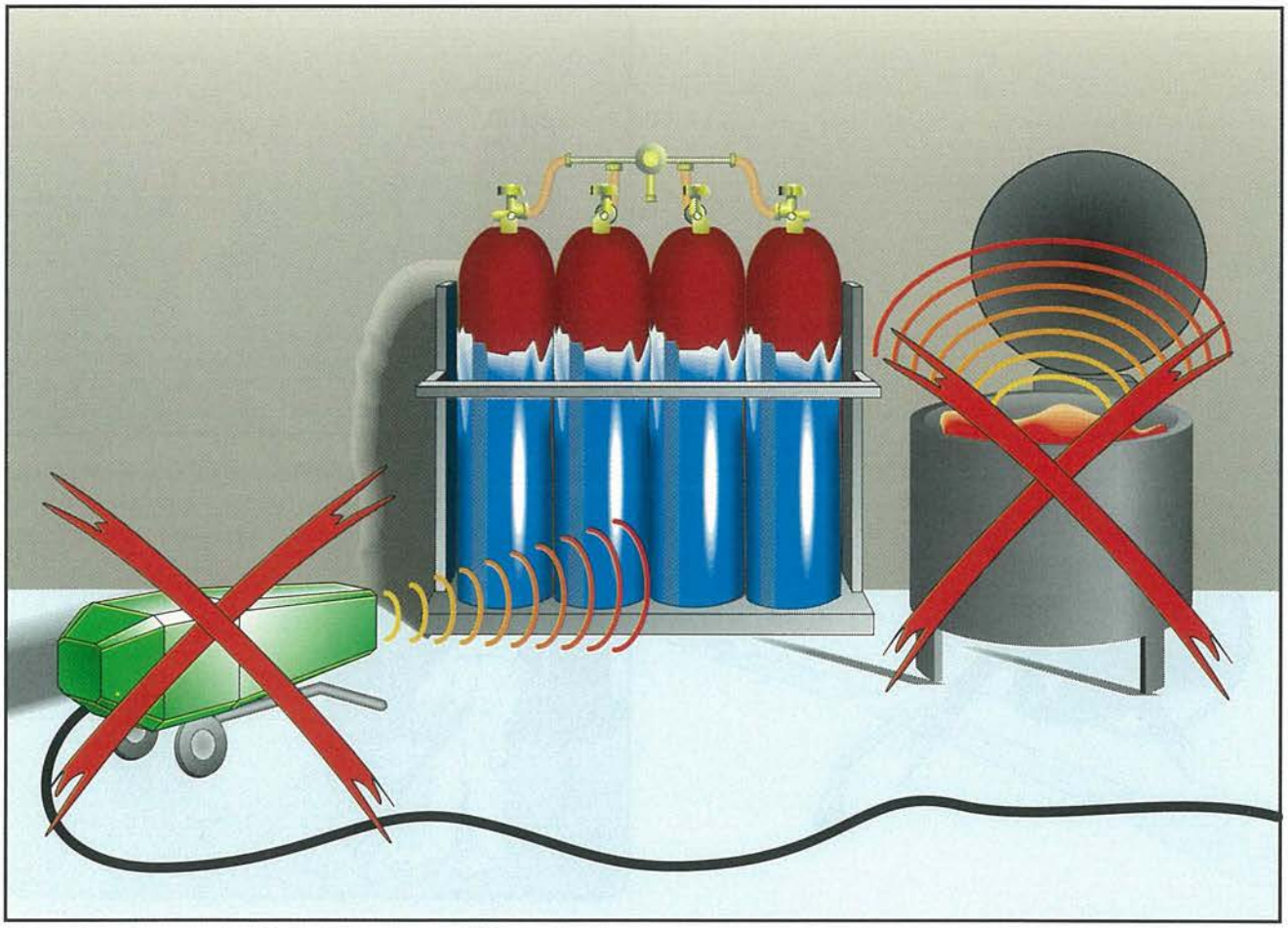


Fig. 23: Inadmissible heating of liquefied gas containers

Who is authorized to install liquefied gas installations?

Liquefied gas installations and the required equipment may be set up only by persons who have sufficient knowledge of the liquefied gases and the installation technique. The erector of liquefied gas installations is responsible for ensuring proper implementation of the safety measures.

When is registration or authorization and/or approval necessary?

Based on the national regulations, the appropriate authorizations for

- the containers and equipment, as well as
- their location and
- the installation

must be obtained.

Supply facilities

What demands must containers such as tanks or cylinders meet?

With regard to the construction and equipping of containers, the national regulations must be observed with special attention being paid to ensuring that

- the **compressive strength** is appropriate to the gas and the admissible temperature,
- with permanently installed containers, **efficient safety valves** are installed that ensure venting at excessive pressures (temperatures).

What must be considered in the installation regarding escaping gas?

In the erection of supply facilities, the following must be taken into account regarding escaping gas:

- The containers and their relief lines must be installed and arranged so that escaping gas is led off in a non-hazardous manner and can not collect in pockets.
- With liquefied gas installations in which an escape of unburnt gas and the formation of an explosible atmosphere can not be reliably prevented, the possible gas escape sites must be surrounded by an adequately sized zone with no ignition hazards (hazardous areas). These zone distances must be taken from the national regulations.

If the boundary conditions are not favorable and if the hazardous area is in the vicinity of building and/or duct openings or similar, a combination of several protection measures may be necessary, e.g.

- vertical extension of the ventilation ducts
  or
- gas-tight walls together with a hazardous area of sufficiently large dimensions.

Depending on the nature of the container and the type of installation as well as the situation at hand, the hazardous areas need to be defined so that within such locations specific requirements to avoid effective ignition sources must be met.

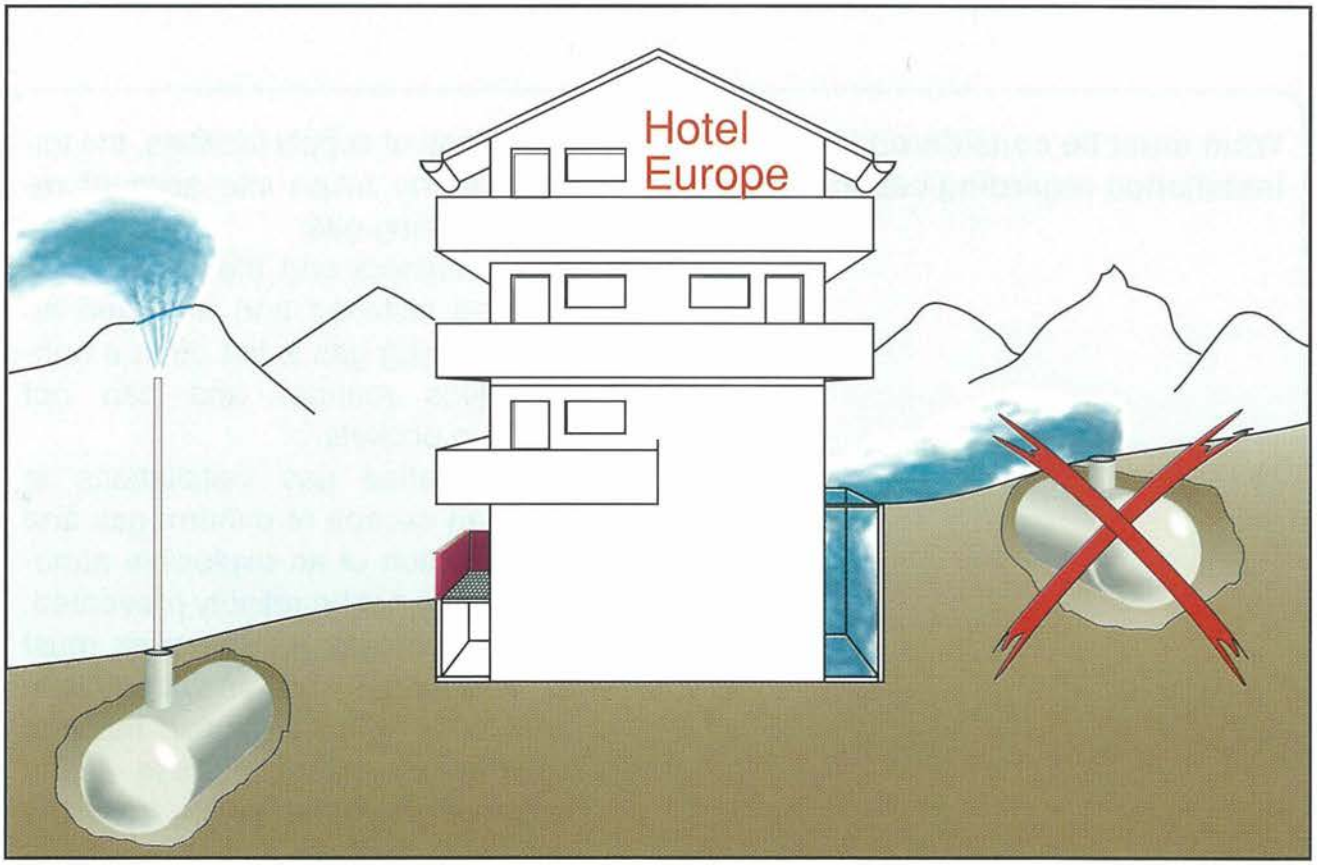


Fig. 24: Arrangement of containers and their relief lines

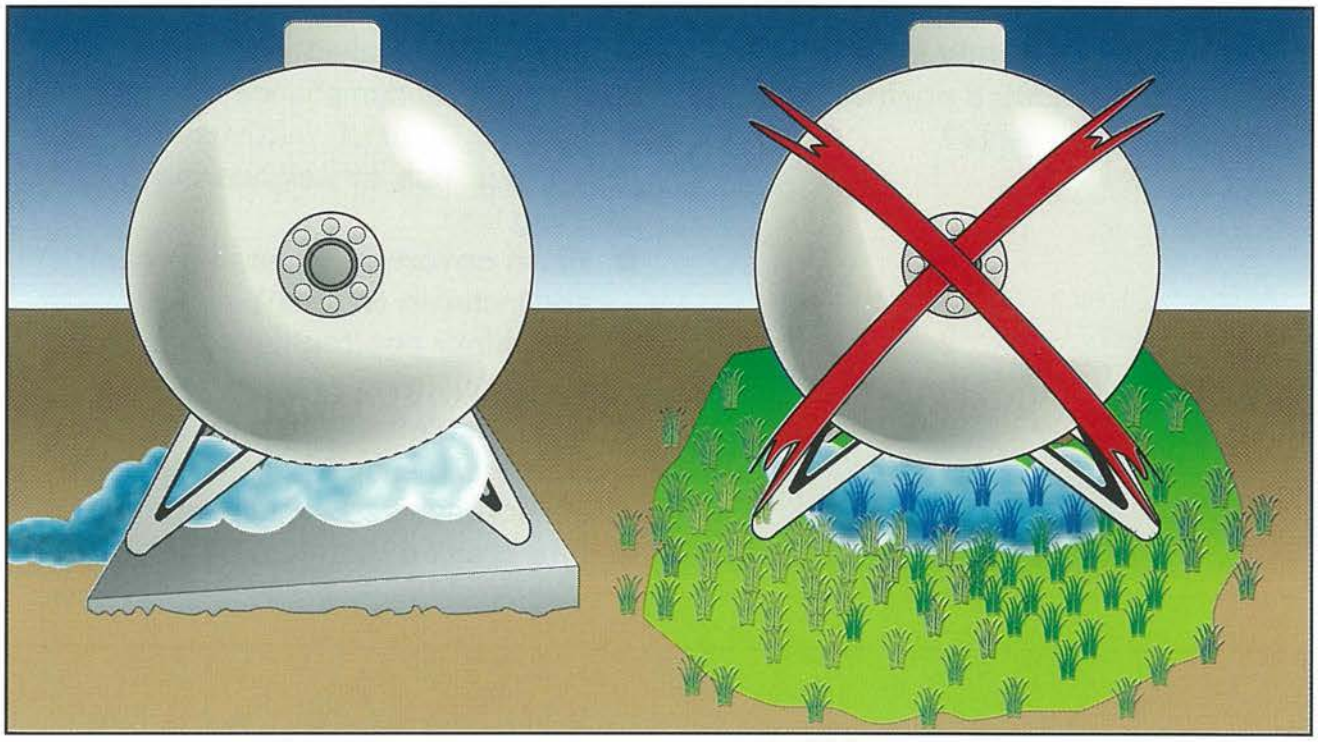


Fig. 25: Prevention of fire underneath permanently installed containers, e.g. through a tank base sloping in a non-hazardous direction

