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VSH1230 Clean Agent Fire Suppression System
Novec™ 1230 Extinguishing Agent

Design Manual

Viking Special Hazards

WARNING: Cancer and Reproductive Harm- www.P65Warnings.ca.gov

UL LISTED ULC LISTED FM APPROVED

Read this manual prior to performing any task!

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1 General

1.1 Non UL or FM Approved items

Please note, that some of the mentioned parts or systems in this manual are not UL[1)] listed or not FM[2)] Approved.

These parts or systems are distinguished with

- an asterisk combined with "not UL", for those parts or systems not UL listed, example:Component* not UL.
- an asterisk combined with "not FM", for those parts or systems not FM Approved, example:Component* not FM.

You will find the distinguished marks either at the headlines or in the product data sheets.

1) Underwriters Laboratories

2) FM Approvals

1.2 Purpose of the manual

This manual describes the design of VSH1230 fire extinguishing systems. Information on fire detection and the electrical control system is not part of this manual.

The prerequisites for working with this manual are in-depth knowledge of the chemically active extinguishing agent, the technical details of VSH1230 fire extinguishing systems, and in-depth knowledge of the local guidelines, directives, and standards.

The best known and most frequently used international regulations for fire extinguishing systems with chemical extinguishing agents are the following:

- NFPA 2001
- ISO 14520, Part 1 and Part 5
- EN 15004, Part 1 and Part 2
- CEA 4045

This design manual contains neither detailed information concerning safe and efficient operation of the system, nor detailed information concerning installation and maintenance. An operating manual can be ordered from the manufacturer (➪ page 2) with the part number 932161. In addition an installation and maintenance manual can be ordered from the manufacturer under part number 932159.

Operation of the DesignManager software is described in a separate document (part number 924240).

See the respective data sheet in the Appendix for technical data on the individual components and components (separate document, part number 932163).

1.3 General information

Fire extinguishing systems are engineered to meet the standards of NFPA 2001, ISO 14520, EN 15004, FM Global, UL, CEA 4045 or other similar organizations, and will also need to comply with the provisions of governmental codes, ordinances, and standards where applicable. The system must be designed by qualified design professionals in conjunction with insuring bodies. The user is responsible for the design and configuration of the system, its appropriateness for the use intended and its compliance with all standards, codes and ordinances. The manufacturer or private labeler of the products, described in this manual, does not design systems for specific installations and makes no representation or warranty concerning whether any specific system installation will be sufficient for the intended use or will comply with any standard, code or ordinance.

System depictions, calculations, graphs or reports provided by the manufacturer or private labeler of the products, described in this manual, are for illustrative purposes only, and are not warranted to be representative or descriptive of any specific system, installation or design, or of the performance of or results attainable through same. The manufacturer or private labeler and its representatives disclaim use of the accompanying system depictions, calculations, graphs and reports for any purpose other than illustration; any other application or usage is solely the responsibility of the user.

The Authorized Distributor is responsible for selecting the fire extinguishing system components used and to ensure that its listing requirements meet requirements of applicable specifications. It is the Authorized Distributors responsibility to ensure compatibility of the components used with system capability and state and local code and that the components selected are used in accordance with their listings and applicable manufacturer’s instructions.

1.4 Changes

The information in this document is subject to change and update. Illustrations in this document are intended to facilitate basic understanding, and may differ from the actual design of the system.

1.5 Copyright

Companies, names and dates that are used in the examples listed in this document are fictitious – if nothing to the contrary is noted.

Trademarks may only be used in accordance with recognized trademark practice, to the extent that output material produced with this software in accordance with this document contains such trademarks and is required for contractual use. This type of trademark use grants no property rights whatsoever relative to the respective trademark.

Before using the trademarks, it must be ensured that the trademark is not protected in favor of a third party in the territory of use. Liability on the part of the manufacturer for trademark infringements in these countries is excluded. With the exception of the above, this document gives no property rights inherent in the software.

1.6 Explanation of symbols

Safety and warning notices

Safety and warning notices are marked with symbols in this document. The introductory signal words express the respective extent of the danger.

⚠ DANGER

The signal word describes a danger with a high risk level. If the danger is not avoided, it will result in death or serious injury.

⚠ WARNING

The signal word describes a danger with a medium risk level. If the danger is not avoided, it may result in death or serious injury.

