FIRE PROTECTION

during hot work

VARME ARBEIDER

Brannvernforeningen

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Fire protection during hot work

Brannvernforeningen

3rd edition, 6. edition, 2024

ISBN 978-82-7485-107-8

Cover, type and paging: Bøk Oslo AS
Cover photo: INTHEBLVCK, Shutterstock.com
Photo: Audun Braastad and Alexander Benjaminsen
Illustrations: David Keeping
Editor: Kristin Rostad
Font: Ideal Sans
Paper: 120 g Munken Polar

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Foreword

When performing hot work, it is crucial to know the risk factors that can lead to fire. With good training and solid knowledge, you will be able to respond effectively in the event of a fire. It is equally important for hot work certification training to contribute to good attitudes and lasting safe conduct among those who perform hot work.

It is both about safeguarding personal safety and preventing the loss of physical property. Therefore, the instructors who hold courses in hot work, and those who prepare and manage online courses, have a great responsibility.

The insurance industry began requiring certification of those who perform hot work back in 2001. Prior to this, the industry had introduced its own safety regulations for carrying out hot work because there had been too many fires with serious consequences. The certification requirement, together with safety regulations and good training, has contributed to significantly fewer fully developed fires related to hot work.

As manager of the certificate scheme on behalf of the insurance industry, the Norwegian Fire Protection Association has established itself as a leading supplier of teaching materials in the field. The textbook "Fire protection during hot work" was first published in 2012 and revised in 2014. It was written by Monica Varan, Sturle Hagen and Dagfinn Kalheim.

The basic fire prevention guidelines from the training are also included in this revised edition of the textbook which has been updated in accordance with the "Safety regulations for the performance of hot work" which entered into force on 1 January 2024. The revision work was carried out by an internal editorial team headed by Kristin Rostad. In addition, Kai Arne Trollerud has been a valuable external contributor.

I would like to thank everyone who has contributed to the revision work and look forward to continuing a well-functioning certification scheme with positive and documented results.

Rolf Sørtorp
Chief Executive Officer

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Definitions

Party responsible	The party responsible for safety in the building where the hot work is to be performed.
Employer	The party employing the individual(s) who will perform the hot work.
Workplace	The location where the hot work is to be performed.
Fire alarm system	A system to detect and warn of fire, consisting of a fire detector, an alarm, a control box and a control panel.
Fire cell	A construction, or a delimited part of a construction, that is designed to act as a fire-resistant cell, allowing a fire to burn without spreading to other buildings or parts of the construction during a given time.
Fire watch	A person whose responsibility it is to ensure that a fire does not start while hot work is being performed.
Building owner	The party who holds registered title to the property.
Entering	Entering a closed room or an enclosed space that is not normally ventilated by natural or mechanical means, e.g. tankers or containers.
The Norwegian Insurance Approval Board (FG)	FG damage technique.
Insurance contract	Contract between an insurance company and the Insured. For a fixed fee (premium), the insurance company undertakes to pay compensation if injury or damage occurs that is covered by the insurance.

Insurance terms	Detailed description of what is covered and what is not covered in the event of injury or damage.
Internal control	Systematic measures to ensure that an organisation's activities are planned, organised, performed and maintained in accordance with requirements stipulated in health, safety and environment legislation.
Employer/Client	The party requesting that an assignment involving hot work be performed.
Party performing the work	The company or individual(s) who undertake(s) to perform the hot work.
Risk	Risk can be expressed as the product of the likelihood and consequences of an undesirable incident.
Risk matrix	Graphical illustration of the scale of risk as a function of likelihood and consequence.
Safety data sheet	A document containing information about the properties of hazardous chemicals and the recommended protective measures for their use.
Safety regulations	A requirement of the insurance terms that the insured must take specific measures to prevent injury and damage, or that the insured under certain circumstances must hold specific qualifications or certificates.
The insured	The party who may claim compensation under the insurance contract.
Extinguisher rating	Measurement of the effectiveness of a particular extinguishing agent.
Causal connection	When an action or a failure to act is the cause of injury or damage.

Finans Norge
Forsikringsdrift

Safety regulations for the execution of hot work, 1 January 2024

Guidance on the safety regulations can be found at www.brannvernforeningen.no.

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2. **Where the safety regulations apply**
   The regulations apply when carrying out hot work in any environment where there is a risk of fire.
   Hot work carried out at specially adapted production and workshop premises is excepted. The premises must be separated from other operations and constitute a separate fire cell. This must have non-combustible surfaces.

3. **Agreement with external tradesman/contractor**
   If hot work is to be carried out by an external tradesman/contractor, the insured party must ensure that the requirements set out in the safety regulations are included in a written agreement or contract with the tradesman/contractor.

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5. **Hot work carried out on roofs**
   In addition to the above points, the following safety requirements are applicable when working on roofs:
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Adopted by Finans Norge Forsikringsdrift, 5 June 2023

1

Hot Work

What is hot work?

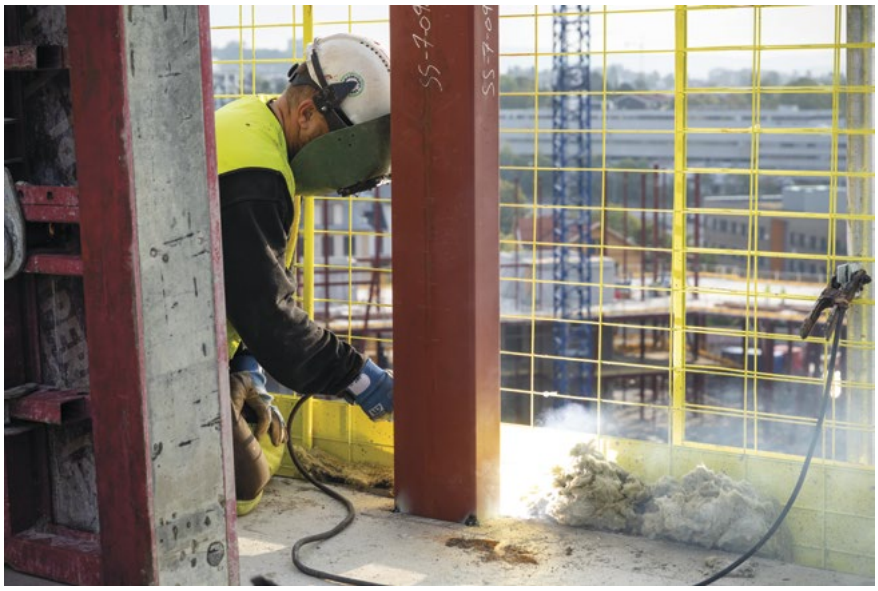
> **"Hot work is defined as work using work tools and equipment that generate sparks and/or heat that may cause fire. Hot work includes the use of an open or concealed flame, hot air equipment, welding equipment, cutting equipment and grinding equipment."**

Equipment used during the performance of hot work includes:

- Gas burners with open flames
- Welding equipment
- Angle grinders
- Angle cutters
- Hot air pistols
- Weed burners

Examples of hot work:

- Cutting metal with a cutting torch
- Cutting metal with an angle grinder
- Heat-shrinking cable tubing with a hot air pistol
- Roofing using a propane burner with an open flame
- Roofing using hot air
- Removing weeds using a weed burner



Knowledge and awareness

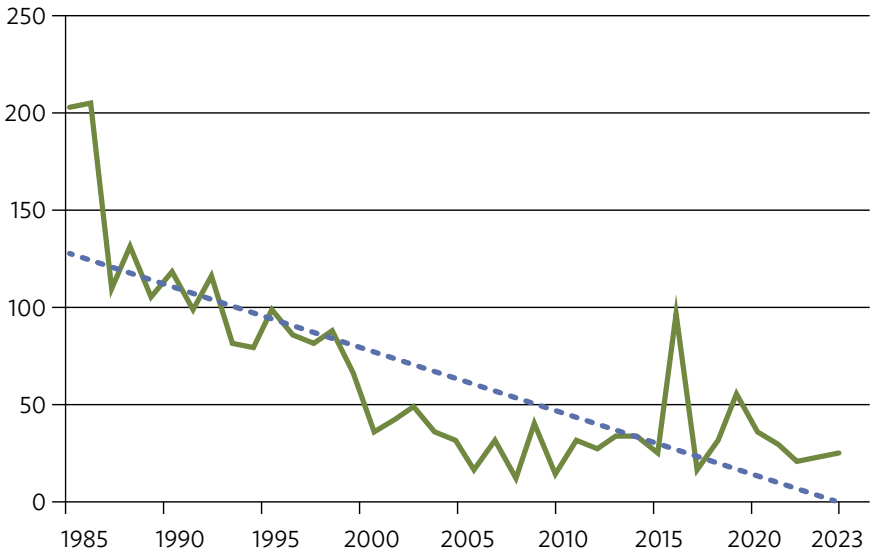
Hot work is associated with risk and has caused many fires. In many cases, the consequences can be great. It is therefore important for the person performing the hot work to know about the various risks associated with hot work and how such fires can be prevented. This knowledge makes it easier to take proper action before, during and after work so that a fire does not start.

Experience shows that hot work can cause fire and explosion. This can result in personal injury and material damage. Due to the risk associated with hot work, the authorities impose strict requirements for the performance of this work in health, safety and environmental legislation. In addition, the insurance industry has drawn up its own safety regulations for hot work. These safety regulations require personnel to have a certificate when performing hot work. The purpose of the certification requirement is to ensure that the person performing the hot work has sufficient knowledge to carry out the work in a safe and secure manner.

The insurance industry's requirements for training and safety measures are good tools for giving those who perform hot work increased knowledge about fire protection and risk-conscious behaviour. The goal is to

reduce the number of fires and insurance payments caused by hot work. Figures from the Norwegian Directorate for Civil Protection show that the number of fires caused by hot work has halved since the insurance industry introduced a hot work certification scheme.

STATISTICS ON FIRES CAUSED BY HOT WORK



■ Statistics on fires caused by hot work (Period 1985–2023).

2

Regulations

Two different regulations affect how we perform hot work: *The public regulations* and *requirements set by insurance companies*.

Public regulations

Government legislation and regulations for health, safety and the environment (HSE) primarily comprise three levels:

- laws
- regulations
- guides

The laws set overall frameworks regarding acceptable conduct for each member of society. The criteria for acceptable behaviour are often given in the form of duties and prohibitions. The requirements are specified in more detail in the regulations. Many laws and regulations have accompanying guides. The guides describe the practical measures that must be implemented in order to comply with the law.

> **The requirement of due diligence is a central point in the safety regulations. To demonstrate due diligence is to do what is necessary to avoid or avert loss, disadvantage, injury or damage.**

Relevant laws and regulations

There are a number of laws and regulations that either directly or indirectly have a bearing on the performance of hot work. The relevant laws and regulations are:

- Working Environment Act
- Fire and Explosion Prevention Act
- Insurance Contracts Act
- Act relating to compensation in certain circumstances
- The General Civil Penal Code
- Construction Client Regulations
- Regulations related to fire prevention
- Regulations on the performance of work
- Regulations on the handling of hazardous substances
- Regulations relating to systematic health, environmental and safety activities in enterprises (Internal Control Regulations)

> **These laws and regulation are constantly being revised and amended. Current laws and regulations can be found at www.lovdata.no (in Norwegian, with some documents translated into English).**

Certain laws and regulations are more central than others to those performing hot work. This applies to the Fire and Explosion Prevention Act, the Working Environment Act, the Internal Control Regulations, the Regulations related to fire prevention and the Regulations on the performance of work. A summary of their most important contents follows below.

The Working Environment Act

One of the most important purposes of this act is to ensure a safe working environment for employees. The act requires that systematic health, safety and environmental work be carried out at all levels within an organisation.

Systematic HSE work requires participation from both the employer and the employee.

The employee is to be made aware of the hazards and risks to health that may be involved in the work. In order to prevent accidents and injuries, the employer must ensure that the employee receives the necessary training, practice and instruction.

If the work may involve particular risk to life and health, dedicated instructions must be prepared of how the work is to be carried out, outlining the safety measures that should be implemented.

