



Safety and Health Protection in Connection with Gas Extinguishing Systems

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Amsterdamer Str. 172-174

D-50735 Köln

Phone: +49-221-77 66-0, Fax: +49-221-77 66-341

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Guidelines for Fire Extinguishing Systems

Safety and Health Protection in Connection with Gas Extinguishing Systems

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These Guidelines represent a summary of BGR 134 (status July 1998, up-dated reprint January 2004), up-dated by BGI 888 (status January 2004) and explanations.

These Guidelines have been developed in co-operation with the "Arbeitskreis Feuer-schutz" (Fire Protection Team) of the industrial Employer's Liability Insurance Association and "bvfa".

They are applicable as from publication, unless terms of these Guidelines have to be observed already due to applicable legal standards or as generally recognised codes of practice.

Preliminary note

These Guidelines are addressed primarily to the owner and are intended to assist him in the implementation of his duties resulting from national work safety regulations or accident prevention regulations and to show him ways how to avoid work accidents, occupational diseases and health risks.

When observing the recommendations included in these Guidelines, especially the exemplary solution possibilities, the owner can expect to have taken appropriate measures for the prevention of work accidents, occupational diseases and work-related health risks. In case the committees established for the concretisation of national occupational safety regulations have determined technical rules, these shall take precedence.

Oxygen-displacing gases, such as carbon dioxide, nitrogen, noble gases (e.g. argon) and mixtures thereof (e.g. Argonite, Inergen) are used as extinguishant in fixed fire extinguishing systems. They extinguish fires, essentially by displacing atmospheric oxygen from the fireground.

Equally, halogenated hydrocarbons (e.g. FM 200 and Novec1230) are used as extinguishant in fixed fire extinguishing systems. Their extinguishing effect is based on a chemical/physical principle.

The extinguishing gas concentration developed for an adequate extinguishing effect or the lowered oxygen concentration respectively does not allow a permanent presence of persons in this atmosphere. Depending on the inhaled concentration, these gases have an exciting, paralysing or suffocating effect.

When using extinguishing gases or gas mixtures in fixed fire extinguishing systems, the respective critical concentrations from which on there is a hazard to life has to be evaluated, determined and documented by the installer (see also Annex 2 Material Data).

E.g. carbon dioxide can be expected to be harmful from a concentration of 5% by volume CO₂ on and from a concentration of more than 8% by volume CO₂ on there is a risk of death.

1 Scope of application

1.1 These Guidelines are applicable to fixed fire extinguishing systems with gaseous extinguishants, hereinafter referred to as extinguishing systems.

1.2 These Guidelines are not applicable to extinguishing systems on seagoing vessels, watercrafts and floating equipment of inland waterway navigation with operating permit as well as in underground mining.

1.3 Deviating from 1.1, paragraphs

- 5.1.4 to 5.10,
- 6.3 to 6.9,
- 7.2.2 to 7.3.2

as well as

- 7.4.3

are not applicable to extinguishing systems of Hazard Class I (see 4) because there is no hazard to persons when these extinguishants are discharged.

Generally, there is no hazard to persons due to these extinguishants in case of objects that are open or not accessible or located in inaccessible rooms. This also applies to rooms in which, because of their size or construction, the extinguishing gas concentration remains under and the oxygen concentration remains above the limit which is critical for a hazard to people, even when the entire extinguishing gas design quantity is discharged. This is also applicable when several such systems are provided in one room whose activation systems can jointly react to the same event or trigger a flooding.

2 Definitions

In the sense of these Guidelines, the following terms are defined:

Work and traffic area: The work and traffic area in the vicinity of rooms or facilities that are protected with gas extinguishing systems is that area which can be reached by people. When the areas protected with gas extinguishing systems are accessible areas themselves, then these areas are included in the work and traffic area.

Activation is the release of the extinguishing system for flooding, either automatic or manual.

Delayed activation is the release of the extinguishing alarm and of the delay device and the delayed release of the extinguishant for flooding.

Flooding is the discharge of the extinguishant into the flooding zone.

Extinguishing alarm includes visual and audible signals that are emitted directly before, during and after flooding in the hazard area.

Hazard Area: In case of **total flooding systems**, this generally corresponds to the extinguishing area. (See also 5.8 and 5.9) In case of **local application systems**, this is the area where the harmful concentration may be exceeded by a release of the extinguishing system.

The **hazard area** shall be defined for each system, since an alarm shall be sounded in the hazard area. The hazard area can, particularly in case of open local application systems, temporarily change due to the discharge of the extinguishing gas into the environment.