⚠ CAUTION

The signal word describes a danger with a low risk level. If the danger is not avoided, it may result in minor or moderate injury.

NOTICE

The signal word describes a danger with a low risk level. If the danger is not avoided, it may result in property and environmental damage.

Further markings

This marking emphasizes useful tips and recommendations as well as information for efficient and trouble-free operation.

2 Characteristics of the system

The following specific characteristics must be taken into consideration when planning fire extinguishing system projects.

2.1 Personal safety in the protected enclosure

For the safety of personnel comply with the LOAEL and NOAEL values of the extinguishing agent.

- NOAEL = 10 % by volume
- LOAEL > 10 % by volume

After the NOAEL value has been reached or exceeded measures to protect personnel are required. The type and scope of the required measures are specified by local regulations.

2.2 Personal safety in the cylinder storage room for the extinguishing agent containers

Extinguishing agent containers in the protected enclosure

If the extinguishing agent containers are located in the protected enclosure, special requirements apply for the safety of personnel ↳ *Chapter 2.1 “Personal safety in the protected enclosure” on page 9*.

Extinguishing agent containers in a separate cylinder storage room

Separate cylinder storage rooms for the extinguishing agent containers with spatial volume that is less than that of the protected enclosure must be adequately vented. The conditions are specified by local regulations.

Safety relief lines

For multi zone systems a safety valve is installed on the distribution pipe of the area. Route the safety relief line of the safety valve to the outdoors. In addition the safety relief line must be designed in such a manner that when venting out, hazards cannot occur for personnel due to the extinguishing agent flowing out under pressure.

2.3 Decomposition products

For fluoride-based chemically-active extinguishing agents, in addition to fire gasses hydrogen fluoride (HF) can also occur during extinguishment. An aqueous solution of hydrogen fluoride results produces hydrofluoric acid.

For class A fires with low fire energy and timely fire detection, as well as sufficient extinguishing agent concentration, the quantity of hydrogen fluoride that occurs when extinguishing is negligibly low.

For class B fires (liquid fires) due to the fast and higher energy release more hydrogen fluoride occurs in the fire event.

2.4 Room permeability and hold time

Due to the optimized and economically-implemented quantity of extinguishing agent and the characteristic that the mixture of air and extinguishing agent that is capable of extinguishing is heavier than air, permeability of the enclosure delimitations of the protected enclosure result in losses of extinguishing agent. This can prevent an effective extinguishing concentration or the required hold time from being reached or maintained. Subjective visual assessment of a protected enclosure’s leak tightness is not precise enough. The door fan test specified in the regulations must be carried out. Alternatives include a test flooding or the use of additional quantities (surface term only VdS 2381).

The protected enclosure must also have the following characteristics:

- The protected enclosure must have automatic closing devices on doors and windows.
- Windows should not open or should only be openable with special tools.
- Enclosure surfaces must be made of non-combustible or flame-retardant materials.
- Use of a fire-safety seal against fire smoke and fire gases to adjacent areas.

- Enclosure surfaces and seals must be designed for the excess pressure or negative pressure that occurs during discharge.
- The enclosure delimitations (walls, doors, partitions, etc.) must be able to withstand the generated under- and over pressure conditions or be protected against them with under- and overpressure flaps.

2.5 Door fan test

The door fan test is used for precise determination of the seal of the enclosure delimitation of a extinguishing zone. For this a fan is mounted in a door of the extinguishing zone.

With the aid of the fan excess pressure and negative pressure is generated in the extinguishing zone. Based on multiple pressure differential and air throughput measurements a leakage surface as well as the theoretical hold time of the concentration capable of extinguishing fires can be calculated. In addition any leakage can be localized for sealing measures.

A description of the door fan test is provided in the following regulations and standards:

- NFPA 2001 Annex C
- ISO 14520-1 Annex E
- EN 15004-1 Annex E
- VdS 2381 Annex A10
- CEA 4045 Appendix A10

For proper use of the fire suppression system adequate room permeability is a crucial factor.

2.6 Filling pressure of the extinguishing agent containers

The extinguishing agent of the fire suppression system has a low inherent pressure (0.4 bar at 20 °C (5.8 psi at 68 °F)). To displace the extinguishing agent out of the extinguishing agent containers through the pipelines to the nozzles in the extinguishing zone a nitrogen blanket over the extinguishing agent in the container is required.