The Fire and Explosion Prevention Act

The Fire and Explosion Prevention Act states that everyone has an obligation to show due diligence and help prevent fire, explosions and other

accidents. All those who are close to a fire, explosion or other accident have an obligation to do what they can to limit its harmful effects.

Employees must carry out their tasks in accordance with the safety provisions in prevailing laws, regulations and internal procedures. In this way, employees can prevent fires, explosions and other accidents and actively help to promote safety in the organisation.

Regulations related to fire prevention

The regulations related to prevention include requirements for preventive measures when carrying out hot work. Persons performing hot work in a temporary workplace must exercise particular care. Before work begins, measures to prevent fire must be taken. Measures must also be taken to ensure that any fires can be extinguished.

Regulations on the performance of work

The purpose of the regulations is to ensure that the work is performed and that work equipment is used in a proper manner, to safeguard employees' health and lives. The regulations include requirements for hot work, risk assessments, documented expertise and working in tanks/confined spaces.

The Internal Control Regulations

According to the internal control regulations, each organisation must identify the risks of undesirable incidents relating to health, safety and the environment. Should any such risks be revealed, a risk assessment must be carried out. The result of such a risk assessment determines whether any plans and measures must be prepared and implemented in order to reduce the likelihood and consequences of any undesirable incidents. The risk identification, assessment and measures must be documented in writing. The employer is responsible for implementing and carrying out internal controls. This work is to be carried out in collaboration with the employee.

When multiple organisations are working in the same workplace, it will be necessary to coordinate the internal control. A written agreement must be prepared to clarify who is responsible for the coordination.

The internal control of the party performing the work is a key part of the coordination. This means that the employer/client must consider the risk that arises when people perform activities at the employer/client's site. The employer/client must provide information about common rules etc., and must check that any deficiencies found during its own internal controls or those of the party performing the work are corrected and any necessary adaptations made.

The complete texts of the laws and regulations can be found at www.lovdata.no (in Norwegian, with some documents translated into English).

Violations of public regulations

The building owner, the employer/client and the party performing the work are jointly responsible for ensuring that hot work is performed in a safe manner that will not start fires. If hot work is performed in a manner contrary to the applicable legal requirements and injury or damage occurs, the building owner, the employer/client and the party performing the work could incur criminal liability.

The provisions on criminal liability are specified in many laws. Criminal liability can be incurred if laws or regulations are broken. Contravention of the provisions in legislation may be punishable by fine or imprisonment. The party that acted in contravention may also incur civil liability.

Insurance company requirements

The Agreements Contracts Act gives insurance companies the opportunity to create their own safety and security regulations related to insurance contracts. These make specific requirements of policyholders regarding actions to take to prioritise safety.

Act relating to insurance contracts of 16 June 1989, Section 1–2. (definitions)
(e) safety and security regulation: a requirement in the insurance contract that:

(1) the Insured must arrange for certain devices or take certain steps of a nature to prevent or limit damage and/or injury,
(2) the Insured or others, when using, storing or maintaining the object insured must hold certain qualifications or certificates,
(3) the Insured or others, when using, storing or maintaining the object insured must proceed according to certain specified routines.

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Adopted by Finans Norge Forsikringsdrift, 5 June 2023

Safety regulations for the performance of hot work

The insurance industry has prepared its own safety regulations for hot work in connection with general insurance and liability insurance.

Most buildings and machinery are covered by insurance that also covers fire. The insurance contract includes the safety regulations for hot work.

The party performing the work will normally also have liability insurance. Liability insurance contracts include the same safety regulations for hot work.

The safety regulations consist of five parts:

1. Definition
2. Where do these safety regulations apply?
3. Agreements with external tradespeople/contractors
4. Security requirements
5. Work on roofs

Certificate for the performance of hot work

Section 4.6 of the safety regulations states that both the fire watch and the party performing the hot work must have valid certificates for the performance of hot work. The certificates must be issued by the Norwegian Fire Protection Association or one of the partner organisations in the other Nordic countries. Certificates are awarded on completion of a dedicated certification course led by an instructor approved by the Norwegian Fire Protection Association.

The certification course includes theory training and practical exercises in extinguishing fires, and concludes with a written exam. A certificate is issued to persons who have completed the course and passed the exam. The certificate must be renewed every five years.

Sweden, Finland and Denmark have similar certification schemes. The Norwegian certificate is also valid in Finland and Denmark.

You can find more about the certification scheme in the Nordic region at www.brannvernforeningen.no

Agreements with external tradespeople/contractors

If hot work is to be performed by an external tradesperson/contractor, the insured party must ensure that the requirements of the safety regulations are included in a written agreement with the external tradesperson/contractor.

Trade categories

Many tradespeople in various trades perform hot work. The safety regulations for hot work apply to almost all of these, but there are some exceptions. You can find a list of exceptions on the Norwegian Fire Protection Association's website: www.brannvernforeningen.no

Violation of insurance companies' requirements

If hot work is performed in a manner that contravenes the insurance company's safety regulations, this is to be considered a breach of the insurance contract. In the event of injury or damage caused by fire due to a breach of the safety regulations, the insured risks the insurance company refusing to pay out part or all of the payment. For the insurance company to reduce the amount of the payment, it must demonstrate a causal connection between the breach of the safety regulations and the injury or damage. This is a requirement specified by the Insurance Contracts Act.

The payment can be reduced, for example, if the fire started because the person performing the work:

- did not follow the safety regulations
- did not possess the knowledge required for the certificate
- had the knowledge, but did not employ it.

Cases of damage or injury in connection with fire may result in legal proceedings under civil law. This will mainly be in situations where the insurance companies involved do not agree on liability. In such cases the employer/client, the party performing the work and others who can shed light on the case will be summoned as witnesses.

3

Fire theory

Knowledge is an important prerequisite for preventing fire. In order for people performing hot work to be able to do the job in a safe manner that will not start fire, it is important to understand how fires start.

> **Fire is defined as an undesirable or uncontrolled combustion process characterised by the release of heat accompanied by smoke, flame or glowing embers.**

The fire triangle

There are three conditions that must be met for a fire to start and for a combustion process to continue. These three factors together form the "fire triangle".

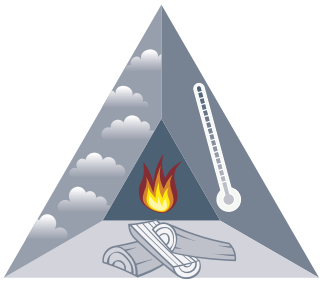


Figure 1: The fire triangle.

1. fuel
2. heat
3. oxygen

In our daily lives we are surrounded by combustible materials (fuel), oxygen and heat, without fires necessarily starting. This is because the components do not exist in the quantities or values necessary for them to react with each other. For a fire to occur, the combustible material must be of a sufficiently high temperature and there must simultaneously be a sufficient supply of oxygen. Only then can a chain reaction occur in the form of a fire.

1. Fuel

Almost all materials can catch fire if the temperature is high enough. Fuel can be in solid, liquid or gas form.

Examples of flammable and combustible materials:

- wood
- building insulation (e.g. plastic and cellulose insulation)
- insulated cables
- packaging and other combustible waste
- work clothes
- furniture
- propane
- petrol

2. Heat

All flammable or combustible materials start to burn at a particular temperature. This temperature differs from material to material.

During the performance of hot work, sufficiently high temperatures are reached to start a fire.

Examples of heat sources that can start fires:

- flames from a propane burner
- sparks from an angle grinder
- heat from a hot air pistol

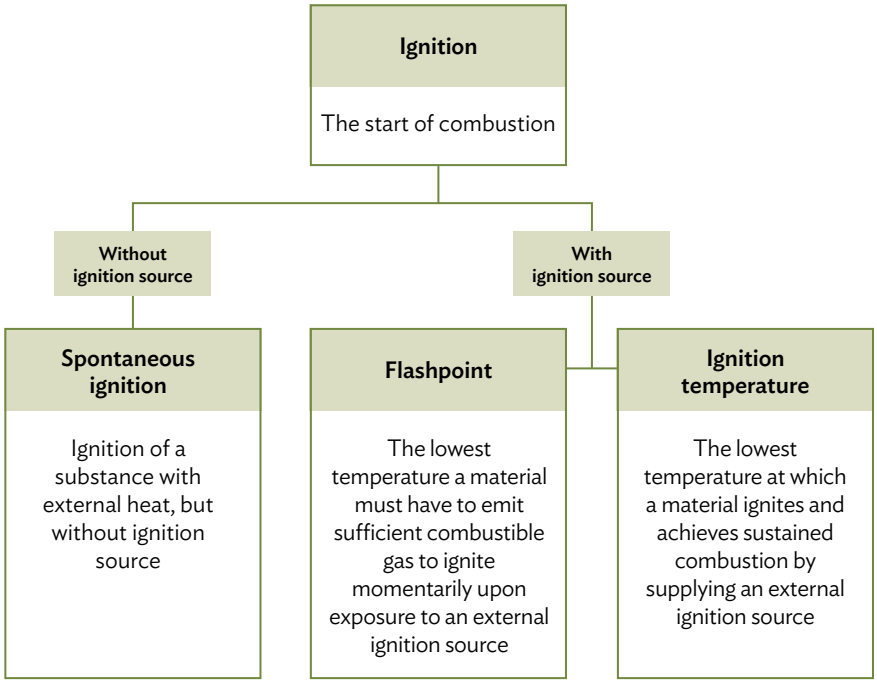
Open flames are not required to start a fire. Sparks can cause a smouldering fire, which can become a flaming fire long after the hot work has been concluded.

3. Oxygen

There is sufficient oxygen in air that, in combination with equipment that produces heat, fires can start in flammable or combustible materials. Normally, air contains 21 per cent oxygen. The amount of oxygen in the environment will affect how high the temperature must be for the material to ignite. At the same time, the need for oxygen will decrease as materials heat up. Accordingly, heated materials will ignite more easily than cold materials.

Ignition

In order for fire to start in a material, there must be a supply of heat. When a flammable or combustible material achieves a sufficiently high temperature, the material could ignite. Ignition may occur with or without a source of ignition. The following ignition mechanisms apply in connection with hot work.



Ignition without ignition source

Spontaneous ignition

Spontaneous ignition is when a material ignites without an ignition source.

An example of spontaneous ignition is when there is a major fire in one building and the radiant heat from the fire hits the neighbouring building which eventually ignites. Another example is the heating of combustible liquid to spontaneous ignition temperature, which we see when, for example, frying oil ignites when it is heated.

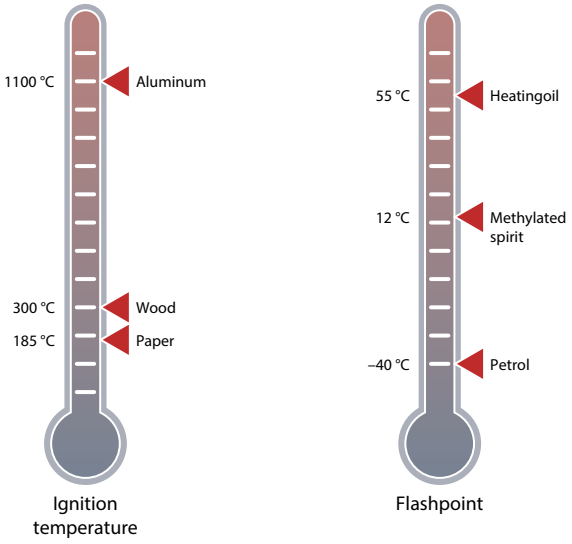
Ignition with ignition source

Flashpoint

When there is a fire in a material, it is in fact the gases released that burn and not the material itself. Flammable and combustible materials release flammable gases at different temperatures. Therefore the materials have different flashpoints. The flashpoint is the lowest temperature required for combustible material to emit sufficient combustible gas to ignite immediately when exposed to flame. For example, the flashpoint of petrol is -40 °C, whereas heating oil has a flashpoint of 55 °C. Flashpoint is most often used when talking about liquids, but it also applies to solids.

Ignition temperature

The ignition temperature is the lowest temperature needed for a material to ignite and continue to burn. The ignition temperature of wood, paper and textiles is between 200 and 400 °C. For example, a hot air pistol can produce enough heat for wood to self-ignite.