Flooding zone is the entirety of all areas which are included in the scope of protection of the extinguishing system and which are flooded simultaneously.

Local application/object protection is the flooding of an object, e.g. a machine, painting facility, with the extinguishing gas quantity designed for the extinguishing effect.

Room protection/total flooding is the flooding of a self-contained and enclosed room with an extinguishing gas quantity designed for the extinguishing effect.

Design quantity is the extinguishing gas quantity that is required for the build-up of an effective extinguishing gas concentration within the flooding zone.

Extinguishing gas quantity is the total gas quantity discharged into the flooding zone. (Decisive for the max. extinguishing gas and the min. oxygen concentration.)

Odourisation is the adding of odourants which make the smell-free extinguishing gas perceptible.

Extinguishing gas concentration (EGC) is the concentration of extinguishing gas in % by volume which is reached after flooding in the atmosphere of the flooding zone and, in case of open local application systems, also in its vicinity.

NOAEL (no observed adverse effect level) is the highest extinguishing gas concentration in % by volume at which no harmful effects have been noted yet.

LOAEL (lowest observed adverse effect level) is the lowest extinguishing gas concentration in % by volume at which harmful effects have been noted.

Life-threatening concentration (LTC) is the lowest extinguishing gas concentration from which on there is acute risk of death already in case of a short-term stay.

Pre-warning time is the time from the beginning of the extinguishing alarm until the beginning of flooding.

Blocking device is a contrivance by means of which the extinguishant discharge can be blocked mechanically.

Delay device is the contrivance which delays the beginning of the flooding.

Emergency stop device is a control device with automatic reset function that prevents flooding during the pre-warning time for the duration of its actuation.

3 General requirements

3.1 For their safe operation, extinguishing systems shall conform to the generally recognised codes of practice and be operated properly. Deviations are admissible, provided that the same level of safety is ensured otherwise.

Generally recognised codes of practice are, for example, the standards specified in the annex as well as the guidelines of VdS Schadenverhütung.

3.2 The technical solutions contained in these Guidelines do not exclude other at least equally safe solutions that might have materialised in technical rules of other member states of the European Union or other contracting states of the Agreement on the European Economic Area.

This applies, for example, to technical solutions that are permitted in VdS approvals for the corresponding hazard class.

3.3 Test reports of testing laboratories which are certified in other member states of the European Union or in other contracting states of the Agreement on the European Economic Area are taken into consideration in the same way as German test reports, provided that the tests, test procedures and constructional requirements on which these test reports are based are equal to those of the German agencies. This is particularly the case when such agencies comply with the requirements as stipulated in the standard series EN 45 000 or EN ISO/IEC 17025 respectively.

4 Hazard Classes

Depending on the substances to be extinguished (fire load) and the extinguishing gases used, differently high extinguishing gas and oxygen concentrations may be applied. These different concentrations also result in a different threat to the persons within the hazard area. Corresponding to this threat, the extinguishing systems with gaseous extinguishants can be subdivided into four classes:

Class I

Extinguishing gas concentration up to NOAEL ($EGC \leq NOAEL$) and oxygen concentration above 12% ($O_2 \geq 12\%$ by volume)

Class II

Extinguishing gas concentration between NOAEL and LOAEL ($NOAL < EGC \leq LOAEL$) and oxygen concentration above 10% ($O_2 \geq 10\%$ by volume)

Class III

Extinguishing gas concentration above LOAEL and below life-threatening concentration ($LOAEL < EGC < LTC$) and oxygen concentration above 8% ($O_2 \geq 8\%$ by volume).

Class IV

Extinguishing gas concentration at and above life-threatening concentration ($EGC \geq LTC$) and/or oxygen concentration below 8% ($O_2 < 8\%$ by volume). The concentrations of the individual extinguishing gases may be gathered from Annex 2 Material Data.

5 Installation and equipment

5.1 Alarm systems

5.1.1 For the warning of persons, flooding zones resp. hazard areas shall be provided with audible and, if required, visual alarm systems in order to ensure the alert of people present in the flooding zone resp. hazard area.

5.1.2 The signal of the audible alarm devices shall be distinctly different from the operational noises and be at least by 5 dB(A) above the environment sound level. If necessary, visual alarm devices shall be available in addition to the audible ones. Visual alarm devices shall provide a conspicuous signal by way of flashing.

5.1.3 As far as extinguishing systems with gaseous extinguishants are concerned, the extinguishing alarm shall be switched off only after it has been ensured that no unauthorised people can enter the hazard areas any more.