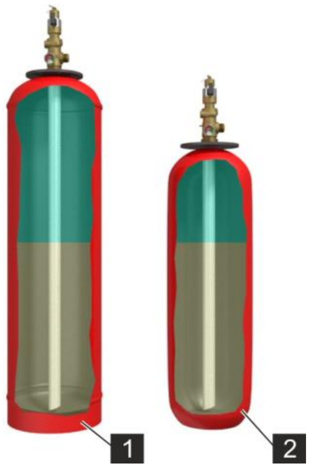


Fig. 1: Nitrogen blanket

1 Nitrogen condensed with 25 bar (360 psi)
2 Nitrogen condensed with 50 bar (725 psi)

The higher the blanketing pressure the higher the efficiency of the system.

The fire suppression system can be operated with a blanketing pressure of up to 50 bar (725 psi) (maximum system pressure). This offers the following advantages:

- With identical pipe diameter the maximum permissible pipeline length is greater than it is for comparable 25 bar or 42 bar systems (360 psi or 610 psi systems).
- The usable filling portion of the extinguishing agent containers (ratio of container volume to filling portion of extinguishing agent) is greater than that of the comparable 25 bar or 42 bar systems (360 psi or 610 psi systems).
- The required pipeline diameter at identical pipeline length is less than it is for comparable 25 bar or 42 bar systems (360 psi or 610 psi systems).
- At a higher filling portion of the extinguishing agent containers the containers are smaller than they are for comparable 25 bar or 42 bar systems (360 psi or 610 psi systems).

2.7 Additional extinguishing agent quantity to compensate for the non-usable residual quantities

Due to the design of the extinguishing agent containers, which are manufactured without seams, a non-usable residual quantity remains in the container after flooding is concluded. This residual quantity must be taken into account in the project planning through an additional quantity.

```
Extinguishing agent container filling
quantity = calculated quantity +
additional quantity
```

Extinguishing agent container size	22 l	40 l	80 l	100 l	80 l	140 l	180 l
Nominal filling	60 lbs	100 lbs	220 lbs	270 lbs	220 lbs	390 lbs	500 lbs
Manufacturing process	Seamless	Seamless	Seamless	Seamless	Seamless	Seamless	Seamless
Diameter	229 mm (9 in.)	229 mm (9 in.)	267 mm (10.5 in.)	316 mm (12.44 in.)	406 mm (16 in.)	406 mm (16 in.)	406 mm (16 in.)
Additional quantity	0.8 kg (1.76 lb)	0.8 kg (1.76 lb)	1.5 kg (3.31 lb)	2.3 kg (5.07 lb)	4.6 kg (10.14 lb)	4.6 kg (10.14 lb)	4.6 kg (10.14 lb)

In the DesignManager the additional quantity is added automatically to the design quantity.

2.8 Additional extinguishing agent quantity for multi zone systems

Extinguishing agent that remains in the pipeline during flooding due to the pipeline design, is not available for extinguishing. For multi zone systems extinguishing agent can remain in the zone distributor pipe at flooding. To compensate, an additional quantity must be taken into account and added to the required quantity.

For calculation of multi zone systems with the aid of DesignManager, approval tests have shown that due to compliance with varied limits the quantity remaining in the zone distributor is negligibly small. However, this only applies for use of DesignManager and of zone distributors manufactured by the manufacturer.

The additional quantity LZMB is calculated as follows:

$LZMB = V_{Pipe} * \rho$

V_{Pipe} = total volume of the pipeline, in which the extinguishing agent remains at flooding

ρ = density of the extinguishing agent

Density extinguishing agent	Unit
1616	kg/m³
1.616	kg/l
100.88	lb/ft³
0.05838	lb/in³