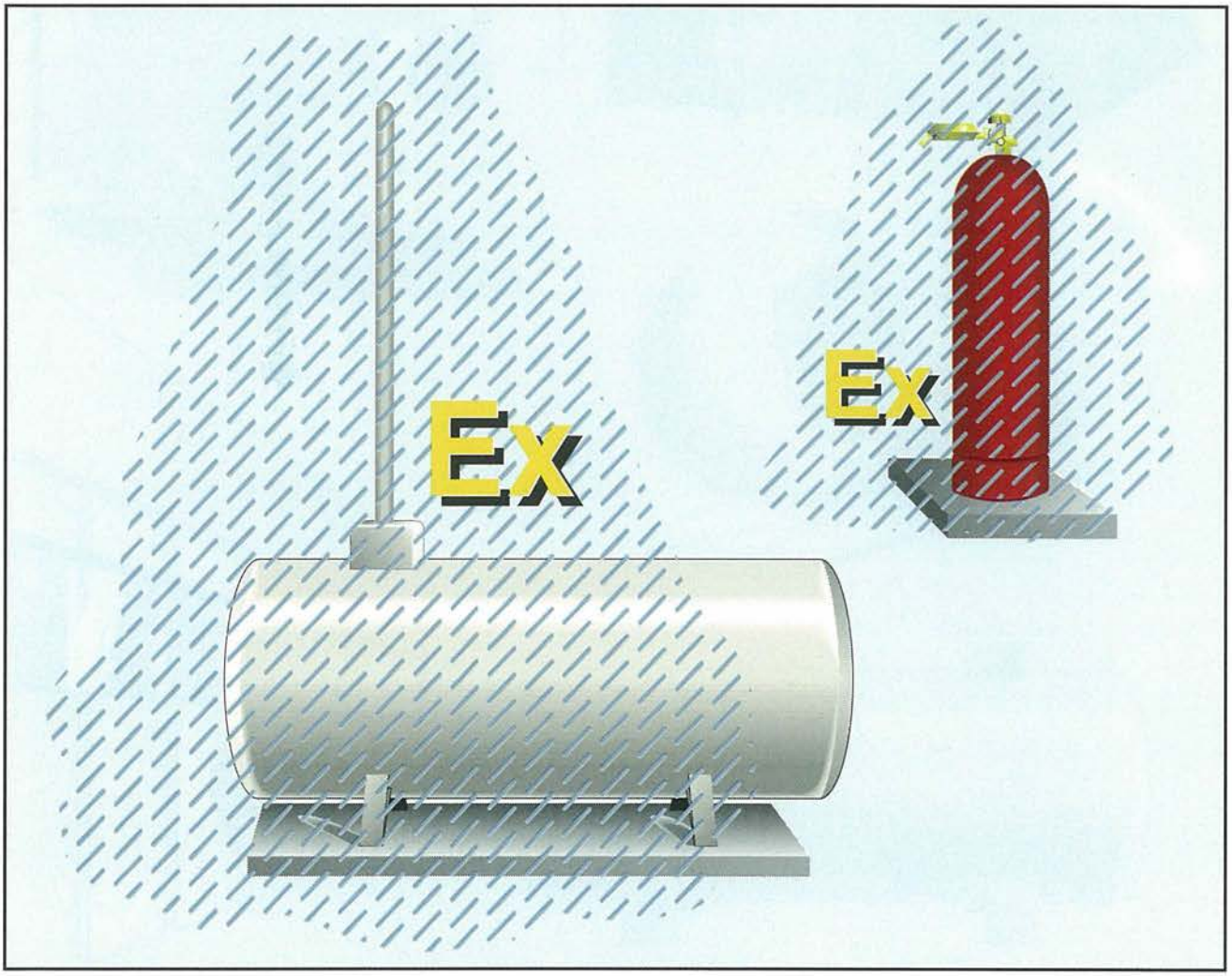


Fig. 26: Hazardous areas surrounding supply facilities

How can permanently installed containers be protected against inadmissible thermal effects?

Permanently installed containers must be protected in compliance with national regulations against inadmissible heat action, e.g. due to neighboring objects catching fire:

- **Earth covering** (covered by earth and installed on earth).
- **Container cooling** by means of a water sprinkling system.
- **Heat insulation** (fire protection insulation) with sufficient fire resistance of floor-mounted containers).
- **Fire break distances.**

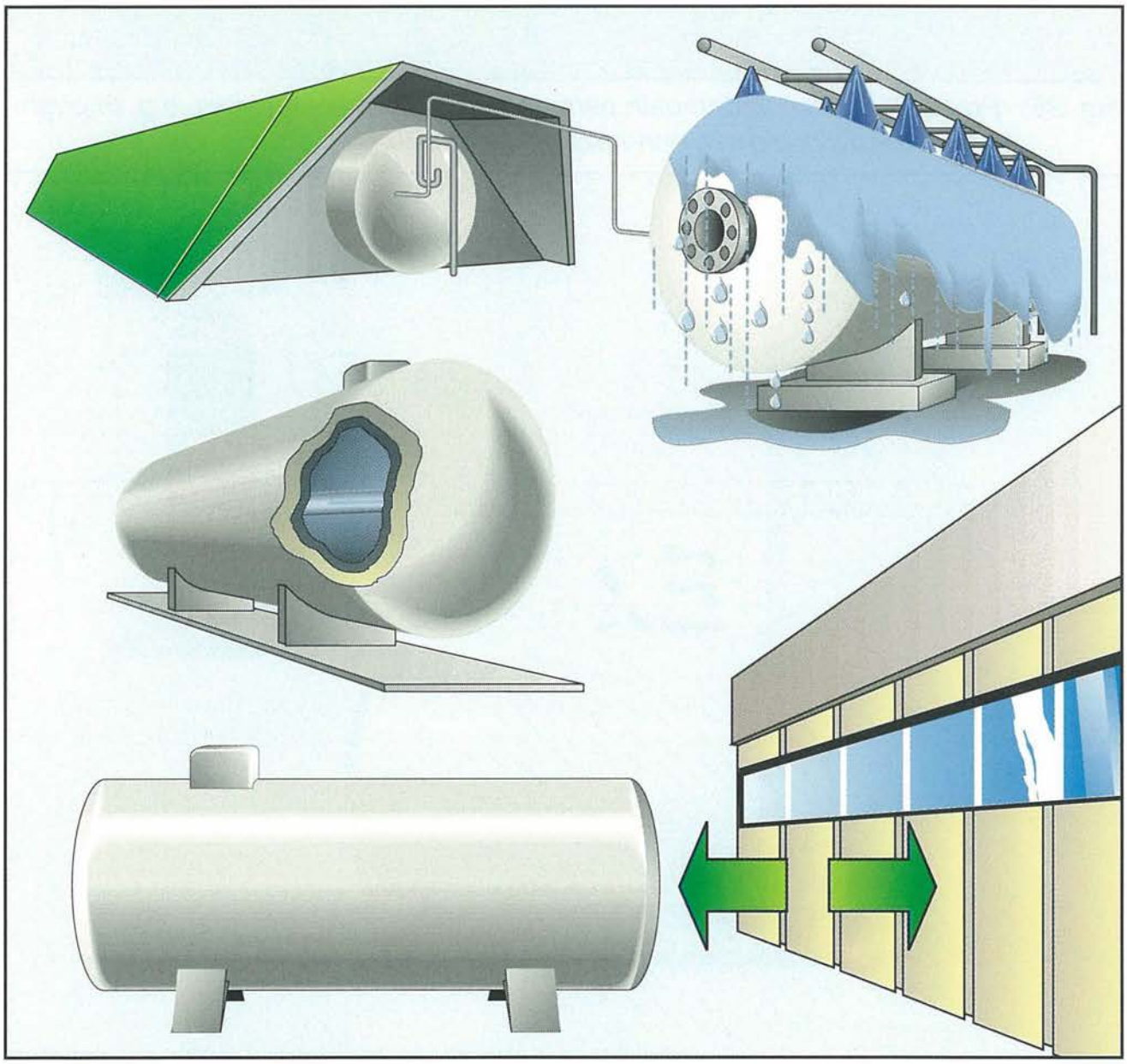


Fig. 27: Protective measures against thermal effects

How can the fire break distances needed for fire protection be determined?

Possible criteria are:

- The greater the **liquefied gas storage capacity**, the greater the fire break distances.
- With neighboring objects, the **construction** is of decisive importance. The less their fire resistance, the greater the fire break distances.
- The **use of neighboring buildings or objects** must be taken into account: The greater the fire potential and the number of personnel, the greater the fire break distances.

What precautions can be taken if the required fire break distances can not be complied with?

Through the erection of blank protective walls (screen walls) with sufficient fire resistance, the radiant heat on the neighboring object due to a fire will be greatly diminished and hence the fire break distances can be correspondingly reduced. Here, it should be noted that the height and length of the protective wall (screen wall) must be matched to the dimensions of the container and the neighboring object.

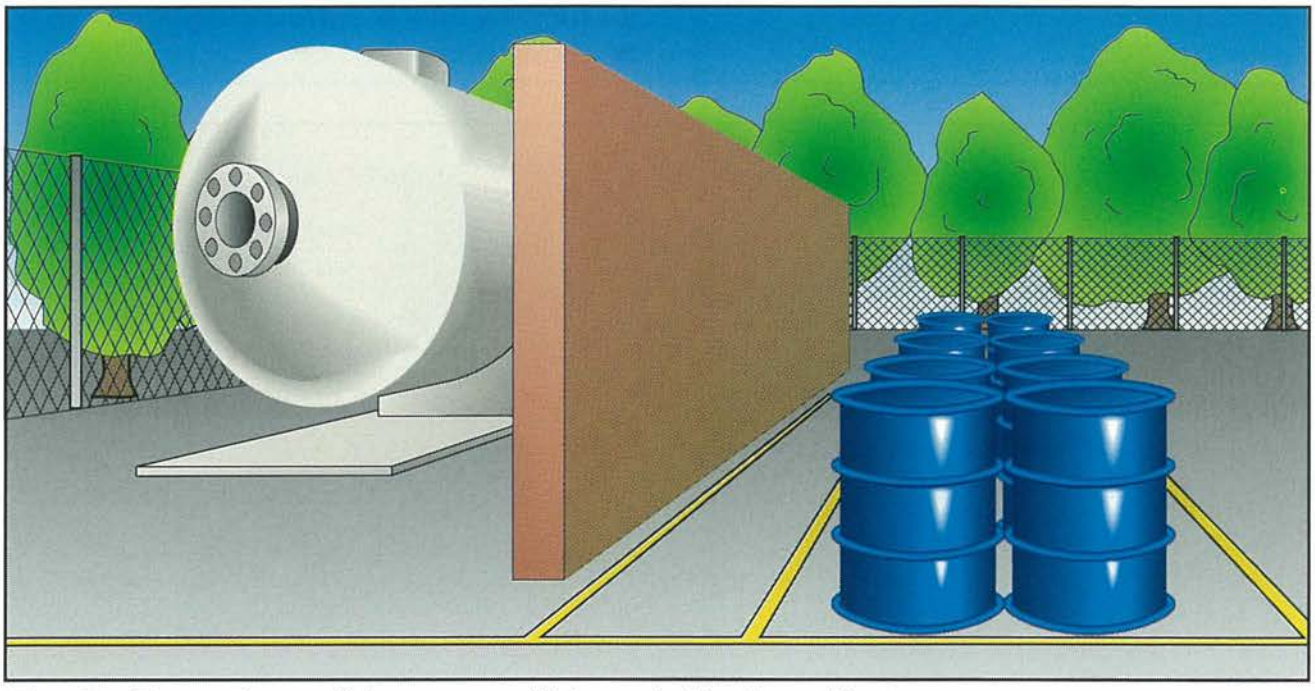


Fig. 28: Protective wall (screen wall) for neighboring objects

How can supply facilities be protected against mechanical damage?