This can, for example, be achieved by warning lamps or luminous signs at the entrances to the hazard areas or by locking the entrances.

These measures shall be maintained until the hazard areas have been vented and can be entered safely again.

Note from the editors: 5.4 to 5.10 of BGI 888 have been replaced by the following tables and paragraphs for better clarity. The content has remained unchanged.

5.1.4 Electrical or pneumatic alarm systems may be used. One distinguishes between the following types of alarm systems:

Type	Requirements for energy supply	Requirements for the cabling from energy supply to alarm devices
Unsecured electrical alarm device	Low voltage supply (230V mains). The supply shall not be able to be interrupted apart from the main distribution panel with its own marked fuse circuit.	
Secured electrical alarms device	Secured electrical supply according to DIN VDE 0833-1	Secured supply line according to DIN VDE 0833-1
Simple pneumatical alarm device	Supervision of gas volume	Standard line of supply
Secured pneumatical alarm device	Supervision of gas volume	Double line of supply (separately routed)

Table 1: Types of alarm devices

5.1.5 The energy supply for the alarm must in any case be sufficient for a duration of 30 minutes

5.1.6 In Hazard Classes I and II, at least one of the alarm devices mentioned in 5.1.4 shall be used. However, the use of unsecured electrical alarm devices in Hazard Class II is not admissible.

5.1.7 In Hazard Classes III and IV, at least two of the alarm devices mentioned in 5.1.4 shall be used.

The alarm systems shall be independent from each other, i.e. separate energy sources, separately routed cables and separate alarm devices. In Hazard Class IV, 5.1.8 shall be observed in addition. The admissible combinations for Hazard Classes III and IV are specified in Table 2.

5.1.8 For extinguishing systems of Hazard Class IV, the delay and alarm devices shall ensure the alarm and evacuation of people present in the extinguishing area even under adverse conditions.

Adverse conditions in the sense of these Guidelines are overvoltages or other electromagnetic influences that may result in the destruction or malfunctioning of electrical/electronic components in alarm or activation devices and thus in an abnormal release of extinguishant.

Alarm type 1 Alarm type 2	Unsecured electrical	Secured electrical	Simple pneumatical	Secured pneumatical
Unsecured electrical	not allowed			
Secured electrical	Class III allowed Class IV allowed ³⁾	Class III allowed ²⁾ Class IV allowed ²⁾³⁾		
Simple pneumatical	Class III allowed Class IV not allowed	allowed	allowed ¹⁾	
Secured pneumatical	Class III allowed Class IV allowed ³⁾	allowed	allowed ¹⁾	allowed ¹⁾

¹⁾ The requirement for independent energy supplies will not apply if two pneumatical audible alarms devices are used for low pressure CO₂ systems where both alarm devices are supplied by the extinguishant container.

²⁾ The requirement for independent separated energy supplies will not apply if two secured supplies are used.

³⁾ Only permitted if fire detection and control are exclusively mechanical or pneumatical.

Table 2: Allowed combinations of the two alarm devices required for Hazard Classes III and IV

5.2 Delay devices

5.2.1 Extinguishing systems that can cause harm to persons due to flooding shall be provided with delay devices.

5.2.2 Delay devices shall ensure that flooding will be performed only after the alarm devices have been activated and the set pre-warning time has elapsed.

5.2.3 For this purpose – depending on the Hazard Class of the extinguishing system – electrical or non-electrical (mechanical, pneumatical) delay devices may be used.

The use of electrical delay devices in Hazard Classes III and IV is not admissible.

5.3 Pre-warning time

5.3.1 The pre-warning time shall be long enough to allow leaving the hazard areas from any point without undue haste. It shall be at least 10 seconds long.

In addition to the automatic delay device, an emergency stop device may be useful for CO₂ systems, see 5.4.

5.3.2 For total flooding systems, a pre-warning time shall become effective for each automatic or manual release of the extinguishing system

5.3.3 For object protection systems, local application systems, or small extinguishing units as per DIN 14497 "Small extinguishing units, requirements, testing" a pre-warning time is required when the entire applicable extinguishing gas quantity exceeds the NOAEL or 5% by volume CO₂ or when the oxygen concentration falls below 12% by volume in the work and traffic area which houses the object to be protected. This is also applicable when several such systems are provided in one room whose activation systems can jointly react to the same event or trigger due to a flooding.