■ Figure 2: Ignition temperature and flashpoint

Petrol and methylated spirits are examples of liquids with a low flashpoint. Waste material such as cotton waste, cloths and paper towels that contains residues of such liquids is very highly combustible. Hot work must therefore not be performed in proximity to such waste.

Heat transfer

The transfer of heat always takes place from a hot area to a cold area.

Heat can be spread in three different ways:

- conduction
- radiation
- convection

All three ways of heat transfer can lead to fire. It is important that people performing hot work are conscious of this.

Conduction

Heat conduction takes place when heat is spread in solid materials. Certain metals, for instance copper and steel, are very good at conducting heat.

When highly conductive materials are heated up in connection with hot work, such materials can cause a fire if they come into contact with flammable or combustible materials.

For example, heat conduction can cause a fire when reinforcement bars, steel pipes, ventilation ducts or similar conduct large amounts of energy to flammable or combustible materials.

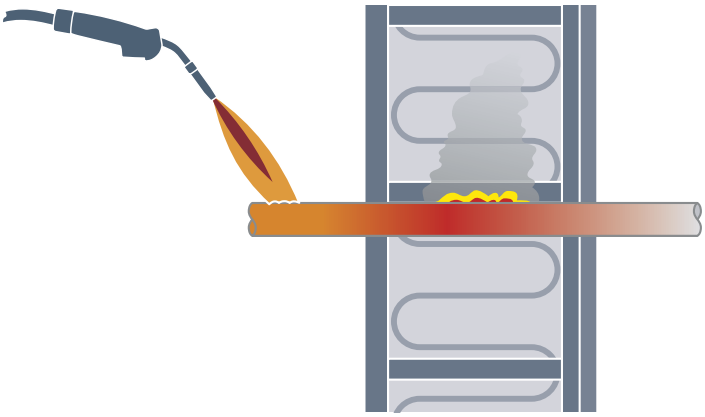


Figure 3: Heat conduction along metal pipe to combustible material in a construction.

Heat conduction can lead to the ignition of flammable or combustible materials in a completely different place from where the hot work is being performed. For example, a fire may start as the result of heat conduction to combustible materials hidden in a building construction. Such a fire can develop slowly and is difficult to spot.

Radiation

Heat radiation takes place when heat is spread by means of infrared radiation from hot surfaces to cold surfaces. The radiated heat helps to pre-heat surfaces. As a result, the surfaces are more likely to ignite.

If a metal construction is heated up to a temperature of several hundred degrees, highly combustible materials in the vicinity of the construction may ignite due to heat radiation. Direct contact between the construction and the highly combustible materials is not needed.

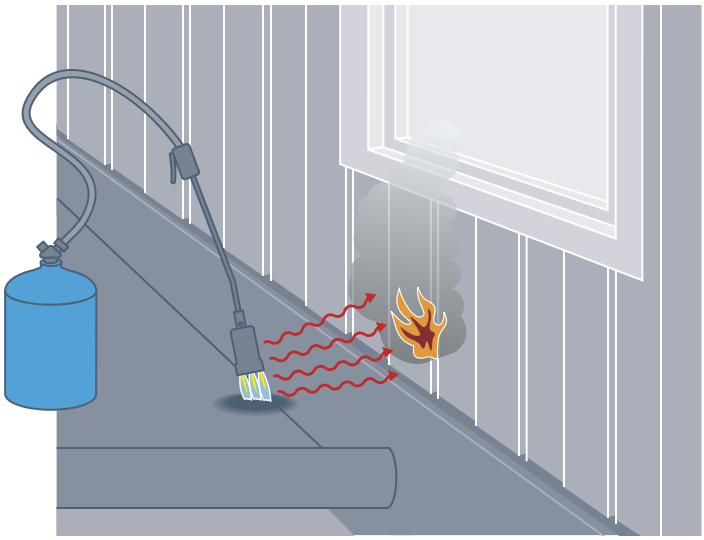


Figure 4: Radiation from a propane burner to combustible materials.

Convection

Hot gases and liquids spread heat by convection. Hot gases rise because they are lighter (less dense) than colder gases. The gas emits heat to the cold surfaces on the way up. Hot liquids flow over surfaces and release heat. This is known as thermal updraft, natural convection or free convection.

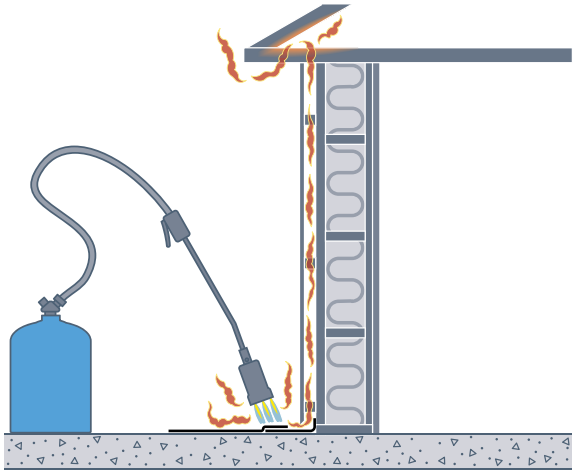


Figure 5: Convection of hot gases into a cavity, towards combustible materials

Forced convection takes place when gases and liquids start moving due to an external force. This force can be provided by a pump or a fan, for example.

A hot air pistol works in accordance with the principle of forced convection. Air passes the filaments, is heated and then streams out of the nozzle. The air can be hot enough to ignite flammable or combustible materials.

Transfer by hot particles

Heat transfer by hot particles is also a risk involved in the performance of hot works.

> **Welding, cutting and grinding create a shower of sparks. These hot particles can ignite flammable or combustible materials well away from the workplace itself.**

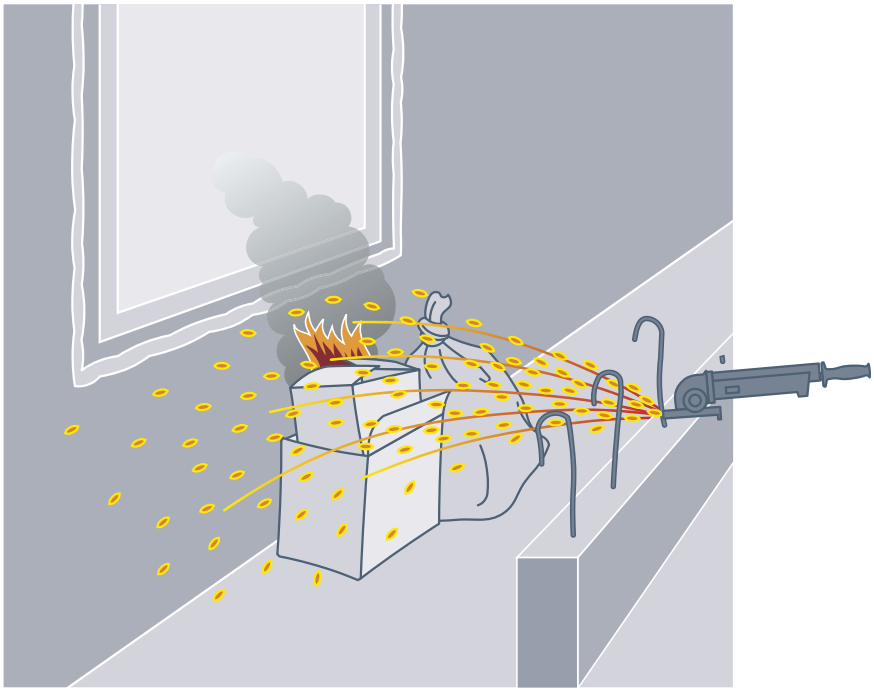


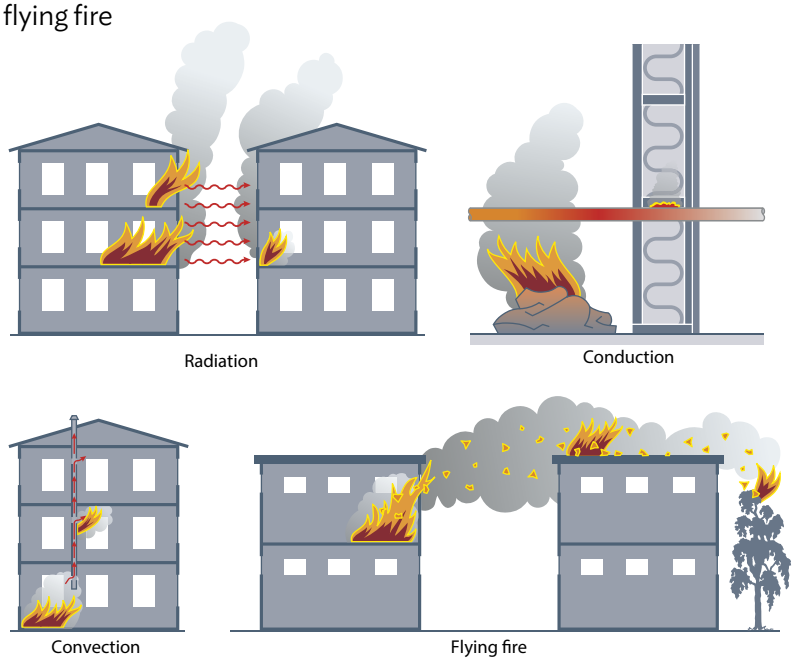
Figure 6: Shower of sparks towards combustible material

Fire propagation

Fire propagation is a concept that is used to describe what happens when one fire causes another fire. Fire propagation occurs on the basis of the same three principles described in the section “Heat transfer”, plus there is also the phenomenon of flying fire. The difference with fire propagation is that it is the fire itself that creates the heat, and not the equipment being used for hot work.

Fire propagation can take place in four ways:

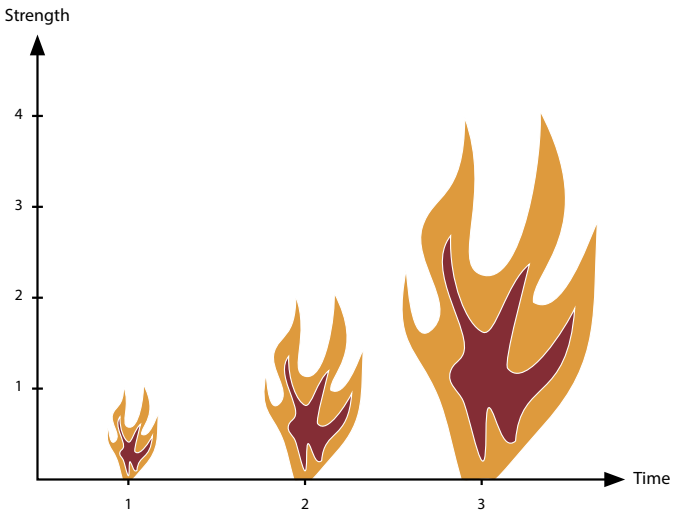
- conduction
- radiation
- convection
- flying fire



■ Figure 7: Different types of fire propagation

Growth of fire

A flaming fire with unlimited access to fuel (flammable or combustible materials) and oxygen will grow in strength in accordance with the "doubling principle": The strength of the fire doubles at fixed time intervals. For example, the strength of a small fire will double after one minute, and will be four times as great after two minutes.



■ Figure 8: Illustration of the growth of fire in accordance with the "doubling principle".

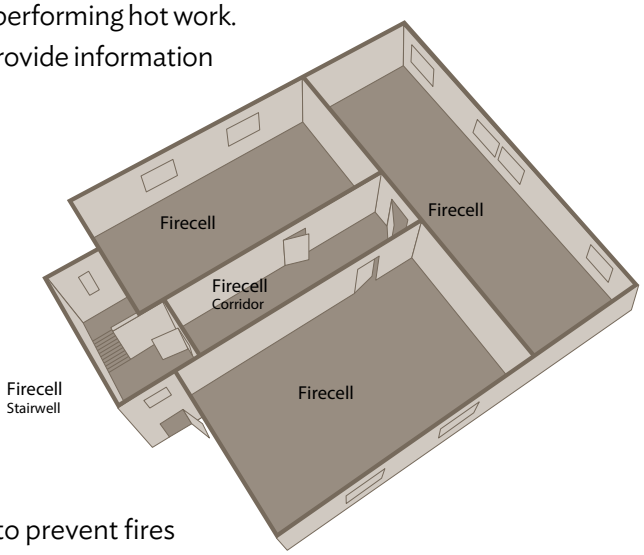
Firebreaks

The purpose of a firebreak is to delay or prevent the propagation of fire. Firebreaks are used to divide up a building into different areas so that it is harder for a fire that starts in one area to spread to other areas within a certain period of time.