Supply facilities such as tanks, batteries of cylinders or bottles which are set up at exposed locations, for instance near traffic routes or in-plant crane installations must be protected against collisions, e.g. by means of crash barriers.

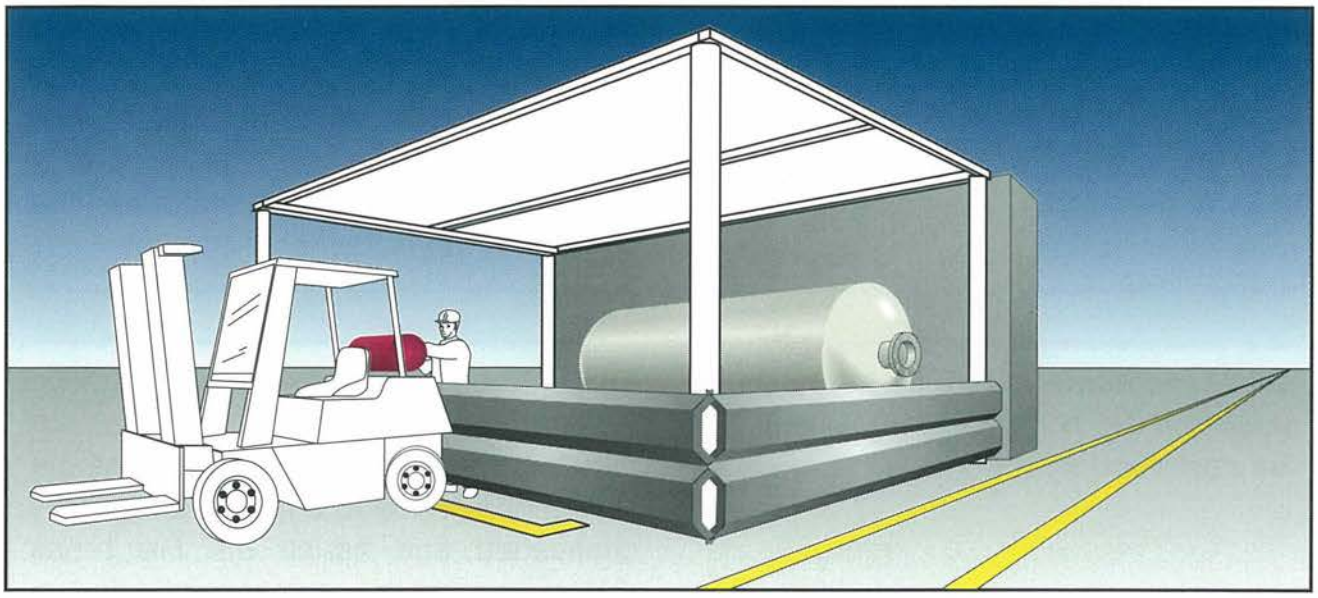


Fig. 29: Protection of the supply facility against mechanical damage

How can the access of unauthorized persons be prevented?

The fittings of tanks, cylinders and the actual containers must be protected against unauthorized access, e.g. by

- closable protective cover,
- caging of the containers or
- fencing off the surrounding area,
- monitoring.

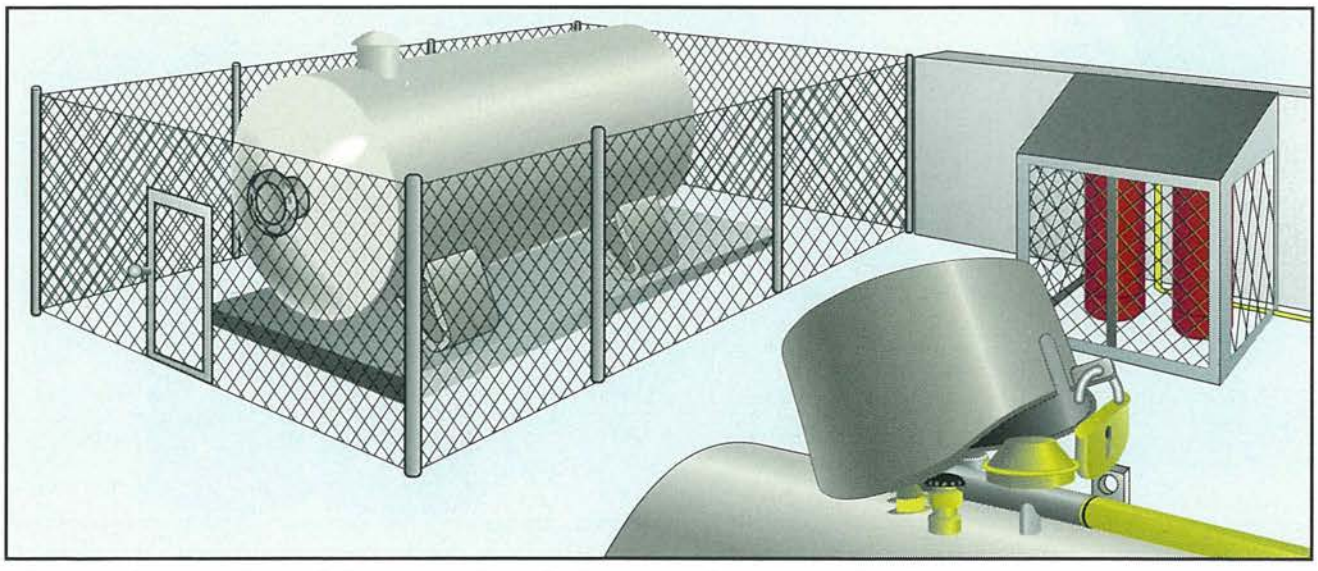


Fig. 30: Protection of the container fittings against unauthorized access

What demands must liquefied gas storage rooms meet?

Among other things, storerooms for liquefied gas must:

- be separated from adjoining rooms by sufficient fire resistance,
- have escape routes which are so designed that they can be accessed quickly and safely at all times; they must be marked if necessary,
- be capable of supporting adequate artificial or natural ventilation, and
- be designed in accordance with the requirements for hazardous areas.

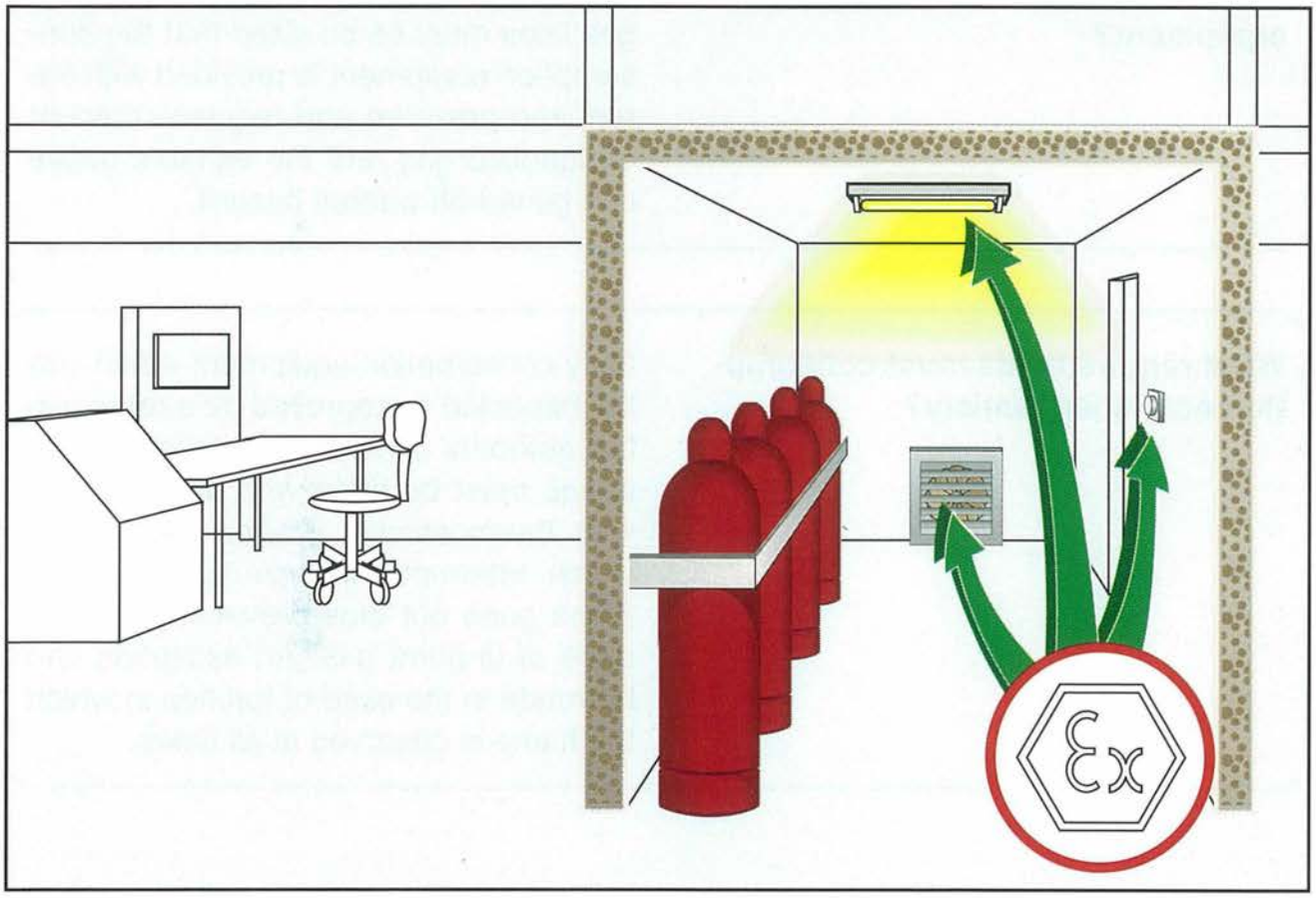


Fig. 31: Requirements for storerooms

When should risk analyses regarding possible malfunctions be implemented?

Depending on the size and complexity of the installation, risk analyses must be conducted in accordance with national regulations and if need be safety plans set up and appropriate technical and organizational protective measures taken.

Consumption equipment

What has to be considered in the design of liquefied gas consumption equipment?

In the design of liquefied gas installations, the widths of the pipes and exhaust gas lines must be so sized that the consumption equipment is provided with the required pressure and requisite amount of liquefied gas and the exhaust gases can be led off without hazard.

What requirements must consumption equipment satisfy?

Only consumption equipment which can be inspected or approved by a responsible authority should be installed. Appliances must be fitted with devices, e.g. with thermoelectric ignition safeguards which interrupt the gas supply if the flame goes out thus preventing the escape of unburnt gas. An exception can be made in the case of torches in which the flame is observed at all times.