This is, for example, prevented when a further activation of adjacent systems is automatically interlocked with the initial activation or when alarm and delay devices are activated in case of a secondary or subsequent activation during which the NOAEL value for the extinguishing gas or 5% by volume CO₂ is exceeded or when the O₂ concentration is less than 12% by volume.

5.4 Emergency stop device

5.4.1 In particular cases, an emergency stop device for CO₂ system as an additional facility may be useful provided that it enables the rescue of people prior to commencement of flooding and meets the requirements specified in Annex 3.

The use of an emergency stop device is purposeful, for example, when principally at least two persons are present who can help in the event of a release.

5.5 Blocking devices

5.5.1 It shall be possible to disable a release of the extinguishing system. The blocking shall be performed mechanically and such that an extinguishant discharge is safely prevented.

See also 6.4.

5.5.2 An actuation of the blocking devices shall be clearly visible. This can be achieved, for example, by a visual indication.

Note: Additional requirements for the blocking devices are included in the VdS Guidelines 2093, 2380 and 2381.

5.6 Overview of alarm and delay devices

Corresponding to their Hazard Class evaluation, at least the alarm and delay devices specified in the table below are required for the safe operation of extinguishing systems with gaseous extinguishants.

Hazard Class	Alarm devices					Delay device
		unsecured electrical	secured electrical	simple pneumatical	secured pneumatical	
I		unsecured electrical	secured electrical	simple pneumatical	secured pneumatical	not required ⁴⁾
		allowed	allowed	allowed	allowed	
II		unsecured electrical	secured electrical	simple pneumatical	secured pneumatical	electrical delay
		not allowed	allowed	allowed	allowed	
III		unsecured electrical	secured electrical	simple pneumatical	secured pneumatical	non-electrical delay ⁵⁾
		not allowed				
		secured electrical	allowed ²⁾			
		simple pneumatical	allowed	allowed ¹⁾		
		secured pneumatical	allowed	allowed ¹⁾	allowed ¹⁾	
IV		unsecured electrical	secured electrical	simple pneumatical	secured pneumatical	non-electrical delay
		not allowed				
		secured electrical	allowed ³⁾	allowed ^{2) 3)}		
		simple pneumatical	not allowed	allowed	allowed ¹⁾	
		secured pneumatical	allowed ³⁾	allowed	allowed ¹⁾	
¹⁾ The requirement for separate energy sources does not apply when two pneumatical alarm devices are used in CO ₂ low pressure extinguishing systems and when both alarm devices are supplied from the extinguishant container. ²⁾ The requirement for separate energy sources does not apply when two secured electrical alarm devices are used. ³⁾ Only admissible when fire detection and control are exclusively mechanical or pneumatical. ⁴⁾ Considering psychological aspects, a delayed flooding with pre-warning time should also take place in this case, unless there is a good reason not to do so. For reasons of property protection, this is also advisable since the extinguishing effect can be adversely influenced by the opening of doors during flooding. ⁵⁾ The non-electrical arrangement is preferred as it is, according to experience, more robust and less prone to failure (EMC).						
Table 3: Overview of alarm and delay devices						

5.7 Piping

Piping must be electrically grounded.

Grounding serves the purpose of avoiding electrostatic charges.

5.8 Enclosures

5.8.1 Rooms that are protected with extinguishing systems shall be arranged such that extinguishants cannot unintentionally escape in such quantities that people in adjacent rooms or areas will be affected.

On principle, the tightness of such rooms should be inspected. This applies in particular, when changes result due to conversion, new installations or modifications of the installation.

5.8.2 If it cannot be prevented that discharging extinguishant also escapes into adjacent rooms or areas, these shall be included in the alarm system.

5.9 Escape routes

Escape routes shall be available for all extinguishing and hazard areas.

For escape route requirements see "Workplace Regulations".

In case of an increased hazard to persons due to particular constructional conditions or due to the facility to be protected, shorter escape routes – than determined in "Workplace Regulation ASR 10/1 Doors, Gates" – may be necessary.

Rooms whose single escape and rescue route runs through the extinguishing area have to be treated, as far as alarm and delay are concerned, like the extinguishing area.

5.10 Doors

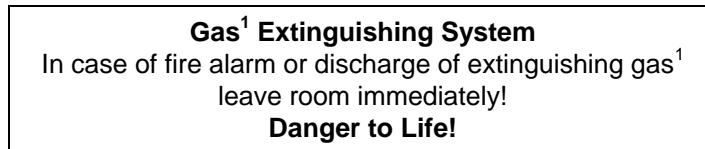
5.10.1 Doors shall be of self-closing construction, swing open in the escape direction and be easily openable from inside at any time and without any other tools.