Firebreaks in the building could affect the safety considerations that must be taken into account when performing hot work. The building owner should be able to provide information about firebreaks in the building.

Fire cells

The purpose of dividing buildings into fire cells is to prevent fire and smoke spreading to large areas of the building during the time considered necessary for evacuation.



Fire compartments

The purpose of compartment walls is to prevent fires spreading from one section to another. The point of creating fire compartments in buildings is to avoid large fires, make evacuation easier, and to give the Fire Service better firefighting options. Compartment walls are solid, normally brick-built or cast constructions.

In order for firebreaks to work as intended, they must be intact and impermeable. For example, ducts and openings must be sealed and doors closed.

4

Extinguishing fires

The chapter on fire theory described three conditions that must be fulfilled in order for a fire to start. The conditions **fuel**, **heat** and **oxygen** make up what is known as the fire triangle.

Fire extinguishing methods

Fires can be extinguished in the following ways:

- by removing the supply of oxygen
- by reducing the temperature
- by removing the fuel (flammable/combustible materials)
- by adding chemical substances that break the chain reaction in the combustion process

The choice of the best method and extinguishing agent depends on the material that is burning.

The most commonly used extinguishing agents are water, foam, powder and extinguishing gas (CO_2).

Water

When water comes into contact with fire, the water evaporates. The evaporation steals energy from the fire, and therefore has a cooling effect. Water vapour also has a smothering effect, as it displaces oxygen.

Water is the most commonly used extinguishing agent. It is well suited for extinguishing fires in solid materials such as paper, wood and textiles.

> **Extinguishing with a dispersed stream of water gives a better result than extinguishing with a concentrated stream of water. A dispersed stream produces small droplets that evaporate easily. The change from water to water vapour requires a lot of energy, which is taken from the fire, thereby reducing its strength.**

Water must never be used on high-voltage electrical equipment due to the risk of shock. However, water can be used on electrical equipment with a voltage of 220 V or 400 V.

Water must not be used on burning fat, oil or other liquids, as it causes the fire to develop explosively.

Foam

Extinguishing foam has the same extinguishing qualities as water. This extinguishing agent has a cooling and smothering effect on fire.

However, unlike water, extinguishing foam is also well suited for extinguishing fires in liquids. Because the foam settles on the surface of the liquid, it prevents the evaporation of flammable gas. It also blocks the supply of oxygen.

Powder

Extinguishing with powder breaks the chemical chain reaction in the fire. When the powder is heated up, a gas is given off that smothers the fire and inhibits the reaction.

Powder is suitable for extinguishing fires in most materials.

It is difficult to extinguish flameless (glowing) fires with powder, and if the embers regain access to oxygen the fire can flare up again. Therefore, powder should be used in combination with an extinguishing agent that reduces the temperature of the burning material, e.g. water.

Extinguishing gas (CO_2)

Carbon dioxide displaces oxygen and has a smothering effect on the fire. CO_2 is a gas that is suitable for extinguishing flaming fires where there are no glowing embers. For instance, this extinguishing agent is used on fires in liquids and in electrical equipment.

CO_2 is not well suited for extinguishing fires outdoors, as draughts and wind can blow the gas away from the fire.

The extinguishing agent does not have a sufficient cooling effect to extinguish glowing embers. The fire can therefore flare up again if it has access to oxygen.

Table 1: Extinguishing agents and their means of operation

Extinguishing agent	Means of operation
Water	Cools and smothers
Foam	Cools and smothers
Powder	Smothers and breaks the chain reaction
CO_2	Smothers (cools certain materials)

Extinguishing equipment

Manual fire extinguishing equipment relevant to the performance of hot work includes hand-held fire extinguishers and fire hoses.

The safety regulations for hot work say the following on the requirement for extinguishing equipment:

"Suitable extinguishing equipment in proper condition, minimum 2 pcs. 6 kg/litre portable extinguishers must be easily accessible. One portable fire extinguisher may be substituted with a fire hose with water turned on up to the nozzle."

The choice of suitable extinguishing equipment must be part of the risk assessment that must be carried out before the hot work starts. You can read more on risk assessments and choice of extinguishing agent in chapter 6.

All hand-held extinguishers to be sold in Norway must be approved. Hand-held extinguishers are marked with letters to indicate the class of extinguisher. The classes indicate which materials the extinguishing agent is best suited for.

Class A: for use with fires involving organic solids such as wood, paper, textiles, etc.
Class B: for use with fires involving flammable or combustible liquids such as petrol, oil, varnish, paint, etc.
Class C: for use with fires involving pure flammable gases such as propane, butane, methane, etc.
Class D: for use with fires involving combustible metals (rarely used)
Class F: for use with fires involving cooking fat and oil

Hand-held extinguishers suitable for use with fires involving electrical equipment were previously marked as Class E. This class has been discontinued. An extinguisher's suitability or limits of use or prohibitions against the use of extinguishers in connection with fires involving electrical equipment are now stated in a declaration on the extinguisher.

Hand-held powder extinguishers are marked "ABC". There are also some older powder extinguishers still in use marked "ABE". Even though the marking is different, an ABE extinguisher has the same uses as an ABC extinguisher.

■ **Table 2**: Extinguishing agents and classes

Extinguishing agent	Class	Material
Water	A	Organic solids
Foam	AB	Organic solids; liquids
Powder	ABC/BC	Organic solids; liquids and gases
CO_2	B	Liquids

Extinguisher rating

Extinguisher rating, or extinguisher class, is a measure of the size of a fire that a hand-held fire extinguisher can extinguish in:

A – organic solids
B – liquids

The number preceding the letter indicates the fire extinguisher's rating. The higher the number, the better the rating and the greater the output.

Checking, inspection and maintenance of extinguishing equipment

The fire regulations set requirements for regular checking, inspection and maintenance of extinguishing equipment. Checking and maintenance must be carried out by an individual or company with specialised expertise in the field. All checks and maintenance must be documented.

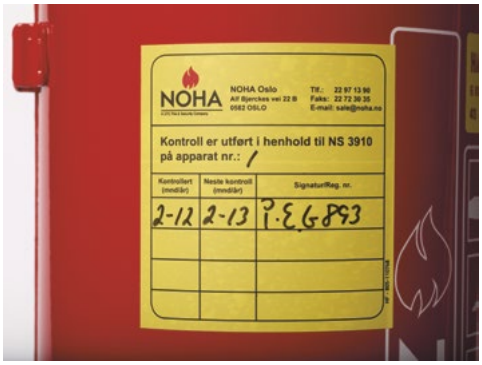
The word "inspection" refers to simple self-checks.

■ Here is a useful checklist for the inspection of hand-held extinguishers:

- The arrow in the pressure indicator must point to the green area.
- The seal must be intact.
- There must be no external damage to the extinguisher.
- The hose must be intact and without cracks.
- The nozzle of the hose must not be blocked.

■ **Table 3**: Intervals for checking, inspection and maintenance of extinguishing equipment.

Extinguishing equipment	Checking	Inspection	Maintenance/service
Water, foam	at least every 3 months	annually	every 5 years
Powder	at least every 3 months	annually	every 10 years
CO_2	at least every 3 months	annually	every 10 years



■ Hand-held extinguishers must be checked by an approved individual. All checks must be documented.

Practice

To prevent a small fire developing into a large fire, the fire must be rapidly and effectively extinguished. In order to do this, one must have tested the extinguishing equipment in advance and must know its effect on a fire. Therefore, fire extinguisher drills are vital.

■ All approved hand-held extinguishers are marked with simple instructions for use. These usually include the following points:

1. Remove the pin
2. Aim the nozzle at the base of the fire
3. Squeeze the trigger

Be aware that a hand-held extinguisher will be used up quite quickly: an extinguisher containing 6 kg of powder will normally be exhausted after 14–18 seconds.

Extinguishing gas fires

During hot work, fires can start in gases leaking from gas cylinders or from the equipment. If possible, close the cylinder valve immediately to stop the gas flow. This action will remove the flammable gas and the fire will go out. The shut-off valve may be hot. Therefore, it is important to wear heat-resistant gloves.

In some cases the extreme heat may make it difficult to approach the cylinder in order to close the valve. The alternative is to allow the flame to burn out, provided that doing so does not risk the fire spreading or an explosion. In such a situation, the area must be evacuated and the Fire Service notified.

If there is a danger of the fire spreading, the flame can be extinguished using a powder extinguisher, but then it is important that the valve is

closed immediately to prevent a gas leak. If the leakage of gas cannot be stopped, the area must be evacuated and the Fire Service contacted due to the high risk of explosion.

Extinguishing fires in clothing

If a person's clothing catches fire, it is vital to act quickly to prevent serious burn injuries. To prevent burns to the head and face, the person must be laid down. Water has a cooling and smothering effect, and is well suited as an extinguishing agent for fires in clothing. Therefore, use water to extinguish the fire if it is readily available. Otherwise, a powder extinguisher can be used. A third option is to smother the fire, for example with a fire blanket or a work jacket – first from the neck and then downwards over the body. Be careful to ensure that there are no remaining air pockets around the armpits and crotch area. Ensure that any burn injuries are quickly attended to and cooled.

In the event of fires in clothing it is important to remember the following:

- **Lay the person down horizontally.**
- **Then extinguish the fire in the clothing.**
- **Cool down any burn injuries.**

5

Dangers of hot work

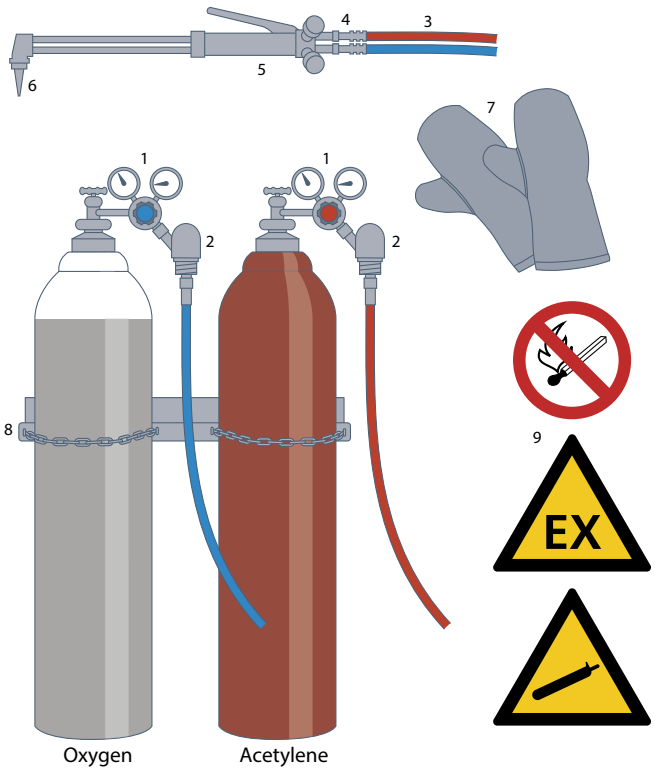
Both the tools used and the way the work is performed can cause fire or explosion. It is therefore vital that the person performing the work is aware of the dangers associated with the various tools and types of work.

Gas

Hot work involving gases has resulted in fires and explosions involving personal injury. Accidents are often due to improper use and handling of the equipment, but also to lack of maintenance and inspections. All the equipment to be used in connection with the use of gas should be set up safely in accordance with the supplier's specifications. Always use hoses and equipment that are approved for the gas to be used.