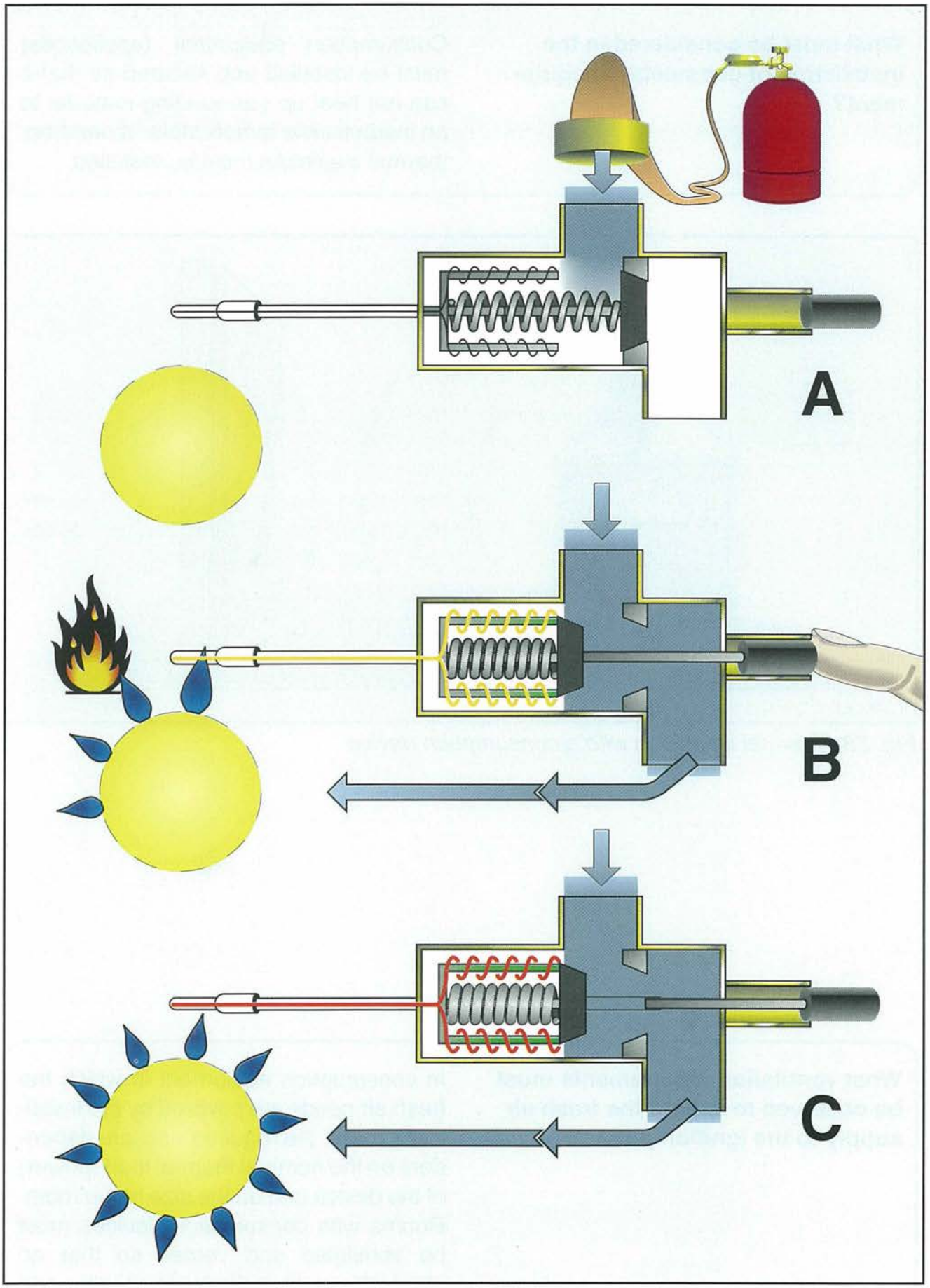


Fig. 32: Operating principle of a thermoelectric ignition safeguard
A) inactive, B) ignition phase, C) continuous operation

What must be considered in the installation of consumption equipment?

Consumption equipment (appliances) must be installed and secured so that it can not heat up surrounding material to an inadmissible temperature. If need be, thermal insulation must be installed.

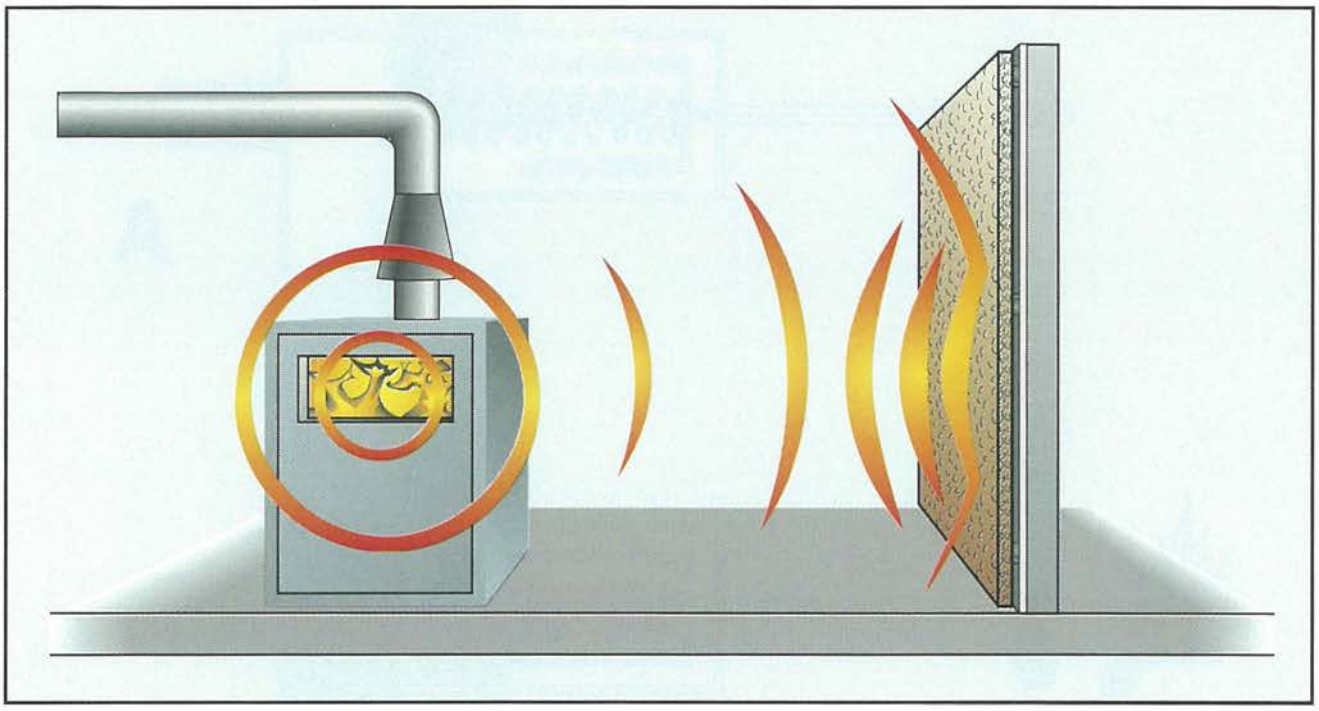


Fig. 33: Thermal insulation with a consumption device

What ventilation requirements must be observed to assure the fresh air supply to the ignition points?

In consumption equipment in which the fresh air needs are covered by the installation room, the requirements are dependent on the nominal thermal load (power) of the device and on the size of the room. Rooms with consumption devices must be ventilated and vented so that no atmosphere hazardous to health can arise in the room.

- Under favorable conditions, natural room ventilation can suffice.
  Such favorable conditions can occur when, e.g. the walls have two permanently opened vents, if possible opposite each other with one near the floor and the other near the ceiling.
- If the conditions are not favorable, the ventilation requirements can be met by artificial ventilation measures.

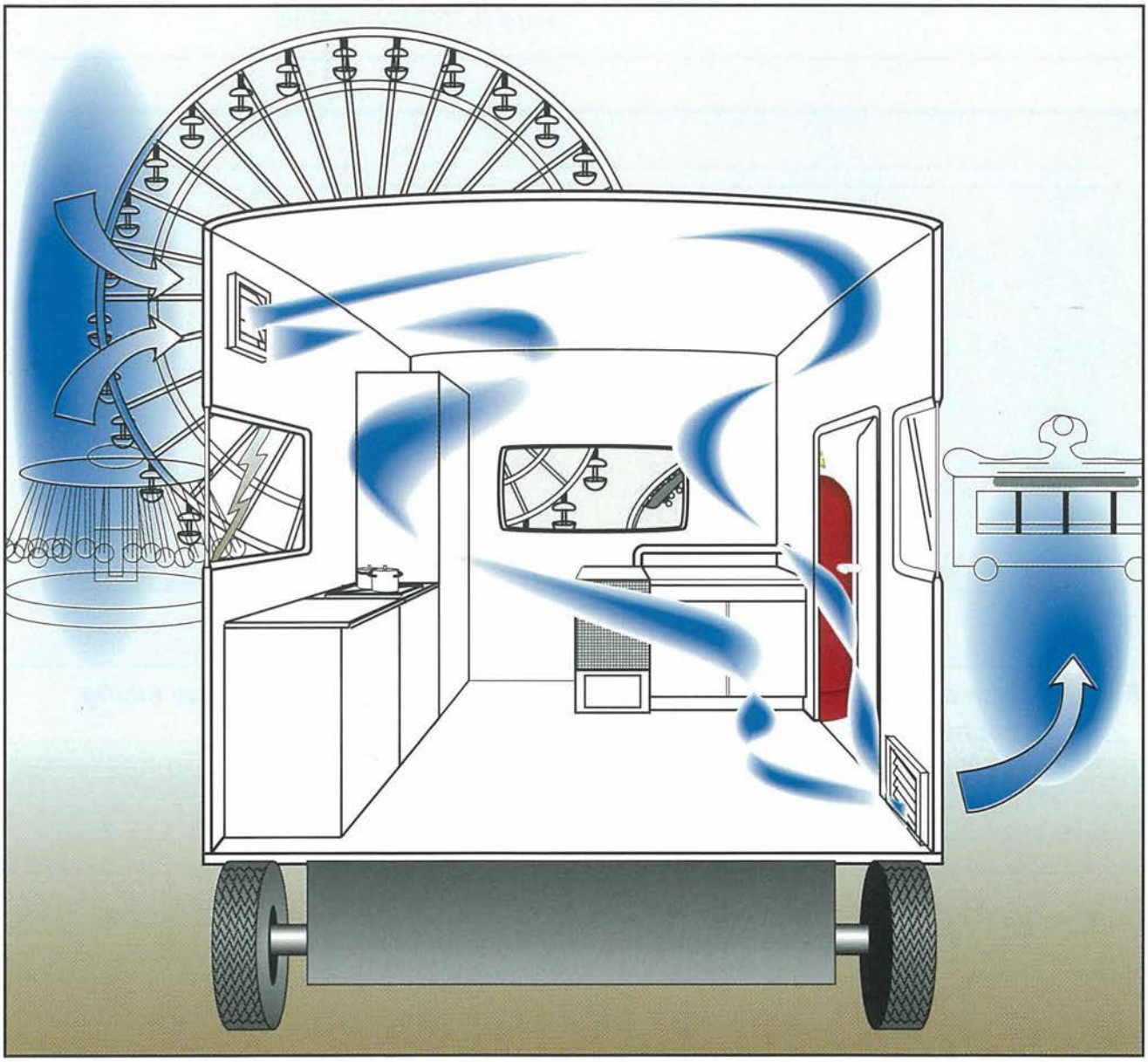


Fig. 34: Ventilation of rooms, e.g. caravan with consumption equipment

When may tubing be used and what requirements must it meet?