Example

V_{Pipe} = 0.35 ft³

ρ = 100.88 lb/ft³

LZMB = 0.35 ft³ * 100.88 lb/ft³ = 35.31 lb

2.9 Nozzle characteristic data

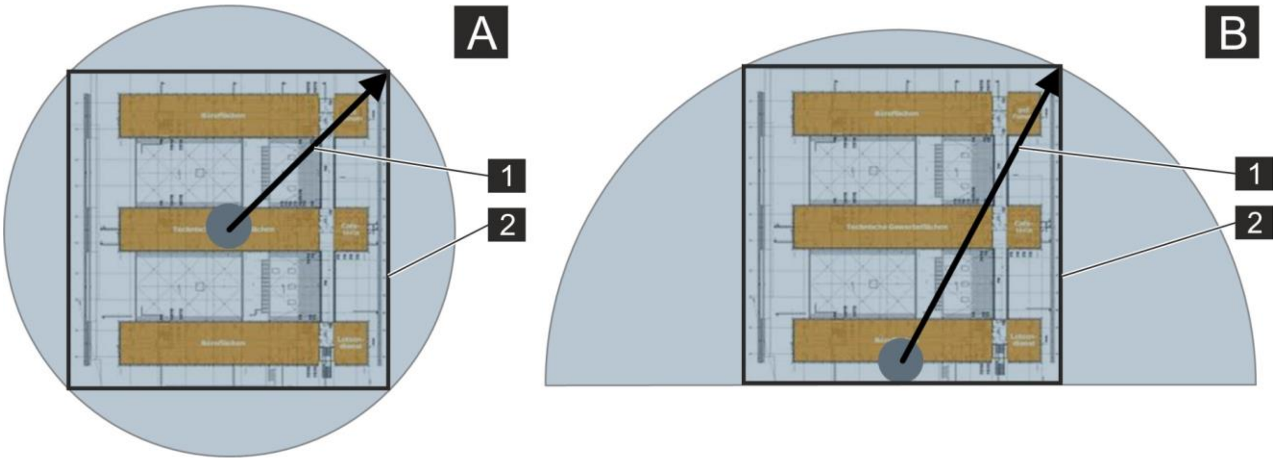


Fig. 2: Maximum effective nozzle radius and maximum nozzle coverage area

A 360° nozzle
B 180 °-nozzle
1 Maximum effective nozzle radius R_{max}
2 Maximum nozzle coverage area A_{max} (squared)

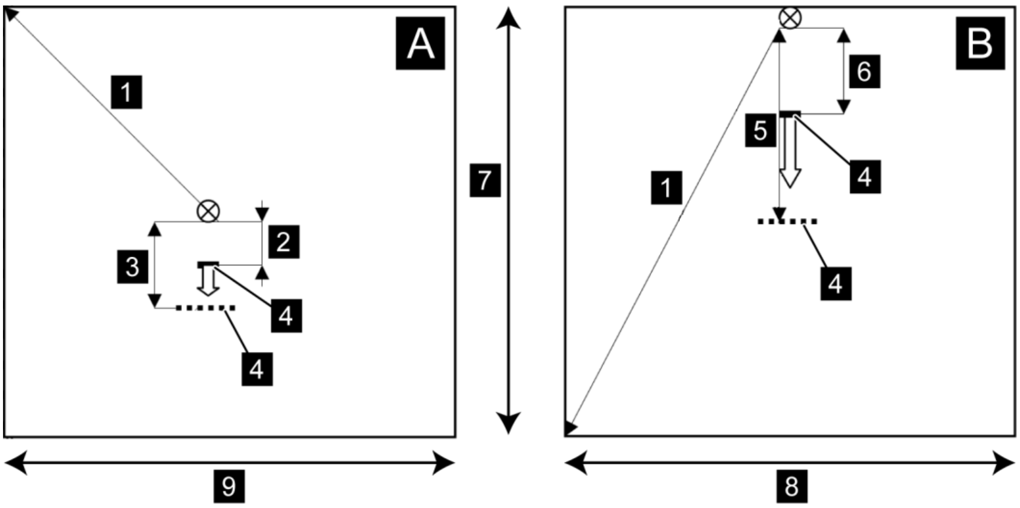


Fig. 3: Nozzle arrangement

A 360° nozzle
B 180°-nozzle
1 Maximum effective nozzle radius R_{max}
2 Minimum distance between a 360° nozzle and a spray obstacle
3 Maximum distance between a 360° nozzle and a spray obstacle
4 Spray obstacle*
5 Maximum distance between a 180°-nozzle and a spray obstacle
6 Minimum distance between a 180°-nozzle and a spray obstacle
7 max. 9.75 m (32 ft)
8 max. 9.75 m (32 ft)
9 max. 9.75 m (32 ft)

* - The maximum height of the spray obstacle should be as high as the enclosure.