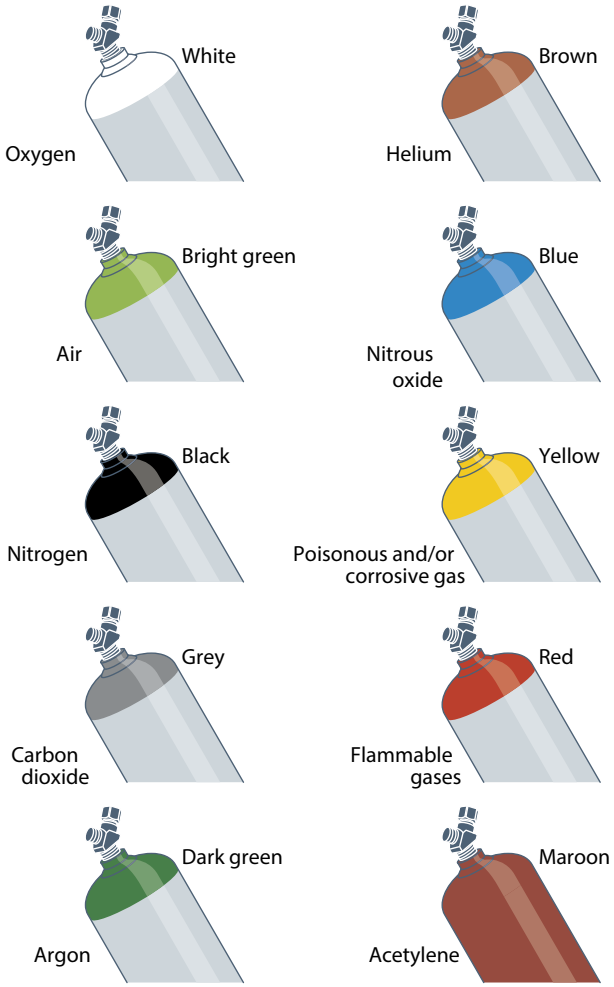
Correctly set-up gas welding and gas cutting equipment should appear as follows:

1. regulator
2. flashback arrestors
3. gas hose
4. check valves on torch handle
5. gasket between handle and torch
6. nozzle
7. protective flame-resistant gloves
8. tether to prevent the cylinder from falling
9. warning signs



Colour codes

The "shoulders" of gas cylinders are colour-coded to indicate the properties of the gases they contain. The rest of the cylinder may be of various colours, depending on the supplier.



Handling and storage of gas cylinders

Gas cylinders must be handled with caution and must not be thrown, tipped over or exposed to shocks or jolts.

Gas cylinders must be stored, kept and transported upright. The cylinders must be tethered to prevent them from falling, for instance with a properly secured chain. It is important that the tethering device can be easily removed so that the cylinders can be quickly moved in the event of a fire. Any storage place for gas cylinders should be well marked. Doors leading into areas where gas is stored should be marked with a yellow warning sign that reads "Gass under trykk" ("Compressed gas").

Important points to remember about the storage of gas cylinders:

- when storing gas, a risk assessment must be carried out by a competent person
- gas cylinders should preferably be stored outdoors
- any indoor storage should be in a dry, tidy, well-ventilated room free from combustible or flammable materials
- flammable gases must be stored in their own fire cell
- the gas cylinders must be stored so that they are easily accessible and easily evacuated in the event of a fire
- underground storage of flammable gas heavier than air is prohibited
- gas cylinders must be protected against abnormal heating and not exposed to temperatures higher than 45 °C
- cylinders containing condensed or dissolved gases must be protected from direct sunlight
- cylinders containing condensed or dissolved gases must be kept upright
- full and empty cylinders should be stored separately
- the distance between oxygen cylinders and cylinders containing flammable gases must be at least 5 m

Gas leaks

Gas leaks are most often caused by faults in or damage to valves, fittings, hoses or pipes. A tightness check of the equipment should be carried out at regular intervals, and always when changing cylinders. Gas leaks can be spotted by means of gas measurements. Some types of gas have special

odours added so that leakages can be smelt. A leakage test can also be carried out by brushing concentrated soapy water on hoses and pipe connections – bubbles will appear where there is a leak. If it is not possible to stop the leak by closing the cylinder valve, the simplest solution is to allow the cylinder to empty itself in a location where the leaked gas cannot cause any harm. In such a case, be aware of the gas's characteristics. Flammable gases that are heavier than air will stream down into depressions; the gas can then remain over time, constituting an explosion risk.

Maintenance

Gas equipment to be used in connection with hot work must be regularly serviced and checked in accordance with the supplier's instructions. All equipment must be in good, sound condition so that it will not present a risk of accident during use. Fittings and hoses should be checked for leaks before use.

Propane

Propane is a gas that is highly flammable and explosive. The gas is often used in the performance of hot work, for instance for roofing, brazing and welding.

Propane is a liquid (condensed) when it is stored in containers or gas cylinders. When the valve on the cylinder is opened, the liquid boils and gas is released. Propane itself is odourless, but an odour is added to it so that leaks can be detected. Propane is heavier than air, and it will naturally find low-lying areas. When mixed with air, the gas is violently explosive and can ignite very easily.

All propane cylinders over a certain size are equipped with safety valves. The safety valve should prevent any abnormal pressure increase in the cylinder from causing it to burst. The cylinders must be kept in an upright position to allow the safety valve to function correctly.

If the cylinder is substantially heated, the pressure in the cylinder can become high enough to cause the safety valve to open. If there is a heat source nearby, the released gas will be ignited. Should a fire occur in gas released from the safety valve of a propane cylinder, the fire should be allowed to burn itself out. The fact that the gas is burning under controlled conditions prevents the gas from leaking to areas where it could explode. If there is a fire involving propane leaking from a cylinder, it is important to cool the surrounding area. Once the gas pressure has returned to a normal level, the safety valve will close and the fire will go out.

Small disposable containers do not have a safety valve and, in the worst case, will explode in a fire.

Important things to remember when using propane:

- propane cylinders should always be kept standing upright
- propane cylinders should not be exposed to strong heat
- propane is heavier than air
- leaks of even small amounts of propane present a major explosion risk

Oxygen

Oxygen in gas cylinders is compressed, colourless and odourless. Although not itself flammable, oxygen has a unique position in connection with ignition and fire. There are oxygen cylinders where an odour is added to the oxygen so that leaks can be more easily detected.

> **Air normally contains 21 per cent oxygen by volume. Even a small increase of the oxygen content, to 25 per cent, results in a considerable increase in the ignitability of combustible materials, such as work clothing. In pure oxygen, a number of metals and other substances that do not normally ignite in air can burn. The danger of ignition is particularly high in the event of contact with lubricants such as oil, grease or organic gasket materials.**

Oxygen to be used in connection with hot work is stored in steel cylinders under high pressure. If exposed to strong heat, the pressure in the cylinder will increase, which can lead to the cylinder rupturing. The risk can be reduced by cooling the cylinder as rapidly as possible.

Important things to remember when using oxygen:

- use only fittings that are free of oil or grease and that are specially designed and labelled for oxygen
- cylinder valves should be opened gradually and carefully, and only once checks have been carried out to ensure that there is no contamination or foreign bodies present
- never use oxygen instead of compressed air
- use only gaskets, sealants and lubricants specially approved for use with oxygen
- do not use any work clothing or tools that are contaminated with oil or grease
- oxygen must never be used to blow clean work clothing

> **Grease and oil should never be used to lubricate valve fittings on oxygen cylinders. If oxygen comes into contact with grease or oil, this can lead to spontaneous ignition.**

Acetylene

Acetylene is a highly flammable and explosive gas that is used for welding and cutting. Acetylene produces the hottest flame of all fuel gases when it burns together with oxygen. When mixed with air the gas is highly explosive. The gas has a characteristic odour of garlic. Acetylene gas is stored in the container dissolved in acetone. The gas is stored in small cell structures in a substance known as Agamassan.

Important things to remember when using acetylene:

- acetylene cylinders must always be used standing upright, or in a gently sloping position, in order to prevent the acetone escaping
- use only equipment and materials approved for acetylene
- the valve must not be opened without a pressure regulator fitted
- the working pressure should never exceed that recommended by the supplier

If an acetylene cylinder is exposed to heat or flashback through the hose, the acetylene may decompose inside the cylinder, resulting in the pressure and temperature increasing. The cylinder will then rupture or explode if it is not cooled down. The signs of decomposition are local heating in the cylinder.

On suspicion of decomposition:

- close the cylinder valve immediately
- move the cylinder out into the open air
- evacuate the area
- call the Fire Service on 110

Equipment

Equipment used to perform hot work can start fires because of the sparks or strong heat they produce. As different equipment spreads heat in different ways, there are different risks associated with the use of the equipment. Remember that the equipment must always be used in accordance with the usage instructions.

Burners with open flames

When using burners with open flames, very high temperatures are reached. Fires can easily start as a result of the flames coming into direct contact with combustible materials. The high temperature of the flame can also cause fires by heat transfer or due to a particular point being strongly heated.

Burners with open flames must be used with extreme care.

Equipment with open flames includes:

- Propane burners
- Gas welding equipment
- Cutting torches

■ Propane burners with open flames are often used during roofing on non-combustible materials.

Hot air

Hot air equipment generates sufficiently high temperatures during use for combustible materials to ignite. Fires can start as a result of the hot air coming into contact with the material over a period of time, or as a result of heat transfer.

Hot air has a lower temperature than open flames. Hot air equipment can be a good alternative in cases where open flames constitute too great a risk or are forbidden.

Hot air equipment includes:

- hot air pistols
- hot air welding equipment

■ Hot air pistols generate enough heat to ignite combustible materials.

Burners with shielded combustion – hot air

Hot air created through the combustion of gas in a shielded chamber develops much higher temperatures than a hot air pistol. Even so, there is a lower risk of fire connected with the use of such equipment than when using open flames. Heating a particular spot for a long period of time can lead to fire. A burner with shielded combustion produces large amounts of carbon dioxide (CO_2) in the area around the heated material. The CO_2 gas reduces the likelihood of fire. Once the burner has been moved away, oxygen takes the place of the carbon dioxide, which means that the heated material may ignite.

Burners with shielded combustion may include:

- specialist roofing equipment

■ A hand-held hot air welder, for use in roofing operations, is an example of a burner with shielded combustion.

Burners with a shielded and hidden flame

Some tools, such as weed burners, have a shielded flame for heating a limited area. The shielding is intended to concentrate the open flame on the areas to be heated. When used in the vicinity of flammable or combustible material, this poses a risk of fire.

In the roofing industry, equipment known as concealed flame has been developed. This means that the combustion process (flames) occurs within a nozzle, with heat and combustion gases heating the roofing material. Experience suggests that flare-ups can occur from the nozzle. This can pose a fire hazard.

■ Angle cutters produce a shower of sparks that can ignite combustible materials, even a good distance from the workplace.

Angle grinders and angle cutters

Angle grinders and angle cutters generate a heavy shower of sparks during use. Such sparks maintain a very high temperature and can ignite combustible materials a considerable distance from the workplace. Due to conduction, the material the work is being performed on can become so hot that fire can start.

Electric welding

Fires caused by electric welding most often start because of a poor contact in the electrical connections. This is normally the result of poorly maintained equipment or dirty contact surfaces. Moreover, due to conduction the material being welded can become so hot that fires start.

To avoid injury or damage caused by fire during electrical welding, the person performing the work must ensure that:

- the workplace is dry
- flameproof work clothing is worn
- the protective gloves are in good condition

Alternative methods

Before work begins, an assessment should always be made as to whether alternative methods to hot work can be used. In many cases it will be possible to use “cold” working methods for all or part of the work.

New equipment that produces no heat, or less heat compared to traditional equipment used for hot work, is constantly being developed.

Alternative methods and equipment include:

- bolt cutters
- bayonet saws
- hacksaws
- pipe cutters
- pressure connectors

■ Roofing operations using an open flame in proximity to combustible wooden constructions and combustible waste is in contravention of the safety regulations.

Hot work on roofs

Carrying out hot work on roofs has caused major fire damage to buildings on many occasions. The risk of fire during hot work on roofs is partly attributable to the extensive use of open flames. Moreover, hidden cavities and combustible materials can be present in constructions close to the workplace.

Methods for performing hot work on roofs

There are three ways to perform hot work on roofs:

1. roofing using an open and hidden flame
2. roofing using hot air
3. roofing using hot bitumen

A risk assessment must be conducted before roofing work begins. The risk assessment should document how roofing is to be carried out safely and fireproof. The documentation should, for example, address the type of roof to be covered, roofing method, insulation solution, covering of flammable materials in insulation solutions, and constructions. The risk assessment should also include a description of the distance to flammable insulation and roofing materials stored on the roof, as well as the location where roofing is taking place.