With permanent liquefied gas installations, tubing should usually be installed only as a connection between the supply system (or the pipelines) and the fixed lines (or consumption equipment). It is admissible only when fixed lines are unsuitable owing to a lack of flexibility or for other operational reasons. Tubing must be gas-tight, pressure-resistant, resistant to liquefied gas and reinforced in the case of portable consumption equipment where tubing damage can not be excluded. With liquefied gas under high pressure, tubing with a special insert which withstands increased pressure is indispensable.

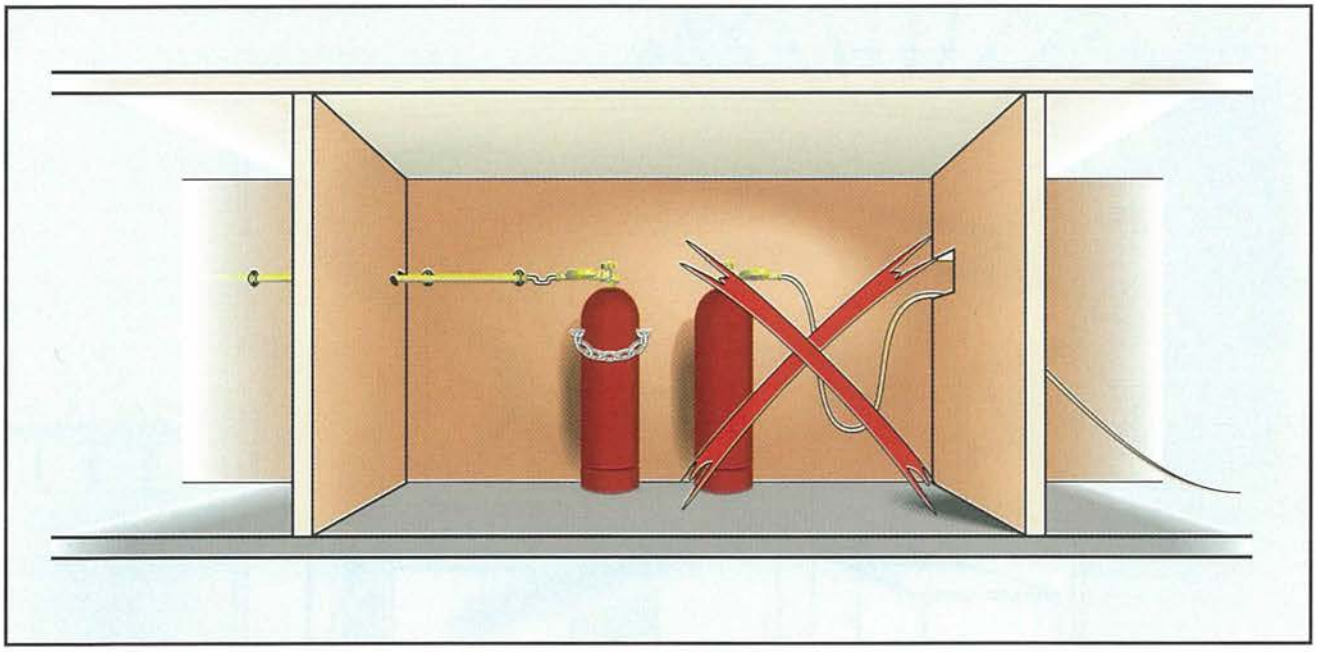


Fig. 35: Use of tubing – Example illustrating admissible and inadmissible tubing connections

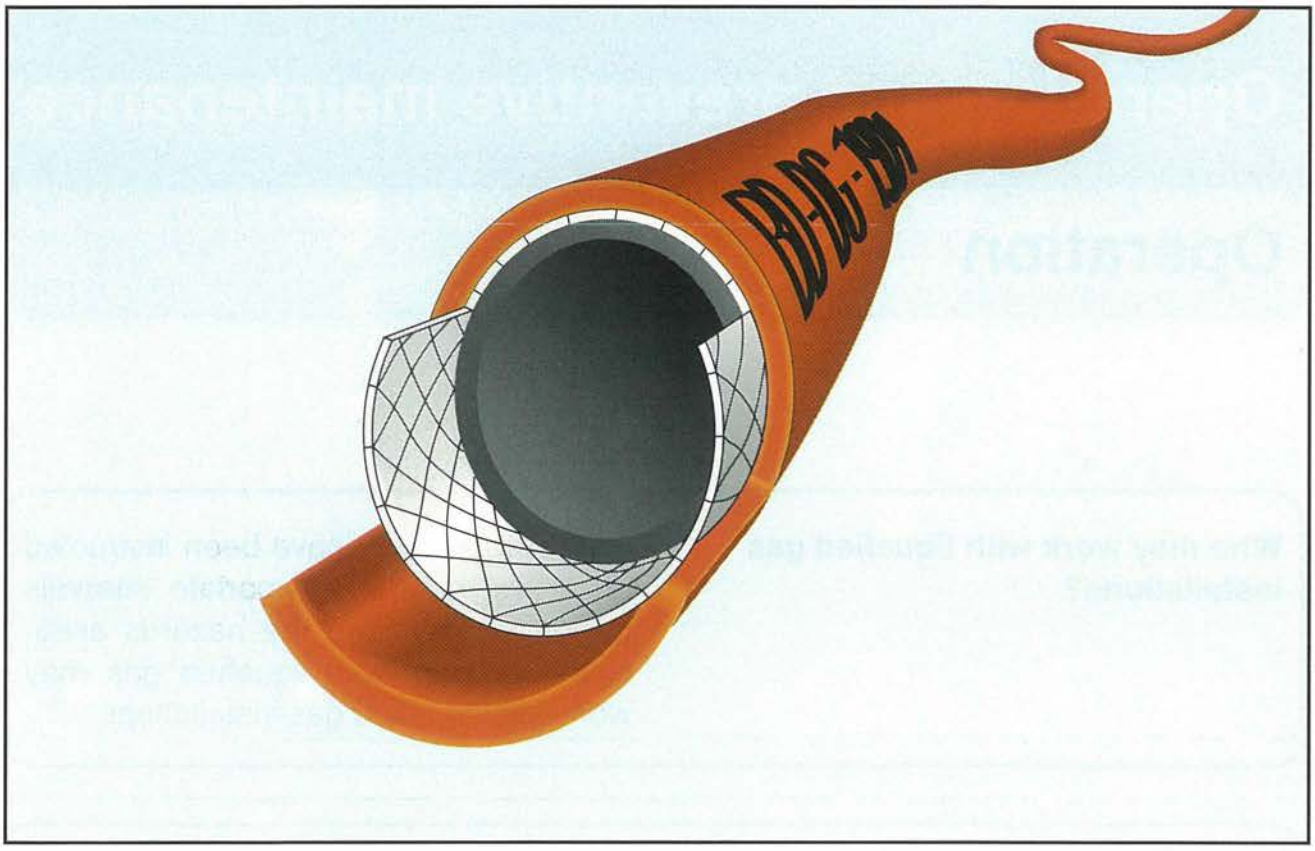


Fig. 36: Reinforced liquefied gas tubing marked in compliance with national regulations

Operation and preventive maintenance

Operation

Who may work with liquefied gas installations?

Only persons who have been instructed on arrival and at appropriate intervals thereafter regarding the hazards associated in work with liquefied gas may work with liquefied gas installations.

What must be observed in the installation of cylinders?

- The installation of cylinders in escape routes is inadmissible. Installation in gangways and thoroughfares is admissible – provided extensive protective measures have been taken – when escape routes are not obstructed.
- Liquefied gas cylinders may not be installed in areas in which there is a high fire potential (e.g. easily flammable or spontaneously combustible solids).
- Liquefied gas cylinders must be installed with the valve upwards and secured against tipping over.
- Unused connections of liquefied gas installations must be tightly covered with caps, stoppers and the like. "Empty" cylinders must be stored with closed valves.

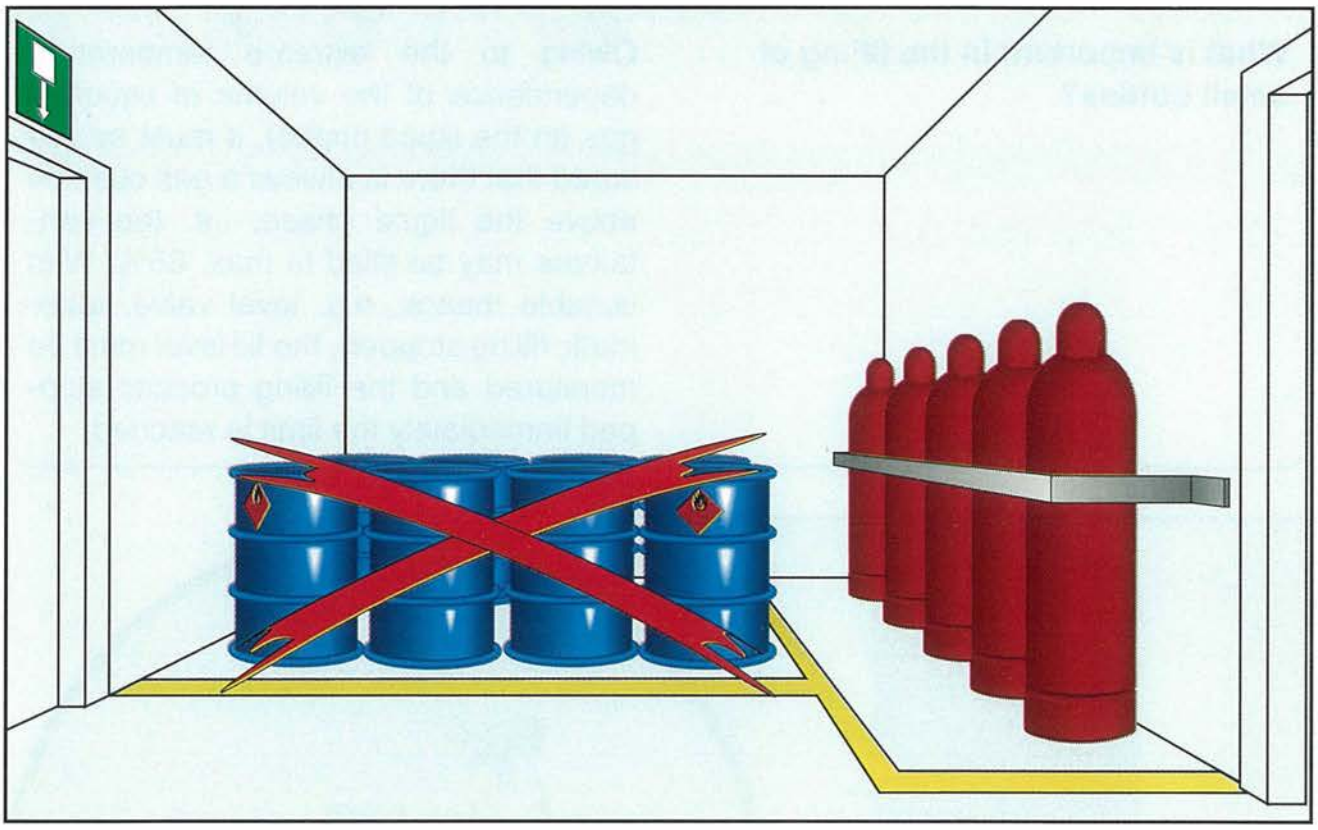


Fig. 37: Installation of liquefied gas cylinders

What must be considered when connecting cylinders?

Before connection, the condition of the seal at the pressure regulator must be checked and after loosening of the regulator the condition and seating of the tubing checked.