For a **360° nozzle** the following characteristic data applies:

- Maximum nozzle coverage area A_{max}: 95 m² (1024 ft²).
- Maximum effective nozzle radius R_{max}: 6.9 m (22.6 ft).
- Maximum effective nozzle height H_{max}, standard: 4.27 m (14 ft).
- Maximum effective nozzle height H_{max}, extended*: 5.45 m (17.9 ft).
- Minimum effective nozzle height H_{min}: 0.3 m (1 ft).
- Minimum distance between a 360° nozzle and a spray obstacle: 1.22 m (4 ft):

  The maximum width of the spray obstacle should be 0.98 m (3.2 ft) (Fig. 3/2).

- Maximum distance between a 360° nozzle and a spray obstacle: 2.44 m (8 ft).

  The maximum width of the spray obstacle should be 1.95 m (6.4 ft) (Fig. 3/3).
- Maximum distance from the ceiling or from the virtual protection height: 0.3 m (1 ft).

For a **180° nozzle** the following characteristic data applies:

- Maximum nozzle coverage area A_{max}: 95 m² (1024 ft²).
- Maximum effective nozzle radius R_{max}: 10.9 m (35.8 ft).
- Maximum effective nozzle height H_{max}, standard: 4.27 m (14 ft).
- Maximum effective nozzle height H_{max}, extended*: 5.45 m (17.9 ft).
- Minimum effective nozzle height H_{min}: 0.3 m (1 ft).
- Minimum distance between a 180°-nozzle and a spray obstacle: 2.44 m (8 ft):

  The maximum width of the spray obstacle should be 0.98 m (3.2 ft) (Fig. 3/6).
- Maximum distance between a 180°-nozzle and a spray obstacle: 4.88 m (16 ft)

  The maximum width of the spray obstacle should be 1.95 m (6.4 ft) (Fig. 3/5).
- Maximum distance from the ceiling or from the virtual protection height: 0.3 m (1 ft).
- Maximum distance from the side wall or from the virtual enclosure partition: 0.3 m (1 ft).

* The extended maximum effective nozzle height has a higher design concentration as the prerequisite (*Chapter 2.12 “Design concentration” on page 23*) and the temperature range for set up of the extinguishing agent container is limited (-5 °C to 50 °C (23 °F to 122 °F)).

The following always applies:

- Minimum nozzle pressure: 7.65 bar (111 psi).
  The minimum nozzle pressure must be maintained to ensure the evaporation of the extinguishing agent on the nozzle as well as the homogeneous distribution of the extinguishing agent in the extinguishing zone.
- Maximum extinguishing agent quantity on a nozzle: 216 kg (476 lbs).
- Spray obstacles:
  Spray obstacles cover and obstruct the spray area of the nozzle. Only one spray obstacle is permitted on one nozzle. If there are multiple or larger spray obstacles, and if these obstacles are outside of the limits specified in Fig. 3, then additional nozzles are required.

According to the VdS Guideline, the maximum or minimum distance is determined based on the duration of evaporation (see VdS 2381).

2.10 Examples of different nozzle arrangements

The following sections present various options for protecting a given enclosure (Fig. 4).

The presented options differ in terms of:

- Number of nozzles
- Nozzle type
- Nozzle position.

Enclosure to be protected

Fig. 4: Enclosure to be protected

Design with two 360° nozzles (inadequate)

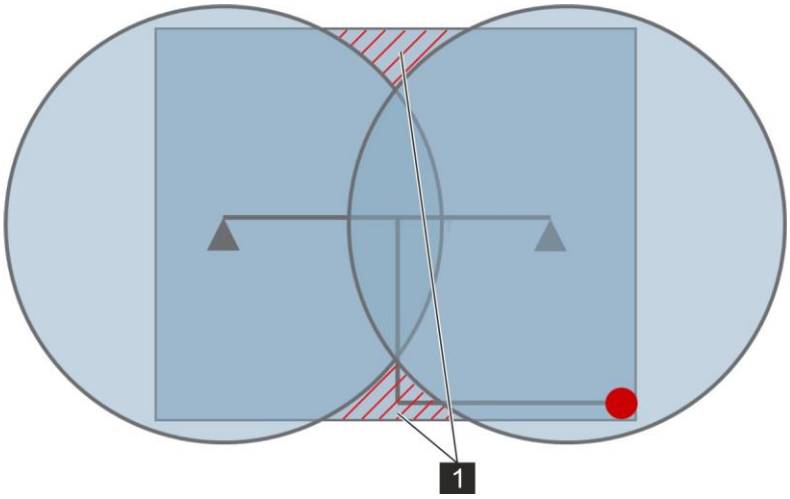


Fig. 5: Design with two 360° nozzles (inadequate)