1. Open and hidden flames

A gas burner is used when roofing using an open flame. The gas burner can produce long flames, and must be used with caution. Fires can easily start in proximity to combustible materials, cavities, ducts and so on.

The safety regulations for the performance of hot work prohibit the use of open and hidden flames on lined and ventilated wooden roofs.

On compact roofs, open flame is allowed if flammable insulation is adequately protected with non-flammable insulation or materials that provide equivalent protection. When using open flame, there should be a sufficient safety distance to parapets, cornices, penetrations, drains, and similar elements made of flammable materials.

An open flame can be used on compact roofs without a safety distance if there are NO flammable or combustible materials in the parapet, cornice, ducts, rainwater outlets, etc. It is therefore a prerequisite that the construction, including insulation, be completely non-combustible.

The condition described for open flame also applies where roofing is done with concealed flame.

2. Hot air

Roofing using hot air is a method that is much less likely to cause a fire than using an open flame. In hot air equipment used for roofing, combustion of gas and air takes place in a shielded chamber. The combustion produces a hot gas low in oxygen.

Despite this, there is still a risk of fire due to the use of hot air. When heat from combusting gas is removed from a heated combustible material, oxygen-rich air rushes in, which can cause ignition.

When roofing with foil, an electric welding machine is mainly used, where hot air comes out of the nozzle of the welding machine. This roofing method is more fire-safe than using open/concealed flame, but the heat from the welding machine has a temperature high enough to cause ignition.

■ To avoid the use of open flames, roofing contractors have developed special hot air equipment with shielded combustion chambers.

3. Hot bitumen

Some types of roofing involve sticking the roofing material down with hot bitumen. In such cases gas-fired bitumen boilers are used to heat up the bitumen to 180–200 °C.

When using hot bitumen in connection with roofing, it is often the bitumen boiler and not the roofing itself that is the main risk.

There are two main risks that should be mentioned:
1. overheating, causing the bitumen to catch fire
2. hot bitumen spray, which can cause personal injury

The bitumen boiler should be placed on a non-combustible base (e.g. a metal vessel) that can hold at least half of the contents and is at least 30 cm wider than the boiler on all sides.

The bitumen boiler should always be placed so that overheating, tipping over or other accidents cause the least possible risk.

Positioning of bitumen boilers:

- the bitumen boiler should be supervised at all times
- the boiler should be placed on a level, non-combustible base
- all flammable and combustible materials in the vicinity of the boiler must be removed
- boilers positioned on sloping ground must be positioned at least 15 m from any flammable or combustible materials
- boilers must be positioned at least 5 m from any buildings constructed of non-combustible materials
- gas cylinders must be kept at least 5 m from the boiler

> **Water must never be used to extinguish fires in bitumen boilers.**
>
> **If water comes into contact with burning bitumen, the bitumen can be violently thrown out of the boiler.**

Known hazards of roofing

Ventilated cladding

When performing hot work on roofing, very hot air and flames can creep behind the wall cladding. As a result, windproofing and other combustible materials in the wall construction can catch fire.

Hidden cavities

There is a high risk of fire when using hot air or open flames in proximity to cavities, cornices, roof ducts or similar. Such structures can hide flammable insulation or other combustible material.

In older buildings where the insulation material is unknown, further investigations must be made. The insulation may contain wood shavings, coke, newspaper and other easily ignited materials.

When using heavier-than-air gases, unburnt gas can permeate down into the construction. The risk of this happening is particularly great when the work is being performed close to rainwater outlets or openings to cavities.

Roofing work on combustible materials

During all roofing work, the practitioner must examine whether the substrate or insulation is made of flammable material. Any cracks/openings exposing flammable insulation must be adequately protected with non-flammable insulation or non-flammable materials.

Heat conduction

Hot work in proximity to roof rainwater outlets, metal fittings or other highly heat-conductive metal constructions must be performed with

great caution. High temperatures can cause the metal to conduct heat to flammable or combustible materials and start fires.

> **During roofing work, fires can start inside constructions and can be difficult to extinguish. In some situations it may be useful to have to hand appropriate tools to dismantle the construction so that it is possible to extinguish any fire that may start.**

Hot work in or on tanks, containers and in potentially explosive areas

Extra caution must be exercised when performing hot work in confined spaces, tanks or on containers in which flammable liquids, gases or chemicals have been stored. The same applies to tanks or containers that contain dust or particles from combustible materials. Very small amounts of flammable substances can be converted to explosive gases when heated.

Any tanks or confined spaces must be well ventilated before anyone enters, and checks must always be made to ensure that the tank/space is free of gas or flammable liquid. Carry out a measurement to ensure that there is sufficient oxygen in the tank/space. Ensure ample ventilation during the work. During breaks or once work has been completed, gas-carrying hoses and equipment must be removed from the tank or space.

> **Hot work must not begin until a work certificate has been issued authorising the work. The work certificate must be signed by a competent person with special training.**

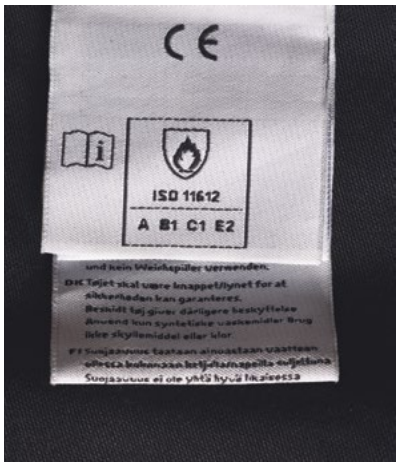
Entry guard

When performing hot work in confined spaces and tanks, there is a risk of oxygen debt and the accumulation of gas. This can constitute a risk to persons performing the work. An entry guard standing by the opening to the space or tank will be able to intervene if a hazardous situation arises.

The standby person must:

- stay by the opening to the space/tank
- observe the persons and the work
- stop the work if a hazardous situation arises
- have rescue equipment available
- have equipment for communication with other helpers
- immediately stop the work in the event of a gas meter alarm

■ A correctly dressed and equipped performer of hot work.



■ Ensure that the work clothing is marked with the symbol for flame-resistant textiles.

Protection against personal injury

Hot work can cause serious personal injury. To prevent and limit personal injuries, those performing hot work should always use personal protective equipment.

Appropriate personal protective equipment includes:

- suitable work clothing
- protective footwear
- gloves
- helmet/hard hat
- ear defenders
- protective goggles
- welding goggles
- welding mask
- breathing apparatus

Work clothes

Persons performing hot work should wear work clothes made from flame-resistant textiles. Flame-resistant textiles do not catch fire, but can be destroyed by extreme heat. Full work clothes should be worn, protecting as much skin as possible. The clothes must be kept fastened throughout the work. This will prevent sparks or gases getting through

openings in the clothes. Protective footwear and gloves should also be made from a material that does not burn.

> **The work clothes must be washed regularly. Dirty work clothes will not have the same flame resistance as clean work clothes.**

First aid equipment

Persons performing hot work must keep first aid equipment easily accessible. It is important that such first aid equipment includes items for the treatment of burns, e.g. bandages and cooling gel.

Burns

Those performing hot work must pay special attention to the risk of burns. However, if a burn injury does occur, then it is important to know the proper basic first aid treatment.

The main principle and rule of thumb is "20–20".

In the event of a serious burn injury, the injury must be cooled immediately with water at around 20 degrees for about 20 minutes. Rapid cooling of the skin prevents the burn injury from penetrating deeper into the tissue and helps to relieve the pain. This can save lives and reduce the likelihood of serious consequences. Call 113 while cooling is in progress.

Minor burns

Hold the burned body part under cold running water for 5 minutes, then up to 20–30 minutes in lukewarm water (15–20 degrees) depending on the extent of the injury. If the injured person has to be moved, a cloth soaked in cold water can be used to cool the burn.

Treating burns:

- take the injured person to safety
- cool as rapidly as possible with water
- remove any loose clothing around the burn
- protect the injured area
- arrange for treatment by a doctor as soon as possible

CO poisoning

Smoke from fire contains carbon monoxide (CO), which is hazardous if inhaled, even in very small amounts. CO displaces oxygen in the blood, leading to suffocation.

If a person has breathed in smoke:

- take the person to an area with fresh air
- check whether the person is breathing
- if the person is unconscious, lay them down on their side
- ensure that the airways are clear
- perform cardiopulmonary resuscitation if the person is not breathing

All persons who have been exposed to CO poisoning should be checked and treated by medical personnel.

6

Risk – identification, assessment and measures

What is risk?

Certain activities and actions will always involve a certain amount of risk, and hot work is no exception. But what is risk?

> **Risk can be expressed as the product of:**
> **the *likelihood* and *consequences* of an undesirable incident.**

For example, an undesirable incident could entail loss of life or harm to health, the environment and/or physical property.

The likelihood describes the probability of an undesirable incident occurring, and can be expressed in words or numbers.

The consequences describe the possible results of an undesirable incident, and can also be expressed in words or numbers.

> **In mathematical terms, risk is defined as a function of likelihood and consequences:**
> ***Risk = likelihood x consequence***

High risk

A risk can be high for two reasons:

- Even if an incident is not particularly dangerous, it may have a high risk if it is very likely that it will occur.
- An incident that is unlikely to occur may also carry a high risk, but only if that incident would have catastrophic consequences if it were to occur.

Low risk

A risk can be low for two reasons:

- The consequences of an incident are so minor that they are not worth worrying about.
- The likelihood of an incident occurring is so small that it can still be correct to accept the risk of a negative consequence.

Risk assessment

In order to reduce risk, first you must make a risk assessment. A number of models for the identification and assessment of risk exist, both advanced and simple. Conducting a risk assessment may sound complicated, but it need not be; consciously or unconsciously, we assess risk in various situations every day. You can make a simple risk assessment of a particular action by asking and answering the following questions:

- What are the hazards?
- What could happen, and how likely is it to happen?
- What could be the consequences of the incident?
- What can be done to prevent it happening?
- What can be done to limit the consequences if it nonetheless happens?

The process of detecting and reducing risk can also be described in the following three steps:

1. Identification
2. Assessment
3. Measures

Identification

In a risk assessment, you start by identifying what undesirable incidents could occur. Undesirable incidents are often conditions that could be hazardous to people or potentially lead to the loss of physical property.

After identifying the undesirable incidents that could occur, you can estimate what risk the incidents represent. You do this by determining a likelihood and a consequence for each incident.

You can see an example of a form that can be used to identify risk associated with an activity or an operation in the figure below.

■ Table 1: After identifying the undesirable incidents, you find the risk by multiplying the likelihood and the consequence.

1: Identification	**2: Assessment**							
	Likelihood			**X**	**Consequences**			**= Risk**
Examples of situations or undesirable incidents that could involve a risk of fire or explosion.	Could happen				Could cause			
	High	Medium	Low	(times)	High	Medium	Low	
	3	**2**	**1**	**X**	**3**	**2**	**1**	Product
Fire in insulation in wall	*3*			*x*	*3*			*9*
Gas leak			*1*	*x*	*3*			*3*
Sparks from cutting disc	*3*			*x*			*1*	*3*
Openings in construction through which sparks may fall	*3*			*x*	*3*			*9*
Flammable liquids near workplace	*3*			*x*	*3*			*9*

In this form, we assess the likelihood and the consequence using a numerical value from 1–3, where:
Low = 1
Medium = 2
High = 3

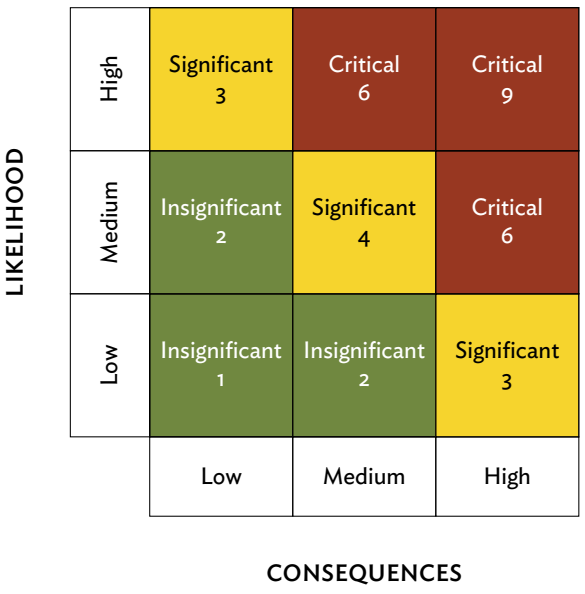
The figures for likelihood and consequence should be multiplied together, and the product gives the risk associated with each incident.