When must container (cylinder) valves be closed?

Cylinder valves must be closed:

- before lengthy breaks in the work
- after consumption of the liquefied gas
- before loosening the pressure regulator
- if malfunctions occur.

How should "empty" liquefied gas containers be handled?

Empty or supposedly empty containers may never be put aside or stored with an open valve as a rise in the ambient temperature could lead to escape of any residual liquefied gas accompanied by its associated hazards (cf. section "Properties and risks", page 15).

What is important in the filling of small bottles?

Owing to the extreme temperature dependence of the volume of liquefied gas (in the liquid phase), it must be ensured that there is always a gas cushion above the liquid phase, i.e. the containers may be filled to max. 85%. With suitable means, e.g. level valve, automatic filling stopper), the fill level must be monitored and the filling process stopped immediately the limit is reached.

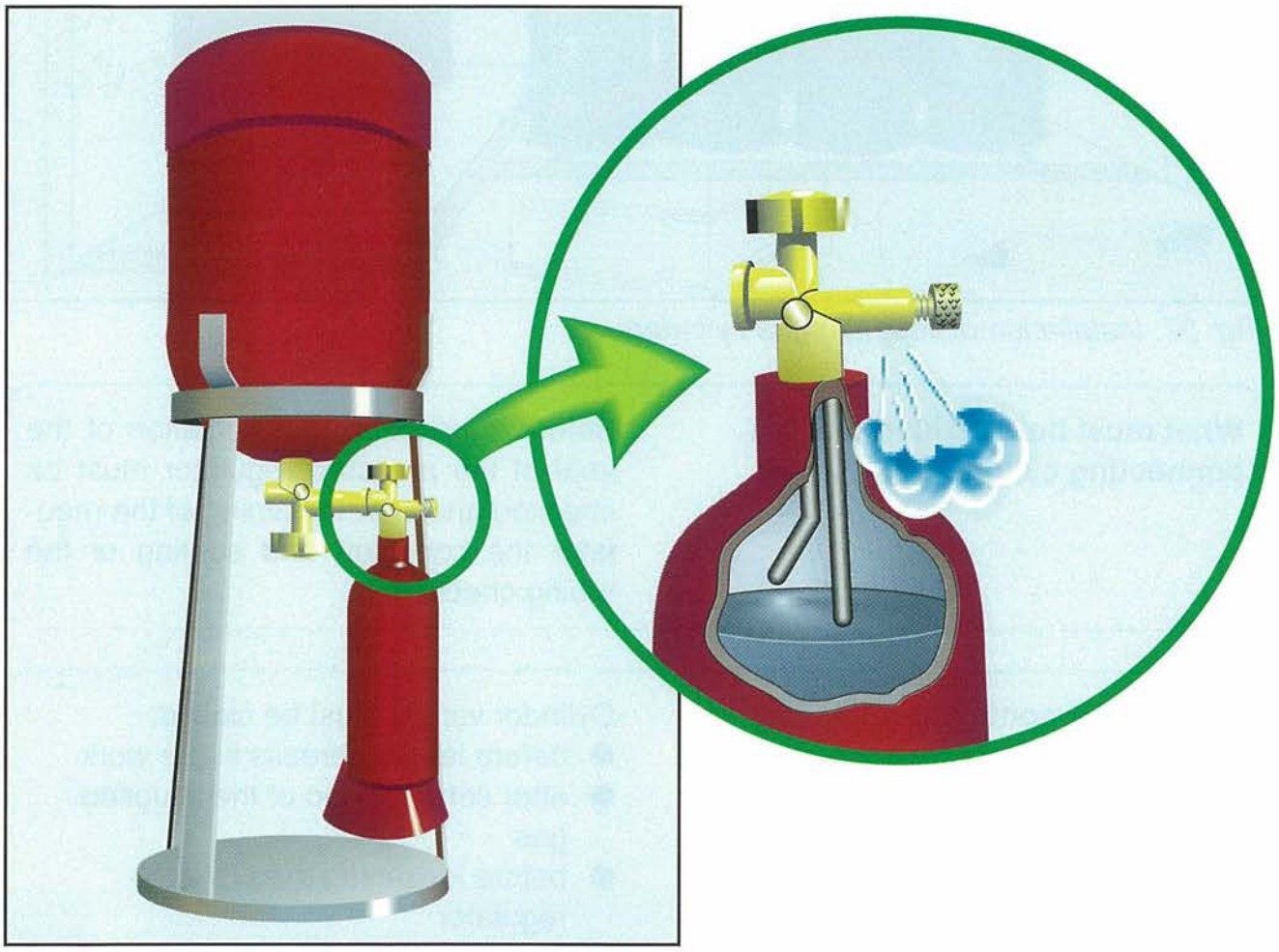


Fig. 38: Filling of liquefied gas into small bottles

What must be done to avoid poisoning when *mobile* consumption equipment is used?

The use of mobile consumption equipment also requires well ventilated areas or rooms. The opening of a window or any other way of supplying sufficient quantities of fresh air remains the most important precaution against a poisoning hazard.

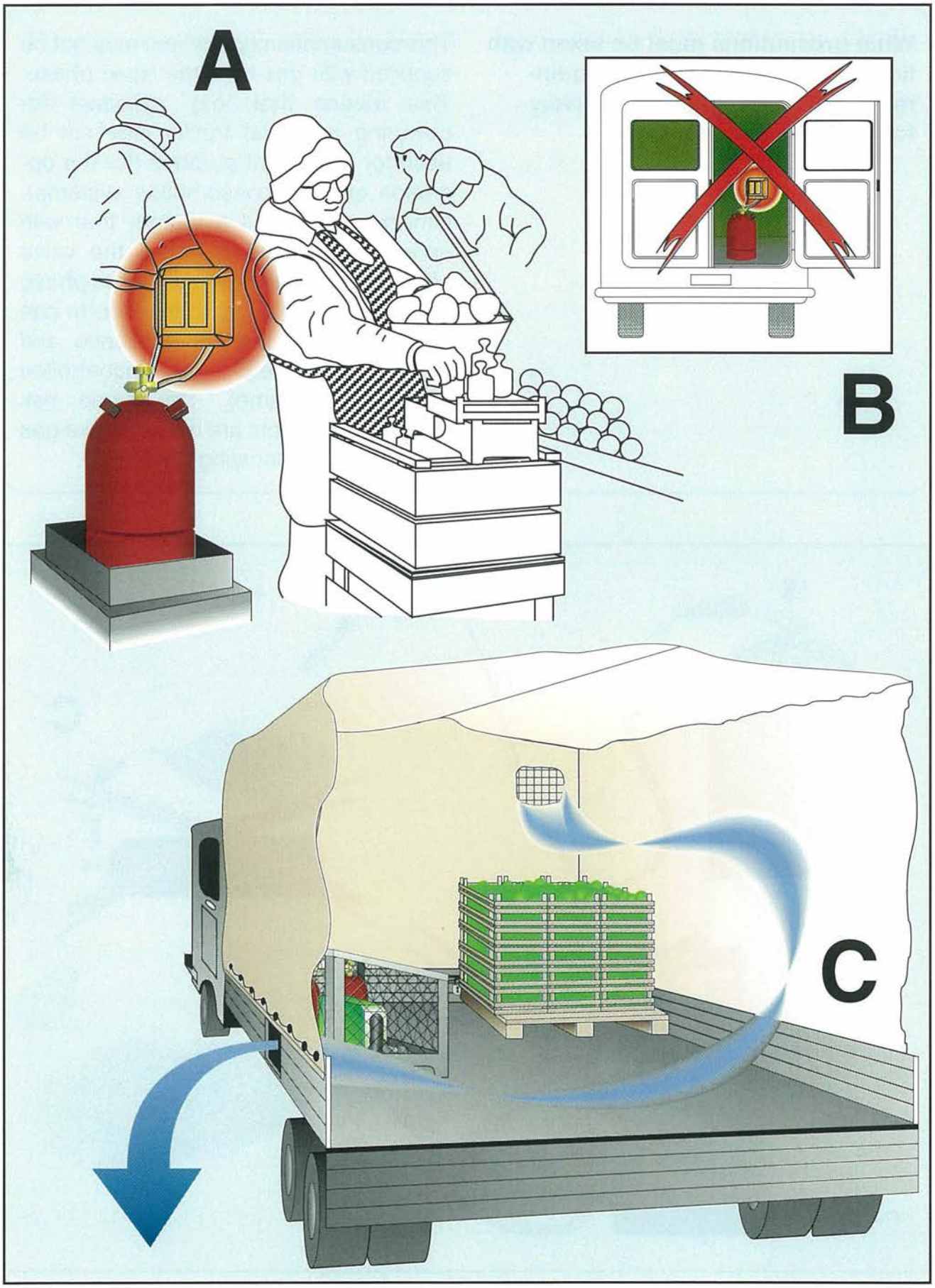


Fig. 39: Use of mobile consumption equipment
A) in the open air, B) in insufficiently ventilated areas,
C) in ventilated areas

What precautions must be taken with liquefied gas consumption equipment that is designed exclusively for gas-phase operation?

This consumption equipment may not be supplied with gas from the liquid phase. This means that, e.g. cylinders for powering industrial trucks may not be used for a different purpose (for the operation of other consumption systems). Otherwise, there is a danger that with upright power gas cylinders the valve offtake pipe projects into the liquid phase of the gas so that gas in liquid form can reach the consumption appliance and there burn fiercely in an uncontrolled manner (jet flame). The same risk appears if attempts are made to take gas from a full cylinder lying on its side.