The following conditions are fulfilled in the design with two 360° nozzles:

- Maximum effective nozzle height
- Minimum effective nozzle height
- Maximum coverage area per nozzle
- Maximum extinguishing agent quantity per nozzle.

The following conditions are **not** fulfilled:

- Coverage of the entire enclosure. The effective nozzle radius is too small, meaning that parts of the enclosure to be protected (Fig. 5/1) are **not** covered.

Design with four 360° nozzles

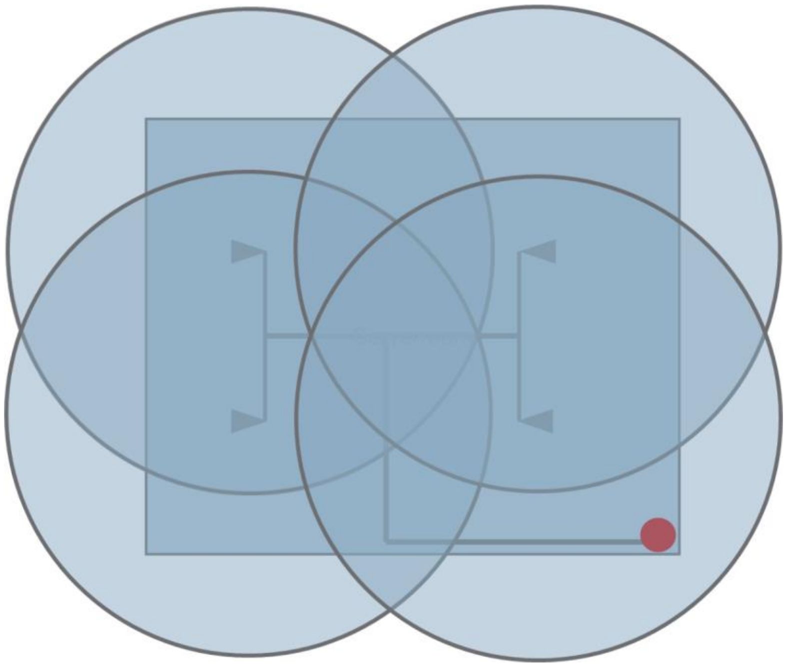


Fig. 6: Design with four 360° nozzles

Simple and symmetric solution, but expensive and subject to the risk of crossing up with lighting systems and ventilation ducts.

Design with three 360° nozzles

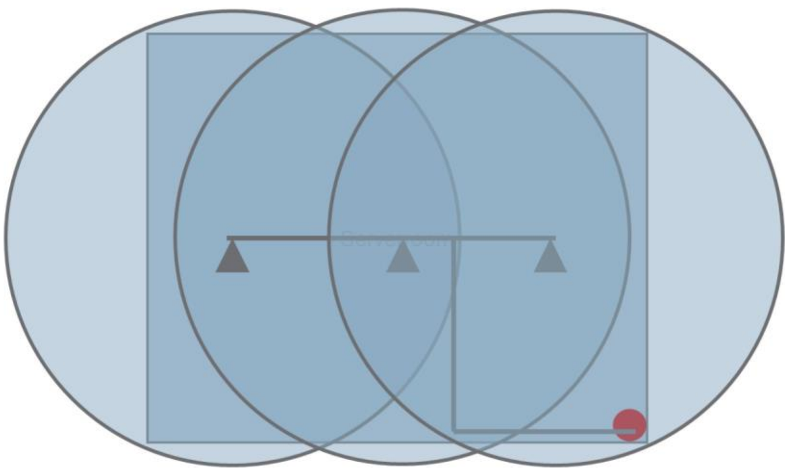


Fig. 7: Design with three 360° nozzles

The surface is completely covered, but the distribution must be handled with care.