*See also "Workplace Regulation ASR 10/1 Doors, Gates".
In case two or more doors are available, it is sufficient when all doors located in the course of escape and rescue routes conform to the requirements of these regulations. When several doors are available and only one escape and rescue route is provided, then a **second** door shall conform to these requirements.*

5.10.2 If, for operational reasons, self-closing doors have to be kept open, these shall be fitted with hold-open systems that are designed such that automatic closing on release of the extinguishing system is ensured.

5.11 Marking

All entrances to hazard areas of Class IV extinguishing systems shall be provided with warning sign W 00 "Warnung vor einer Gefahrstelle" [Hazard Area Warning] and an additional sign bearing the inscription



¹ Name of the extinguishing gas used

The signs shall conform to the regulation for the prevention of accidents "Sicherheits- und Gesundheitsschutzkennzeichnung am Arbeitsplatz" (BGV A8).

At all entrances to hazard areas of extinguishing systems of Classes I, II and III, the term "Danger to Life" may be replaced by "Danger to Health".

5.12 Operating instructions

For extinguishing systems, operating instructions of the installer shall be available in the German language and contain all information required for safe operation. This must include, in particular, information about

- commissioning;
- behaviour upon release;
- maintenance and testing;
- behaviour in case of fault;
- behaviour in case of shutdown.

6 Operation

6.1 Proper Operation

The owner shall be responsible for the proper operation of extinguishing systems.

6.2 Operating procedure and training

6.2.1 The owner shall develop an operating procedure based on the operating instructions provided by the installer, which covers, in particular, all necessary safety information.

Suitable operating procedures are, for example, information sheets of the system manufacturers, provided they contain all information important for safety and are easily understandable.

6.2.2 The owner shall instruct any persons who have access to the hazard areas before they take up their activities as well as regularly, and at least annually regarding any possible hazards of the extinguishant and any necessary protection measures on the basis of the operating procedures. The instruction shall be documented.

The instruction may be part of the general instruction at the workplace.

6.3 Rectification of faults

The owner shall have rectified any faults of the extinguishing system which impair personnel protection without delay. If this is not possible, he shall shut down the system. During this time fire protection shall be ensured in another way.

6.4 Blocking of extinguishing systems

6.4.1 In case work has to be done in hazardous areas that does not allow leaving of the rooms within the pre-warning time, then the extinguishing system shall be blocked.

Work that requires such a blocking can be for example: Work on scaffolds or in narrow rooms.

6.4.2 When people that have not been instructed (see 6.2.2) are present in the hazard area, the extinguishing system shall be blocked.

6.4.3 A blocking of the extinguishing system may be purposeful when performing work that may cause unintentional release of the extinguishing system.

Work for which such a blocking may be useful can be for example: Work in the extinguishing area that may deceive the fire detection system, testing and maintenance work on the extinguishing system.

6.4.4 The blocking of extinguishing systems may only be performed or arranged for by a person authorised by the owner and who at the same time is responsible for ensuring fire protection in another way.

6.5 Behaviour in a fire situation

Upon release of the extinguishing alarm by audible or visual alarm devices, any people present in the hazard areas have to leave these. Re-entry of the rooms is permissible only after a person authorised by the owner has issued a release for entry of the areas exposed to the extinguishing gas.

It is appropriate to fix assembly points where the Insureds have to go to after evacuation of the workplaces. This way, the missing of people who had previously been working in the hazard area can be ascertained.

There is a hazard to life not only due to the extinguishing gas or too low an oxygen concentration but also due to the fumes caused by combustion.

6.6 Fighting of initial fires

When initial fires are fought manually, the extinguishing work shall not be continued after release of the extinguishing alarm.

6.7 Re-entry of flooded areas

6.7.1 Flooded rooms may only be re-entered when a release to do so has been issued by the person authorised by the owner or by the fire brigade after thorough investigation. If required, concentration measurements of the extinguishing gases and of the oxygen concentration need to be performed.

6.7.2 Flooded rooms shall be ventilated prior to re-entry. In doing so, it shall be ensured that people in adjacent rooms and in the vicinity will not be jeopardised.

6.7.3 The venting of the flooded rooms shall only be performed by people who have been instructed accordingly. In case the rooms have to be entered for venting, this is permissible only when using a breathing apparatus that is independent from the surrounding atmosphere.