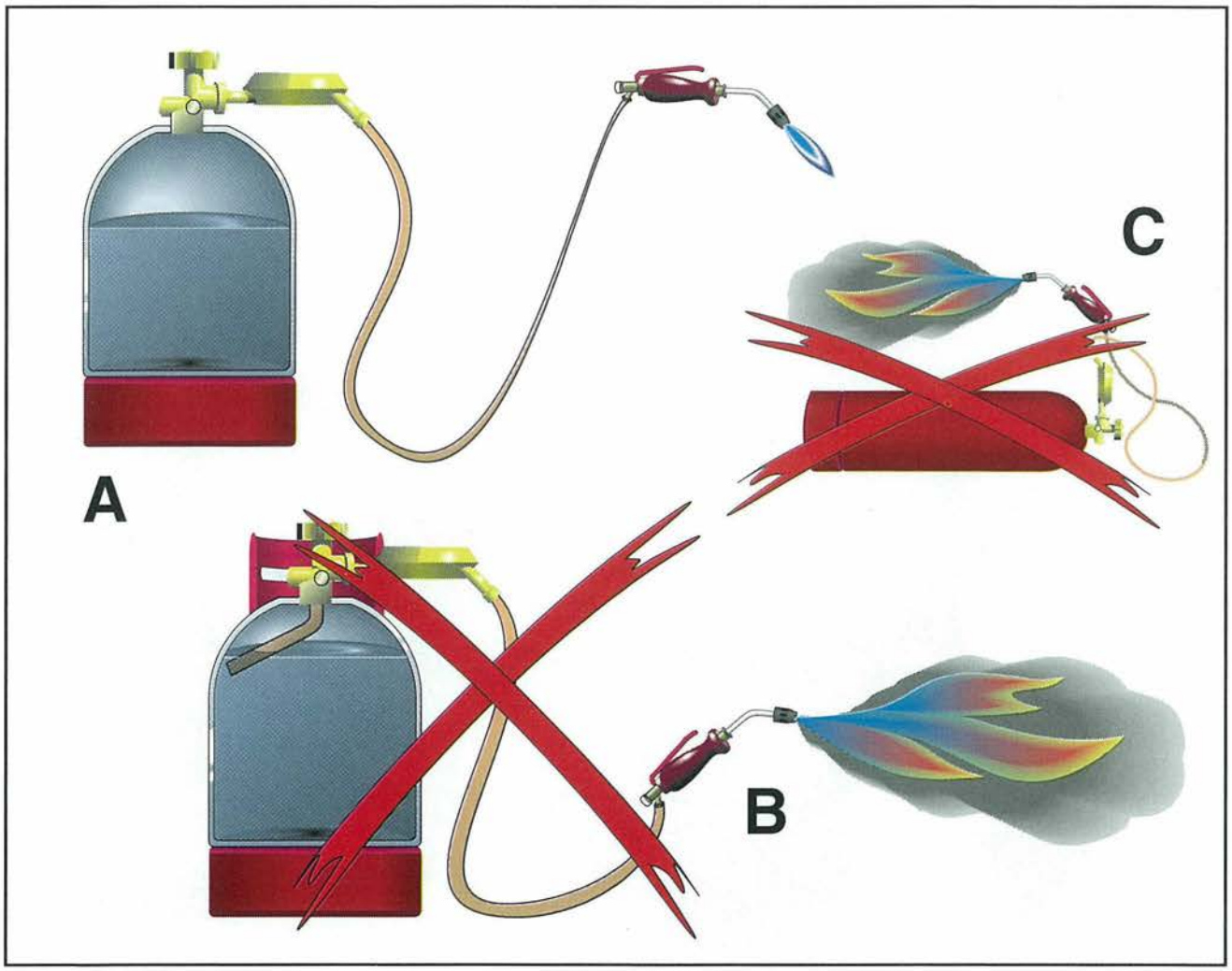


Fig. 40: Hazard due to the improper use of liquefied gas cylinders
A) correct use; B) wrong use: power gas used for combustion gas purposes;
C) wrong use: full gas cylinder used when lying on its side

What precautions must be taken when using hand torches?

Torches that are in use or still hot may not be placed on liquefied gas cylinders or tubing or in their immediate vicinity. They must be hung up, e.g. in special holders or rested only on suitable supports made of non-flammable materials and in a manner such that the flame can have no contact with flammable substances. With relatively long work breaks or pauses, the torches must always be shut off.

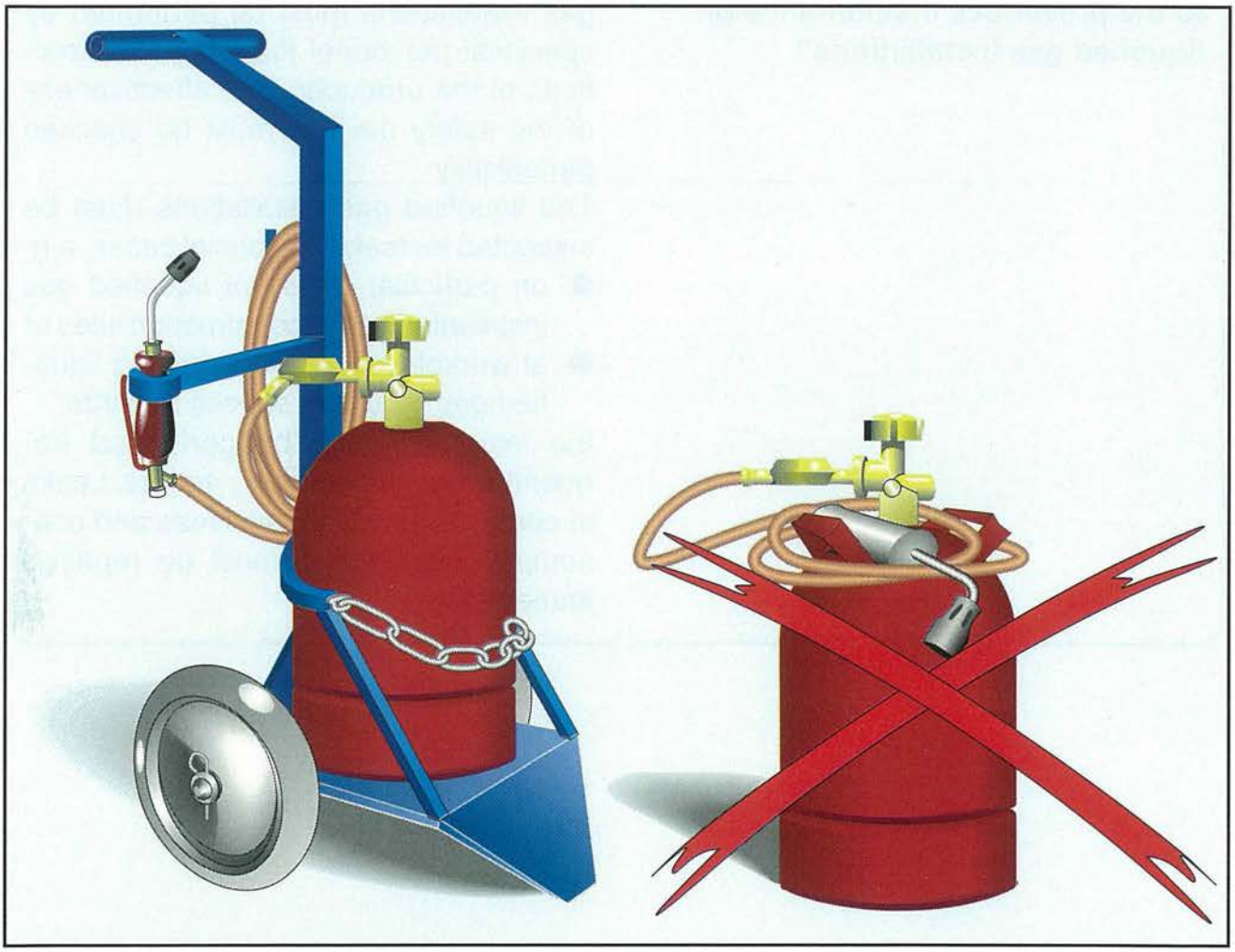


Fig. 41: Stowage of hot hand torches

The safety directions (e.g. around the cylinder neck) must be observed. After every offtake of liquefied gas, the cylinder valve must be closed.

Preventive maintenance

What must be observed with regard to the preventive maintenance of liquefied gas installations?

The preventive maintenance of liquefied gas installations must be performed by specialist personnel following the directions of the producer. The effectiveness of the safety devices must be checked periodically.

The liquefied gas installations must be inspected for leaks. In special cases, e.g.

- on particular stress of liquefied gas installations as in construction sites or
- at workplaces where escaping liquefied gas results in special hazards,

the leak test must be performed frequently, e.g. with foaming agents. Leaks in containers, fittings, pipelines and consumption equipment must be repaired immediately.

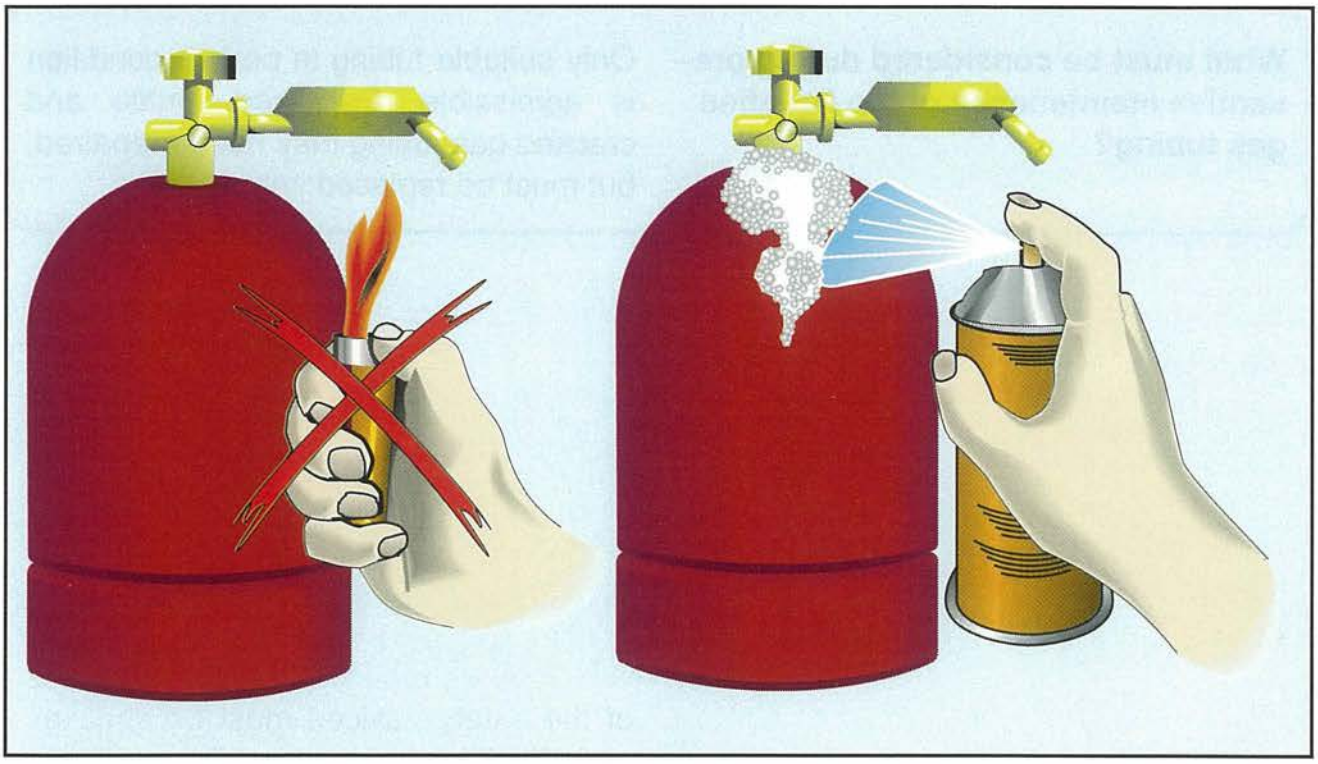


Fig. 42: Leak testing of liquefied gas facilities

What precautions must be taken in the vicinity of liquefied gas facilities?

If maintenance work such as welding or grinding has to be performed in areas hazarded by explosion or fire, the requisite special safety measures must be implemented.