> **It can be difficult to quantify the consequence of an undesirable incident. It is primarily a matter of material damage and personal injury and the consequences of these. If the consequence includes death or permanent injury, you must always choose the highest value, 3.**

Assessment

When the risks have been identified and quantified, you can find the overall risk situation. Based on the risk situation, measures are considered with a view to reducing risk where necessary. The risk figures are placed into a risk matrix. The risk matrix provides a graphical representation of the level of risk, showing areas of different risk levels:

- Critical risks (red – 6 or 9) are unacceptable and must be reduced before work starts.
- Significant risks (yellow – 3 or 4) may be either unacceptable or acceptable. The need to take action should be assessed and any necessary measures implemented. Whatever the decision taken, significant risks must be monitored while the work is being performed and after it has been completed.
- Insignificant risks (green – 1 or 2) are acceptable.



■ Figure 2: The risk of each event is placed in a risk matrix. The green area shows acceptable risk, while the red area is unacceptable risk.

Measures

Based on the risk situation, you must consider measures to reduce risk where necessary. Critical risks (red) are, as already stated, unacceptable and require action to be taken. This may also apply to significant risks (yellow). The measures taken should ensure that the risk of the incident concerned is reduced to an acceptable level.

An example of an action plan is shown below:

Company: *Stålmannen as* Date: 3 January 2019
Prepared by: *Per Stålesen and Gunnar Rørvik*
Valid for the period: *3–4 January 2019*
Workplace: *Stålfjæra 17*

incidents	measures	deadline	responsible
Fire in insulation in wall	Remove insulation from workplace	Before work starts	PS
Gas leak	Remove gas cylinders from building	Before work starts	GR
Sparks from cutting disc	Stop sparks with steel plate	During work	GR
Openings in construction through which sparks may fall	Block openings with mineral wool	Before work starts	PS
Flammable liquids near workplace	To be collected by building owner	Before work starts	PS/owner

Identification and assessment of risks related to hot work

Before starting any hot work, it is important to identify the risks presented by the work at the workplace concerned. The person performing the work must assess three things: the **method**, the **material** and the **environment** . Based on this assessment, you can then take any preventive measures necessary.

Method

The first thing the person performing the work should do is to consider which method of working to use and which tools to employ, bearing in mind the risk of fire at the workplace concerned.

If the risk of fire is particularly great, hot work should be avoided and a "cold" method chosen instead, if possible in practice. Some tools used for hot work generate greater heat than others. The likelihood of starting a fire will therefore vary depending on the tool used. Whenever possible in practice, the person performing the work should choose a tool that generates as little heat and as few sparks as possible. For example, when cutting pipework, consider whether it is possible to use a hacksaw rather than a cutting disc.

Material

Before starting hot work, it is important to be familiar with the properties of the materials to be worked with, in particular how flammable or combustible they are. If the materials are easily ignited, consider whether to change to a less combustible material.

Environment

Identifying the risk of fire – and the risk of fire spreading in the area surrounding where the hot work is to be performed – is also an important task for the person carrying out the work. For example, if there are any openings, cavities or easily ignitable materials nearby, these must be covered or removed.

Duty to provide information and duty to investigate

In order to identify possible risks connected to hot work, detailed information must be obtained in advance about the workplace concerned. Such information is necessary in order to be able to carry out an assessment of the measures needed to take care of safety. Both the employer/client and the party performing the work have obligations relating to identifying possible risks in connection with the performance of hot work. Such identification requires teamwork between the employer/client and the party performing the work.

Duty to provide information

The employer/client would normally be expected to know the risks of the area where the work is to be carried out, and has a duty to inform the party performing the work of such risks. For example, this could include such risks as flammable or combustible materials in building constructions or the storage of flammable liquids.

Duty to investigate

The party performing the work has a duty to request any information from the employer/client that could be important for assessing the risks connected to the performance of hot work. The party performing the work requires such information to be able to assess the overall risk.

The duty to investigate on the part of the party performing the work goes further than the employer's/client's duty to provide information. The party performing the work is the professional party, and is in the best position to assess the risk and the measures necessary in connection with the work to be performed.

Fire protection during hot work

If the identification work establishes that there is a risk of fire associated with the performance of hot work, preventive measures must be taken.

The safety regulations for hot work describe which measures must be taken to prevent fire. In some cases it may be necessary to take further measures above and beyond those described in the safety regulations. Such assessments must consider the risk at the specific workplace.

Most of the measures described in the safety regulations are preventive measures, intended to reduce the likelihood of a fire starting. There are also mitigation measures, designed to reduce the consequences if a fire breaks out despite preventive measures having been taken.

The measures required by the safety regulations are additional to those specified by other laws and regulations.

Requirement to have a fire watch

When performing hot work, a fire watch must always be on duty. This is because the person performing the work will often have a limited ability to monitor the surroundings. For example, there will be areas that will not be visible from the actual workplace. When a person performing hot work uses personal protective equipment such as a welding mask or welding goggles, this also limits their view of the surroundings.

It is just as important that the fire watch has good knowledge about fire prevention as it is for the person performing the work. Therefore, a fire watch should have a valid certificate for the performance of hot work.

■ When using a welding mask, the person performing hot work has a restricted view of their surroundings in the workplace.

Location of fire watch

The fire watch should be located in the area where there is the greatest risk of a fire starting. The identification of potential dangers and the subsequent risk assessment will determine where the fire watch should be located.

The fire watch's tasks

Before the start of hot work, both the person performing the work and the fire watch must familiarise themselves with the surroundings of the workplace. In addition, the fire watch must make sure that sufficient extinguishing equipment is in place and in functional condition.

While the work is being performed, the fire watch must continually monitor the workplace and the surroundings to detect any fires that may break out. If the work involves a risk of heat transfer, the fire watch must also monitor nearby areas, rooms and cavities.

The fire watch should look out for smoke, glowing embers or over-heating – the signs that a fire is developing. In the event of a fire starting, the fire watch should immediately stop the hot work, notify that a fire has started and start to extinguish the fire.

> **The fire watch should stop the hot work if they believe there is an imminent risk of fire.**

The fire watch should not leave the workplace while the hot work is being performed, and they should remain for a minimum of one hour after the

work has finished. If the fire watch needs to take a break they should be replaced with a substitute. It is important to prepare sound procedures to define what should be done if the fire watch unexpectedly has to leave the workplace during the watch period. The fire watch must continuously assess whether it is necessary to remain on watch for longer than one hour after the work has finished.

■ It should be very clear who the fire watch is.

Extra time

In cases where there is a particularly high risk of a fire starting after the hot work has finished, the fire watch period must be extended. The identification of potential dangers and the subsequent risk assessment will determine how long it is necessary for the fire watch to remain on duty after the conclusion of the work.

Multiple fire watches

In some cases it will be necessary to have more than one fire watch, for instance if the workplace is particularly difficult to monitor.

In the event that fire alarm equipment is to be disconnected, the need for safety measures to replace the disconnected equipment must be assessed. Such measures may include the provision of an extra fire watch to monitor the area no longer covered.

Fire watch when there is a low risk of fire

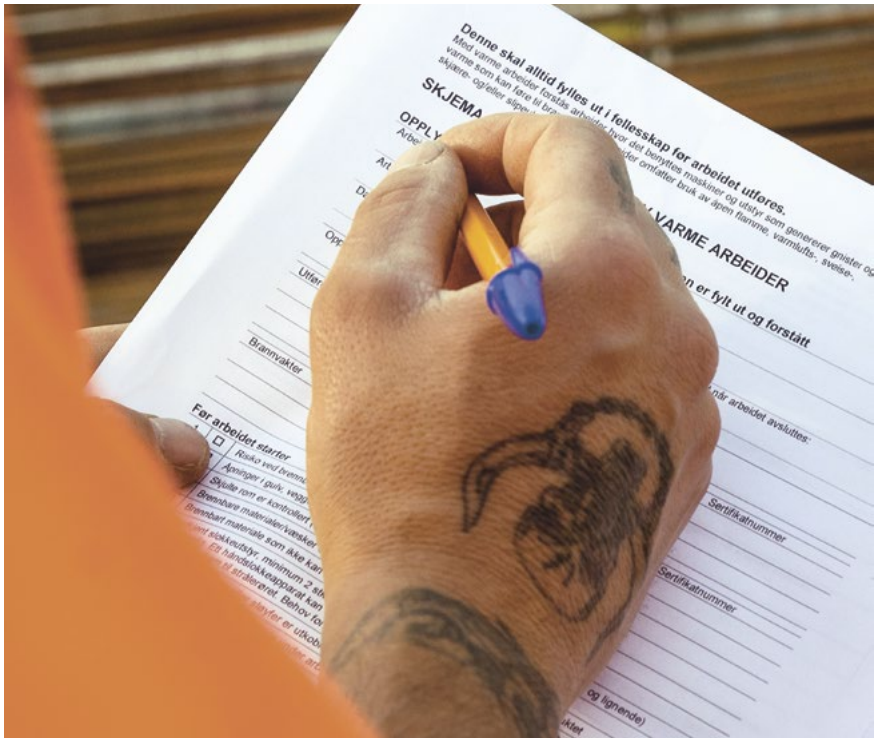
When the fire risk at a workplace has been assessed as low, the person performing the hot work can himself or herself act as fire watch. In practice, this applies in work situations where the person performing the work has assessed the likelihood of fire to be virtually zero.

7

Safety documentation

As is the case for other organisations, companies that perform hot work must identify the risk of undesirable incidents relating to health, safety and the environment (HSE). The risk associated with employees' work must be assessed. If necessary, measures must be taken to reduce the risk. The Internal Control Regulations require that identification work, risk assessment and measures be documented.

> **Risk in connection with the performance of hot work must be identified and documented before the start of work.**



■ Risk in connection with the performance of hot work must be identified and documented before the start of work.

The safety regulations for the performance of hot work also make requirements regarding documentation in the form of a specific checklist. "Checklist for the performance of hot work" (or an equivalent instructions document) is to be completed before work starts. The checklist is to be signed by the employer/client, the person performing the work and the fire watch.

A completed checklist acts as documentation and work permit and checklist. It includes information about who holds which roles and responsibilities relating to the task in hand.

A completed and signed checklist is part of the performing organisation's HSE documentation.

Brannvernforeningen

Finans Norge
Forsikringsdrift

Checklist for the execution of hot work, 1 January 2024

This must always be filled in and signed jointly **before** work is carried out.

Hot work is defined as work using work tools and equipment that generate sparks and/or heat that may cause fire.
Hot work includes the use of an open or concealed flame, hot air equipment, welding equipment, cutting equipment and grinding equipment.

Nature of the work:			
Worksite/address (describe where the work is to be carried out):			
Date and time when work is to begin:		Date and time when work is to end:	
Client, individual/company:	Mobile number:	Sign.:	
Person(s)/company doing the work:	Mobile number:	Sign.:	Certificate no.:
Fire watcher(s):	Mobile number:	Sign.:	Certificate no.:

SAFETY REQUIREMENTS

Anyone carrying out hot work (person/company doing the work) is obliged to ensure that the work is done safely and in a manner compliant with applicable laws and regulations. Hot work must be completed well before the end of the working day.