6.8 Use of emergency stop device

After operation of the emergency stop device the extinguishing area may be entered during the pre-warning time only for rescuing people.

6.9 Odourisation

If there is a risk that people in lower rooms may be jeopardised by the discharge of CO₂, then the extinguishant shall be odourised for olfactory perception by non-toxic additives having an odour that is typical of the hazard.

Odourisation of other extinguishing gases may be purposeful in individual cases.

A hazard to life by the discharge and accumulation of extinguishants in hazardous concentrations shall be expected in lower unventilated rooms, e.g. in press pits and cellars of hydraulic units.

7 Inspections

See also 3.2.2

7.1 Obligatory inspections

7.1.1 The owner shall have extinguishing systems inspected by an expert or a competent person.

See also BG-Grundsätze 920 "Grundsätze für die Prüfung von Feuerlöschanlagen mit sauerstoffverdrängenden Gasen" (Employer's Liability Insurance Association principles 920 "Principles for the inspection of fire extinguishing systems with oxygen-displacing gases").

An expert is who, on account of his technical education and experience, disposes of particular knowledge in the field of extinguishing systems and who is familiar with the relevant national work safety regulations, accident prevention regulations and the generally recognised codes of practice (e.g. rules, DIN standards, VDE regulations, technical rules of other member states of the European Union or other contracting states of the Agreement on the European Economic Area). He shall be capable of inspecting and assessing extinguishing systems.

A competent person is who, on account of his technical education and experience, disposes of sufficient knowledge in the field of extinguishing systems and who is familiar with the relevant national work safety regulations, accident prevention regulations and the generally recognised codes of practice (e.g. rules, DIN standards, VDE regulations, technical rules of other member states of the European Union or other contracting states of the Agreement on the European Economic Area) to such an extent that he can evaluate the safe condition of extinguishing systems. The necessary knowledge may, for example, be acquired from the installer of the corresponding system.

7.1.2 The competent person shall dispose of the technical equipment required for testing, servicing and maintenance.

7.1.3 In case the expert or the competent person finds any deficiencies, he shall report these deficiencies to the owner. The owner shall arrange for the rectification of the deficiencies reported to him.

7.1.4 In case a hazard to life has to be expected due to the deficiencies found, the extinguishing system shall be shut down. Prior to re-commissioning of the extinguishing system, the owner shall arrange for the rectification of these deficiencies and, within 3 months after re-commissioning at the latest, he shall initiate a new inspection carried out by an expert.

See also 6.3.

7.2 Approval inspections

7.2.1 For extinguishing systems whose use does not involve any hazard to life, the owner shall arrange for an approval inspection carried out by a competent person after installation or after major modifications of the system. The competent person shall document in an approval protocol that the system does not involve any hazard to life. In case of doubt, the Employer's Liability Insurance Association in charge may require the inspection to be carried out by an expert.

See also Annex 1.

7.2.2 For extinguishing systems during whose operation a hazard to life cannot be excluded, the owner shall arrange for an approval inspection by an expert after installation or after major modifications of the system. This inspection shall have been completed 6 months after commissioning at the latest. For the evaluation of the extinguishing systems, the necessary documents, such as installation certificate, pipework calculation and drawings shall be made available to the expert.

Expert: see explanations referring to 7.1.1.

7.2.3 The owner shall have the expert provide a test report on the compliance with the requirements of these Guidelines.

7.2.4 The owner shall have these extinguishing systems be subjected to a preliminary inspection by a competent person prior to commissioning, unless the test as per 7.2.2 has already been completed.

7.3 Periodical inspections

7.3.1 The owner shall, in addition to 7.2.2, have the proper functioning of extinguishing systems, during whose use a hazard to life cannot be excluded, tested by a competent person or expert as required, however, at least once a year. However, periodical inspections of the extinguishing systems shall be carried out by an expert at least every two years.

These inspections may, for example, be carried out on an alternating yearly basis by an expert and a competent person, however, an inspection of the extinguishing system by the expert is required every two years.

Particular operational conditions may require to have the alarm system inspected at shorter intervals.

7.3.2 After each release of the extinguishing system, the owner shall have the entire system additionally checked by a competent person.

7.4 Inspection records

7.4.1 The results of the inspections as per 7.1 to 7.3 shall be recorded in a log book or inspection report. This also applies to deficiencies found or objections against the operation of the system.

7.4.2 The records about the approval inspections as per 7.2 shall be kept on file over the entire useful life of the extinguishing system.