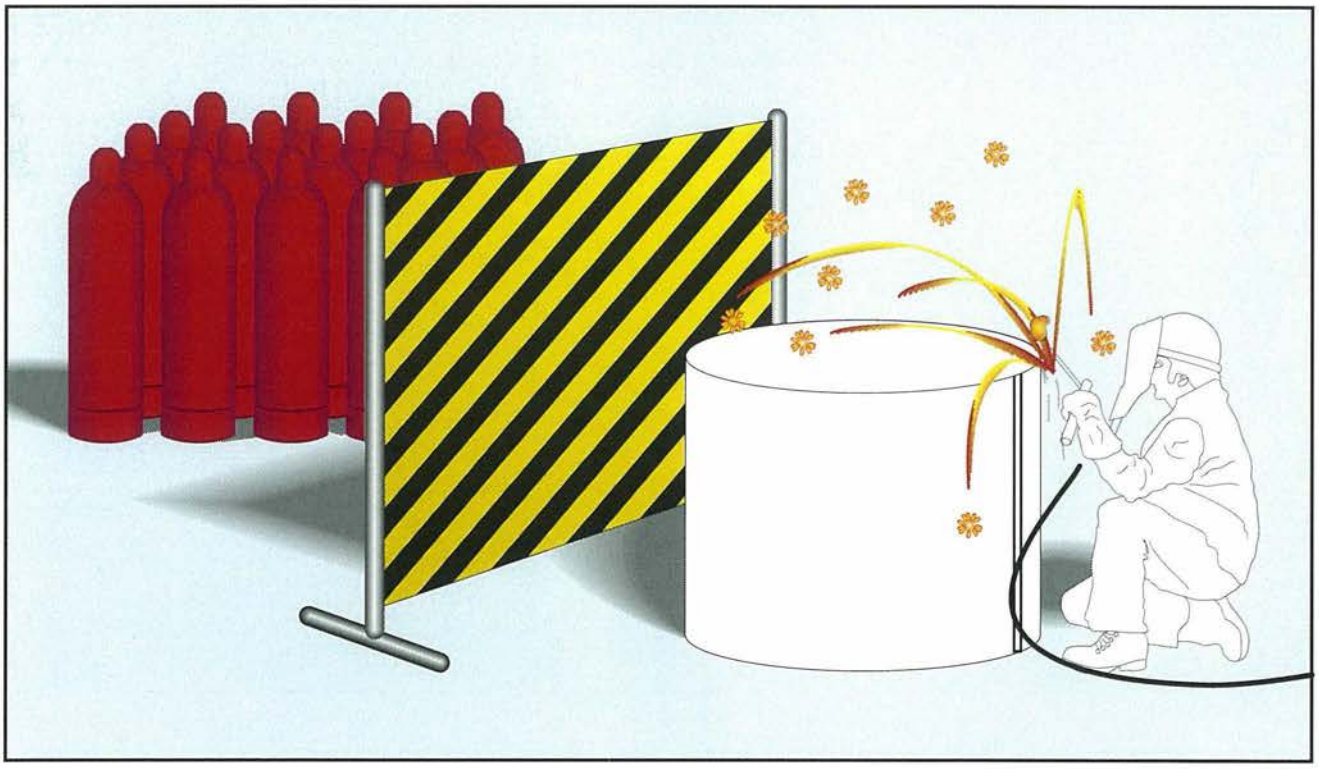


Fig. 43: Special safety measures during welding work in areas hazarded by explosions and fire

What must be considered during preventive maintenance of the liquefied gas tubing?	Only suitable tubing in perfect condition is admissible. Damaged, brittle and cracked gas tubing may not be repaired, but must be replaced immediately.

Measures on liquefied gas escape with or without fire

What measures must be taken in the case of fire?

Measures must be implemented to extinguish fires. Liquefied gas installations in which fire must be anticipated must be equipped with suitable fire extinguishing equipment. The fire extinguishing equipment and fire protection systems (or their tripping devices) must be mounted in a suitable position so that they can be reached and operated quickly should a hazard arise.

What is the procedure on liquefied gas escape without fire?

The following immediate measures should be taken on liquefied gas escape in the absence of fire:

- Closing of the shutoff devices to prevent gas escape and
- avoidance of all types of ignition sources. Never operate any electrical switches and the like, if possible – if they are outside the hazard area – switch off the main electrical switches and/or remove the main electrical fuses. Extinguish naked flames and do not smoke.

In the case of liquefied gas escape to the open air, generous hazard zones must be cordoned off and alarm given to the fire department as well as gas specialists. With gas escape in rooms, ensure effective ventilation. Leaking cylinders must be removed from the rooms and transported to a safe place in the open air.

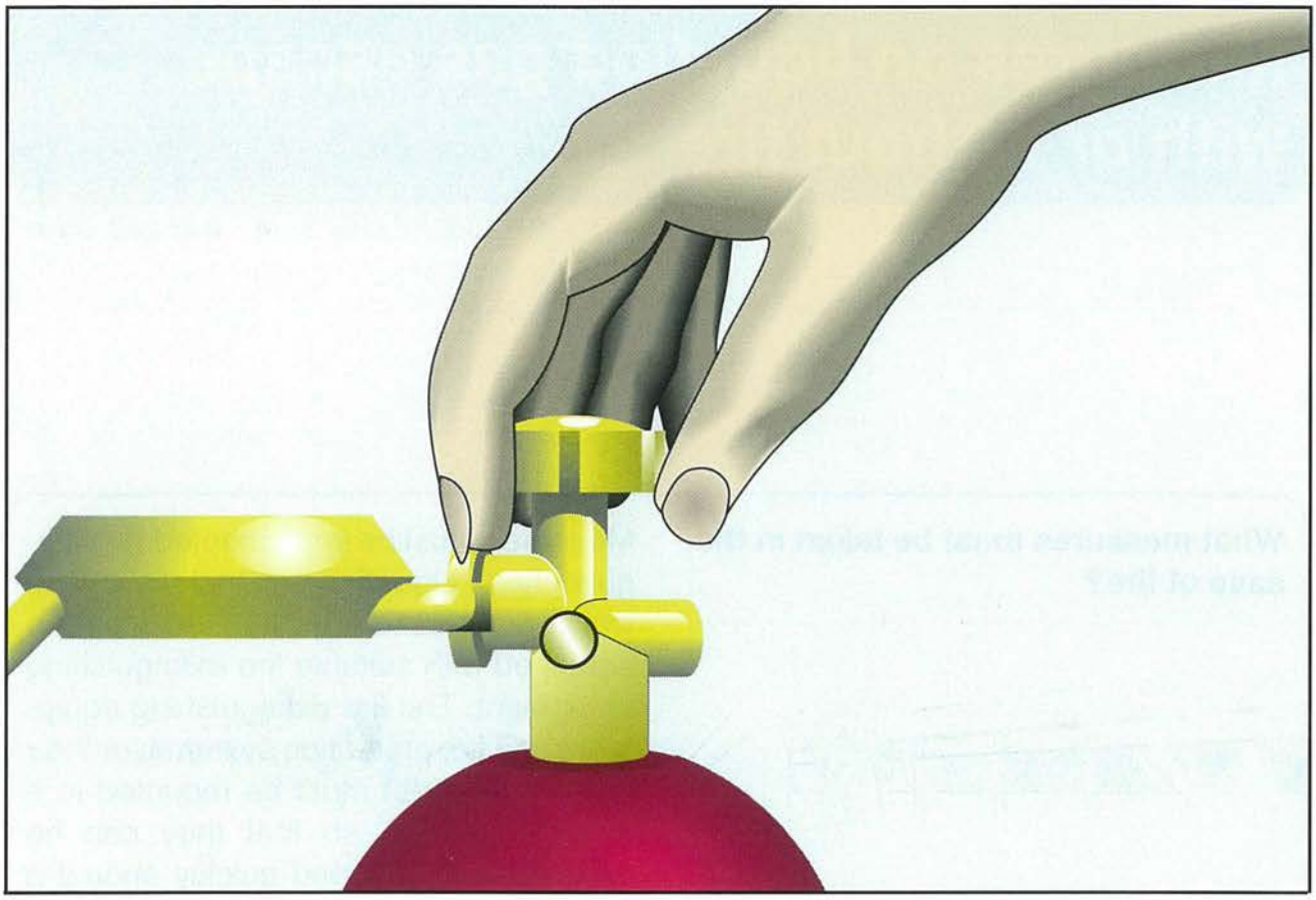


Fig. 44: Closing of the shutoff devices on gas escape

Fig. 45: Avoidance of ignition sources on gas escape

What is the procedure with liquefied gas installations on gas escape accompanied by fire?

As an immediate measure on gas escape accompanied by fire in the case of liquefied gas installations, it must be ensured that all accessible shutoff devices are closed to interrupt the gas supply. Permanently installed containers and objects hazarded by fire must be cooled with water. If possible, transport burning cylinders whose valves can no longer be closed and/or spare cylinders to a safe place in the open air. Alert fire department and gas specialists.

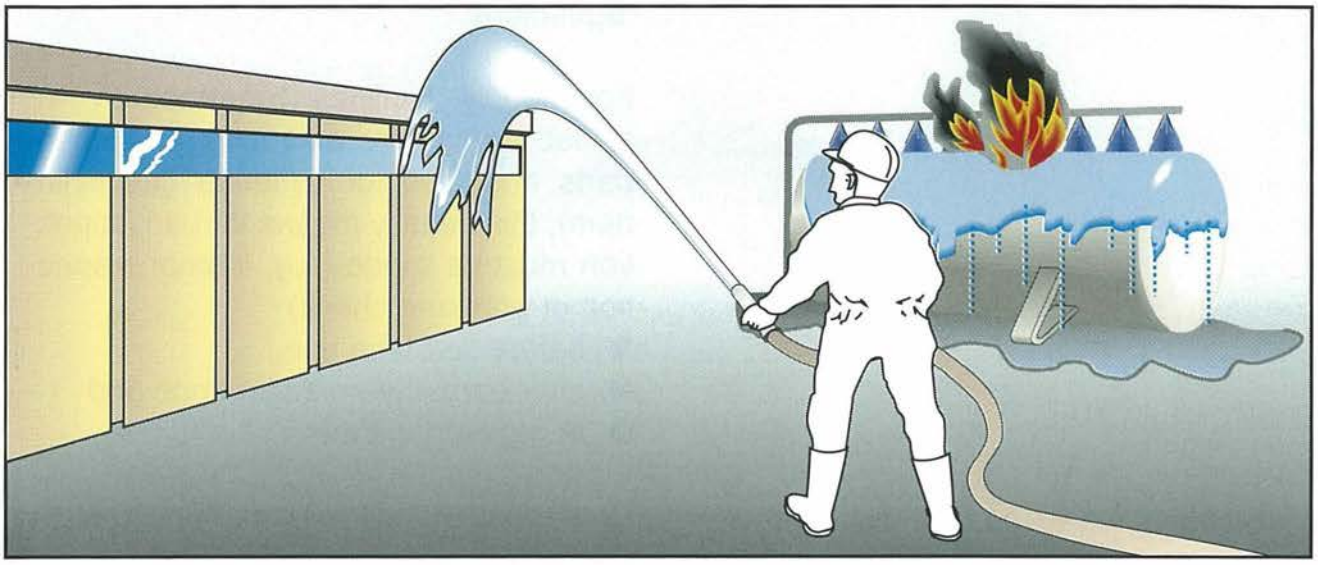


Fig. 46: Cooling of containers and hazarded objects on outbreak of a fire

Extinguish burning liquefied gas at the escape point only if the leak can be sealed (avoidance of explosion hazard).

What measures must be implemented with a fire in the vicinity of liquefied gas installations?

- Cool permanently installed containers and units (e.g. with stationary sprinkler systems or water cannons).
- Remove gas cylinders from the hazard zone or, if this is not possible, cool them.
- Give alarm.
- Extinguish fire in the vicinity of liquefied gas installations.

Inspection of liquefied gas installations

When must liquefied gas installations be inspected?

Liquefied gas installations must be inspected in accordance with the **national** regulations.

For supply facilities (permanently installed containers and their equipment parts and also for liquefied gas cylinders), this usually means that an inspection must be made (e.g. interior inspection or pressure check)

- before first-time use,
- after corrective maintenance and
- at regular intervals.

Consumption facilities must be specially checked for

- leaks,
- proper condition and
- functioning.

ISSA publications

ISSA Section for the chemical industry
Working party "Explosion protection"

List of regulations concerning explosion protection (German)
(1987)

Protection against dust explosions (English, German, French, Italian, Spanish)
(1987)

Protection against explosions caused by flammable gases,
vapors or mists in admixture with air (English, German, French, Italian)
(1988)

Liquefied gas documentation (German)
(1988)

Safety of liquefied gas installations (propane and butane)
(English, German, French, Italian)
(1992)

Address for orders: ISSA Section Chemistry
Postfach 10 14 80
D-6900 Heidelberg, Germany

ISSA Section Machine Protection
Working party "Dust explosions"

Dust explosion protection for machines and equipment

- Preventive and constructional measures (English, German, French)
  (1987)
- Collection of examples (English, German, French)
  (1990)

Explosion suppression (English, German, French)
(1990)

Address for orders: ISSA Section Machine Protection
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