Before the work begins:	
1 ☐	The contractor has liability cover insurance appropriate to the scope of the work and the risk involved.
2 ☐	A written risk assessment of roof work has been completed and enclosed with this checklist. This check box may be omitted for any work other than roof work.
3 ☐	The risk posed by combustible insulation in structures has been assessed.
4 ☐	Openings in floors, walls and ceilings/roofs are sealed.
5 ☐	Concealed spaces have been checked (wooden joists, ventilation and extraction ducts, suspended ceilling cavities, pipes, etc.).
6 ☐	Combustible materials/liquids have been removed.
7 ☐	Combustible materials that cannot be relocated and combustible structural elements have been protected or wetted.
8 ☐	A sufficient quantity of suitable extinguishing equipment (at least two 6 kg/litre handheld fire extinguishers) in regulation-compliant condition must be readily accessible. One handheld fire extinguisher may be replaced with a fire hose with a water supply reaching directly to the jet spray nozzle. A separate suitability and quantity assessment is enclosed with this checklist.
9 ☐	Fire alarm detectors or loops have been disconnected. Disconnected by:.....
10 ☐	The named fire watcher(s) is/are in attendance while the work is being carried out, during breaks and for the necessary time (at least one hour) after the work has been completed.
11 ☐	The work equipment has been checked and found to be in working order.
12 ☐	The need for an increased state of readiness to be able to cope with the onset of fire has been assessed.
13 ☐	There are at least two escape routes from the risk zone.
14 ☐	People are aware of emergency numbers and procedures for alerting others to fires and accidents. People are aware of the address of the worksite.

Potentially explosive spaces and zones, not applicable ☐

This section of the instructions is applicable to spaces, parts of spaces and zones where there is a risk of explosion on account of explosive substances or because the air is normally or may occasionally be mixed with flammable gas, vapours and/or combustible dust in such a ratio that the air admixture may become explosive. Use of an open flame of any kind, including welding, cutting, etc. without a written work permit signed by the inspector pursuant to Section 29-1 of the Regulations concerning the Performance of Work is not permitted.
15 ☐ The written work permit is signed by the inspector. Name of inspector:.....

Follow-up after work is completed:	
16 ☐	Follow-up inspection to ensure there is no risk of fire.
17 ☐	Fire alarm detectors or loop reconnected by.....
18 ☐	Gas cylinders are located near to an outer door/gate allowing their easy removal to a safe place in the event of a fire.

Checklist with explanatory notes

Before the work starts:

1 The party performing the work has liability coverage in relation to the size and risk of the assignment.

If in doubt, the client/employer should request documentation of valid liability insurance.

2 A written risk assessment of roofing work has been carried out and is attached to this checklist. For work other than roofing, checkboxes may be omitted.

A risk assessment of roof covering and documentation of this assessment should address all conditions that may pose a fire hazard during roof covering work. The risk assessment should also include a description of the distance to combustible insulation and roofing materials stored on the roof, as well as the location where the covering is being done.

3 Risks associated with combustible insulation in structures have been assessed.

If the employer/client is not certain of the contents of the construction, the party performing the work must check. If necessary the construction must be opened to ascertain whether it contains combustible materials or not.

4 All openings in floors, walls and ceilings have been sealed.

All openings and gaps in building constructions close to the workplace must be made safe. Openings and gaps should be covered or sealed with non-combustible materials, such as mineral wool. See also point 4.

5 Any hidden cavities (e.g. tiers of wooden joists, ventilation and extraction ducts, ducting, pipework and the like) have been checked.

The building structure must be checked for hidden cavities. Check if there are cavities where combustible gas from equipment used in the

performance of hot work could accumulate. For example, constructed wooden roofs can contain cavities where flammable gas can accumulate and combustible materials can be ignited.

6 Flammable and combustible materials and liquids have been removed.

An important measure to reduce risk is to remove flammable and combustible materials and liquids from the areas where hot work is to be performed.

7 Combustible materials that cannot be moved and combustible building components must be adequately protected or dampened.

Both combustible materials that cannot be moved and combustible building components must be covered or dampened. Suitable covering includes blankets or tarpaulins made of fire retardant materials or mineral wool, or sheets of plaster or steel. Felt soaked in water can also be used as a cover.

8 Suitable extinguishing equipment in proper condition, minimum 2 pcs. 6 kg/litre portable extinguishers must be easily accessible. One portable fire extinguisher may be substituted with a fire hose with water turned on up to the nozzle. Is there a need for additional extinguishing equipment? Yes:.. No:..

Hand-held extinguishers should be checked before they are installed in the workplace. Check the pressure, the seal, and that the extinguisher and hose are undamaged. Only use equipment that has been checked during the last 12 months. Before the work starts, pull out the fire hose as far as the workplace to check that it is long enough. Pressurise the hose by opening the stopcock to ensure that there are no leaks. Check that the water reaches as far as the jet nozzle.

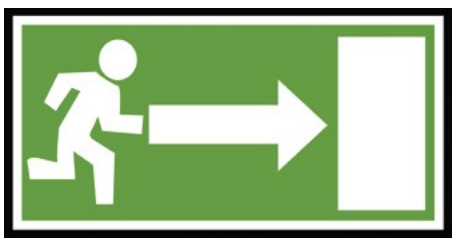
9 Fire detectors or detection loops have been disabled.
The performance of hot work can create smoke, which can set off fire alarm equipment. Ensure that any detectors or alarm loops have been disconnected in the area where the work will be performed. This must be done in consultation with the employer/client.

10 The specified fire watch(es) must be present during the work, during breaks and for at least one hour after work has finished.
The fire watch must monitor the workplace to warn of and extinguish any outbreak of fire. The fire watch must stop the hot work if there is an imminent risk of fire.

11 Work equipment has been checked and is in order.
All work equipment used to perform hot work must be checked before work starts. Work equipment and electrical connections must be undamaged. Flammable gas equipment should be checked regularly.

12 The need for heightened readiness to be able to tackle an outbreak of fire has been assessed.
If the risk identification shows that there is a particularly high risk of fire, extra fire safety measures must be taken. This may involve arranging for extra fire watches, additional extinguishing equipment and more frequent breaks for inspections. In certain special cases the Fire Service should be involved when assessing heightened readiness.

13 There are at least two emergency exits from the hazard area.
It is important that all persons involved familiarise themselves with the closest emergency exits before work starts. It is also important to check that the emergency exits are unblocked and lead to a safe place.



14 People are familiar with the emergency phone numbers and procedures for reporting fires and accidents, and the address of the workplace is known.

Before the hot work starts, both the person performing the work and the fire watch(es) must make themselves familiar with the procedures for notifying fires or accidents. Before the work starts, ensure that:

- there is a working telephone available, with signal if a mobile
- the exact address of the workplace is known
- the telephone numbers of the emergency services are known

Areas of high explosion risk (not relevant) ☐

This part of the instruction applies to areas, enclosed spaces or parts of same where there is a risk of explosion due to the presence of explosive substances or because the air is normally or may occasionally be mixed with flammable gases, fumes or combustible dust in such a proportion that the mixture can become explosive. The use of open flames of any sort is forbidden, including welding, cutting and similar operations, without written permission from the owner or employer/client.

15 Work permit signed by the inspector. Name of inspector.

State the name of the inspector who has carried out checks and necessary measurements and signed the work permit.

Follow-up after completion of work:

16 A follow-up inspection has been made to ensure there is no risk of a fire starting.

When leaving the workplace, the person performing the work must check that there are no signs of fire breaking out anywhere. Burners must be extinguished, and if electric welding has been involved the master power switch must be turned off. The valves of gas cylinders must be closed and protective caps fitted.

After the hot work has finished, the fire watch must remain on the lookout for any signs of an outbreak of fire. These include the smell of smoke, visible smoke and glowing embers, abnormally strong heat or crackling sounds. Extinguishing equipment must be kept available for as long as the fire watch remains on duty.

16 Fire detectors or detection loops have been reactivated by: ...

Once the hot work has finished the fire alarm system should be reconnected. This must not be done until gases and smoke from the work have been fully ventilated from the area.

17 Any gas cylinders have been placed close to an outer door/ gateway so they can be easily moved to safety if a fire starts.

The gas cylinders should be transported to a storage location as close to an outer exit (to fresh air) as possible. The area should be clearly marked so that the cylinders can be quickly located and moved if a fire starts in the building.

8

If a fire starts

If a fire starts, it is vital to react rapidly and in the correct manner. There are often only a few minutes to prevent a recently started fire from turning into a catastrophe. The extent of the damage can be limited if the correct actions are taken early enough.

Actions to take in the event of fire

- **notify**
- **extinguish**
- **save**

Notify

If a fire has started, it is important to immediately notify anyone else who is in the building.

The Fire Service should also be contacted. Give them as much correct information as possible about the course of events and the scope of the fire.

The Fire Service must be informed immediately:
- **whether there are any people missing in connection with the fire**
- **whether there is a risk of explosion due to gas nearby**

Extinguish

A newly started fire can be easy to extinguish in the early stages, but a fire grows and develops quickly. The person performing the hot work must assess whether it is safe to try to extinguish the fire. The assessment should take into consideration the size of the fire and the danger involved.

Extinguishing depends on:
- what is burning
- how large the fire is
- the expertise of the person trying to extinguish it

If a fire is extinguished during the start phase, the area must be cleaned up. The purpose of this is to find any remaining embers or residual heat. Water should be used to cool down the area. Consider whether the Fire Service should be contacted.

Limit

It is important to limit the scope of the fire as much as possible. A fire can be limited by closing doors, shutters and windows. Removing combustible materials around the location of the fire can also help to limit the extent of the fire. If gas cylinders are located close to the fire, these should be moved to a safe location if possible.

Save

If a fire cannot be extinguished during the start phase, it is important to get yourself and others to safety before continuing efforts to extinguish it. A developing fire can quickly give off sufficient heat and smoke to make it hazardous to remain nearby. Inhaling even small amounts of smoke can be fatal.

> **All fires are different. Therefore, there is no easy answer to the order in which the various actions (notify, extinguish, save) should be carried out. This is an assessment that must be made in each individual case of fire.**

Fire in gas from gas cylinders

In the case of a small local fire from the valve of a gas cylinder or equipment connected to a gas cylinder, the valve should be closed if possible. The fire should then be extinguished using a hand-held extinguisher. If the fire in the gas cylinder poses no danger to the surroundings, it is best to let it burn until the gas bottle is empty.

If it is not possible to shut off the supply of gas, it may be hazardous to extinguish the fire. The escaping gas may explode if reignited. In such cases the area should be evacuated and the Fire Service called. Provide information to the Fire Service about the number of gas cylinders, their location and the types of gas they contain.

9

After a fire

Any injury or damage resulting from a fire caused by hot work must be reported to the employer/client, the police and the insurance company. In the event of personal injury, the Norwegian Labour Inspection Authority must be notified.

Employer

It is very important that all fires, even small ones, are reported to the employer/client. It is vital that the employer/client learns about such incidents to be able to implement fire prevention measures. This is an important part of the organisation's internal control.

Police

All fires should be investigated by the police. This is the case whether or not there are reasons to suspect that a criminal act has occurred. It is important to establish the likely cause of the fire. The police will also assess whether negligence was involved. The investigation may uncover a criminal act in connection with the start of the fire or non-compliance with important legal requirements.

If the police conclude that there has been any non-compliance with legislation, this may lead to prosecution and/or a fine.

In connection with the investigation, the police will interview all persons who may have relevant information about why the fire started and the course of events.

Norwegian Labour Inspection Authority

If a fire has occurred that has caused personal injury, the employer has an obligation to notify the incident to the Norwegian Labour Inspection Authority. In some cases the police or Fire Service will notify the Labour Inspection Authority, irrespective of whether any personal injury was caused, for instance in connection with major incidents or incidents that had the potential to become major.

Insurance company

Insurance companies normally wait to receive the police's conclusions in cases of fire. In some cases the insurance companies will carry out their own investigations. They will endeavour to establish whether the safety regulations were followed or not. If the safety regulations were breached, and a causal connection can be shown between the breach and the fire, the insurance company will be able to limit the amount they pay out.

Cases of damage or injury in connection with fire may result in legal proceedings under civil law. In such cases, the employer/client, the party performing the work and others who can shed light on the case will be summoned as witnesses.

Consequences of fire

Every fire has negative consequences, large or small. In the worst cases fire can cause loss of life or serious long-term injuries. Every year insurance companies pay out many billions of Norwegian kroner for fire damage to buildings and materials.

Organisations that have been affected by fire may face many challenges, such as loss of market share and loss of premises in which to work.

Reference list

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ISBN 978-82-7485-107-8