7.4.3 The records about the periodical inspections as per 7.3 shall be kept on file for at least 4 years. A storage on EDP data carriers is admissible.

7.4.4 The records shall be submitted on demand to the authority.

Annex 1 – Sample for Approval Protocol

Sample for an approval protocol for gas extinguishing systems whose use does not involve any hazard to life

Approval protocol for agas extinguishing system:

Manufacturer/installer:

Type:

Extinguishing gas:

Extinguishing gas quantity: Chemical composition:

Installation site:

Company:

Flooding zone:

Total flooding/enclosed volume:

The room volume (breathing air volume in flooding zone) is approx..... m³.

The gas concentration in the flooding zone does not exceed % by volume ¹⁾

The oxygen concentration in the flooding zone does not fall below..... % by volume ¹⁾

A harmful - gas concentration (.....% by volume) is not exceeded.

A harmful oxygen concentration (12% by volume) is not fallen below.

The flooding zone is not accessible.

Adjacent rooms/environment shall be separated from the flooding zone in a sufficiently gas-tight way.

¹⁾ Evidence of: flooding test with concentration measurement (Report No.)
 calculation (see annex)

Object protection/local application (not or partly enclosed volume):

The gas concentration in the work and traffic area does not exceed% by volume ¹⁾

The oxygen concentration in the work and traffic area does not fall below% by volume ¹⁾

A harmful gas concentration (.....% by volume) is not exceeded.

A harmful oxygen concentration (12 % by volume) is not fallen below.

The flooding zone is not accessible.

The work and traffic area is separated from the flooding zone in a sufficiently gas-tight way.

¹⁾ Evidence of: flooding test with concentration measurement (Report No.)
 calculation (see annex)

Competent person: Company:

Address:

.....

Place, Date

Signature

Annex 2 – Material Data

The following table specifies examples of presently used extinguishing gases whose data are required for hazard classification.

The safety data sheets and its instructions regarding the safe handling of extinguishing gases shall be followed at any rate. This also applies to any extinguishing gases not specified here, for which the relevant safety data sheets shall be adhered to.

In the case of gas mixtures the hazardous potential of all components shall be considered.

Extinguishing gas	NOAEL in % by volume ext. gas	LOAEL in % by volume ext. gas	LBK in % by volume ext. gas	Density at 20°C and 1013mbar in kg/m ³
CO ₂ ⁸	5,0	5,0	5,0	1,84
IG 01 Argon	43,0 ⁴	52,0 ⁵	62,0 ⁶	1,662
IG 100 Nitrogen	43,0 ⁴	52,0 ⁵	62,0 ⁶	1,165
IG 541 (52% nitrogen, 40% argon, 8% CO ₂) (Trade name: Inergen)	43,0 ⁴	52,0 ⁵	62,0 ^{6,7}	1,418
IG 55 (50% argon, 50% nitrogen) (Trade name: Argonite)	43,0 ⁴	52,0 ⁵	62,0 ⁶	1,412
HFC227ea (Trade name: FM-200)	9,0	10,5	12	7,283
FK-5-1-12 (Trade name Novec 1230)	10,0	not available	not available	13,908
⁴ corresponds to 12% by volume oxygen ⁵ corresponds to 10% by volume oxygen ⁶ corresponds to 8% by volume oxygen ⁷ corresponds to 5% by volume CO ₂ ⁸ from 5% by volume CO ₂ a hazard to life is involved				
Table 4: Toxicity classification for extinguishing gases				

Annex 3 – Requirements for emergency stop device

A 3.1 The CO₂ emergency stop device shall be effective during pre-warning time only.

A 3.2 The CO₂ emergency stop device shall be effective for the duration of its uninterrupted operation only.

A 3.3 After release of the CO₂ emergency stop device flooding shall start immediately, however, it shall be ensured that the pre-warning time established for the system will be observed. The extinguishing alarm shall continue sounding while the CO₂ emergency stop device is being operated.

A 3.4 An operation of the CO₂ emergency stop device shall be indicated visually and audibly at a permanently manned location on the premises from which quick help can be initiated. In case a separate parallel indication is required in addition to the indication device, the transmission cable shall be a primary line. Any faults on this primary line shall be indicated on the parallel indication. If this is not possible, the use of a CO₂ emergency stop device is not purposeful. The indication shall remain until it is reset manually.

A 3.5 If in electronic data processing systems, this applies for example to

- EDP areas with false floors >20m² (room and false floor)
- EDP systems (room, false floor and equipment protection)

structurally separated extinguishing areas can be flooded separately as well as all together, then the CO₂ emergency stop device(s) shall act simultaneously on all delay devices.

In case of a malfunction in the incoming cables to the CO₂ emergency stop device or in the incoming cables to the controls of the fire extinguishing system required for the stop function (e.g. stop valve) it shall be impossible to initiate an extinguishing function. This also applies to malfunctions that occur during the pre-warning time with or without operation of the emergency stop device. Any malfunction shall be indicated at a permanently manned location.

Annex 4 (informative) – Calculation of the extinguishing gas and of the residual oxygen concentration

1 Extinguishing gas concentration

The extinguishing gas concentration prevailing in a room after discharge of the entire extinguishing gas quantity, can be estimated by means of the following equations:

1.1 Inert gases

$$C = 100 \cdot \left(1 - \frac{1}{e^x} \right) \text{ with } x = \left(\frac{M}{\rho \cdot V} \right)$$

with:

C = extinguishing gas concentration in Vol%

M = mass of extinguishing gas discharged into the room, in kg

ρ = density of extinguishing gas at normal ambient conditions (e.g. 20°C, 1,013 bar), in kg/m³

V = volume of room into which the extinguishing gas is discharged, in m³

1.2 Halogenated hydrocarbons

$$C = 100 \cdot \left(\frac{M}{M + \rho \cdot V} \right)$$

with:

C = extinguishing gas concentration in Vol-%

M = mass of extinguishing gas discharged into the room, in kg

ρ = density of extinguishing gas at normal ambient conditions (e.g. 20°C, 1,013 bar), in kg/m³

V = volume of room into which the extinguishing gas is discharged, in m³

2 Residual oxygen concentration

The residual oxygen concentration prevailing in a room after discharge of the entire extinguishing gas quantity can be estimated by means of the following equation:

$$O_2 = 20,9 \cdot \left(\frac{100 - C}{100} \right)$$

with:

O₂ = oxygen concentration after flooding in room, in % by volume

C = extinguishing gas concentration in % by volume (e.g. calculated acc. Clause 1)

Note: The equation is based on an oxygen concentration of 20,9% by volume before flooding (value for dry air).

Annex 5 – Rules and Regulations

The following relevant rules and regulations need to be observed in particular:

Laws, ordinances

- Labour protection laws
- Equipment safety law
- Operational safety ordinance

Source of supply: Buchhandel oder Carl Heymanns Verlag KG, Luxemburger Straße 449, 50939 Köln

Employers' Liability Insurance Association (BG) principles and regulations for operational safety and health

- Regulation for accident prevention "Principles of prevention" (BGV A1)
- Regulation for accident prevention "Safety and health protection signs at workplaces" (BGV A8)
- BG Regulation "Provision of fire extinguishers at workplaces" (BGR 133)
- BG Regulation "Regulations for the use of breathing apparatus" (BGR 190)
- BG Principles "Principles for the inspection of fire extinguishing systems with oxygen-displacing gases"

Source of supply: competent Employers' Liability Insurance Association or Carl Heymanns Verlag KG, Luxemburger Straße 449, 50939 Köln

Standards

- DIN 2403 Identification of pipelines according to the fluid conveyed
- DIN 3179-1 Classification of breathing apparatus; Overview
- DIN 4066 Information signs for fire brigade
- DIN 14 406-4 Portable fire extinguishers; Maintenance
- DIN EN 3 Portable fire extinguishers
- DIN 14 497 Small extinguishing units; Requirements, testing
- DIN 14 675 Fire detection and fire alarm systems; Design and operation
- DIN 33 404 Danger signals for workplaces
- DIN EN 54 Components of automatic fire detection and fire alarm systems
- DIN VDE 0833-1 Alarm systems for fire, intrusion and hold-up; Part 1: General requirements
- ISO 17025 General requirements for the competence of testing and calibration laboratories

Source of supply: Beuth Verlag GmbH, Burggrafenstraße 6, 10787 Berlin resp. VDE-Verlag GmbH, Bismarckstraße 33, 10625 Berlin

VdS Guidelines

- VdS Guidelines for CO₂ fire extinguishing systems – Planning and installation, VdS 2093
- VdS Guidelines for fire extinguishing systems using non-liquefied inert gases VdS 2380
- VdS Guidelines for fire extinguishing systems for halocarbon gases VdS 2381
- VdS Guidelines for the triggering of fire extinguishing systems VdS 2496

Source of supply: VdS Schadenverhütung GmbH, Amsterdamer Str. 172-174, 50735 Köln