Design with two 180° nozzles, "back to back"

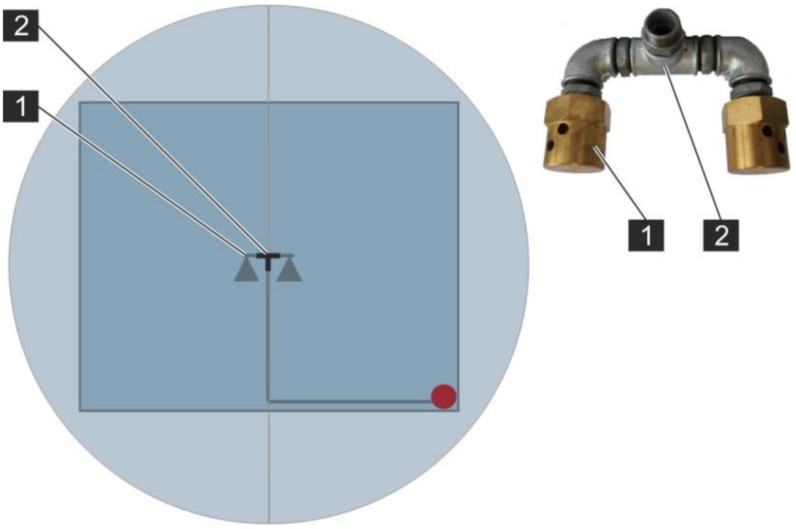


Fig. 8: Design with two 180° nozzles, "back to back"

1 180°-nozzle
2 T piece

Nozzles on a virtual wall (central in the enclosure), installed vertically.

Maximum distance between the nozzles: 0.6 m (2 ft).

Design with two 180° nozzles, "side by side"

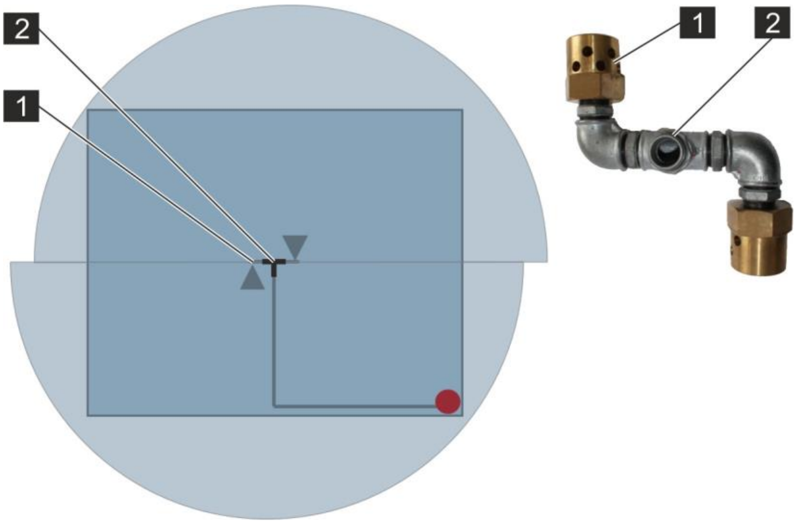


Fig. 9: Design with two 180° nozzles, "side by side"

1 180°-nozzle
2 T piece

Nozzles on a virtual wall (central in the enclosure), installed vertically.

Maximum distance of the lowest nozzle to the ceiling: 0.3 m (1 ft).

Design with two 180° nozzles, "face to back"

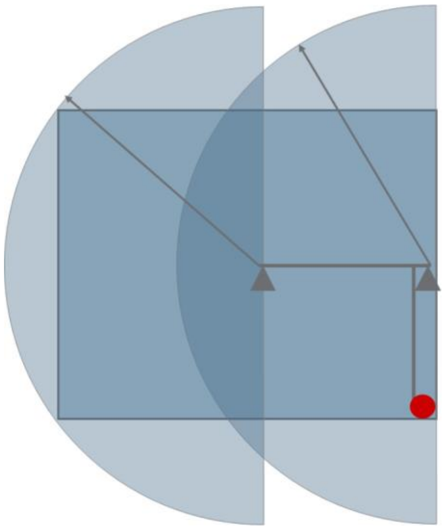


Fig. 10: Design with two 180° nozzles, "face to back"

Design with two 180° nozzles, "face to face"

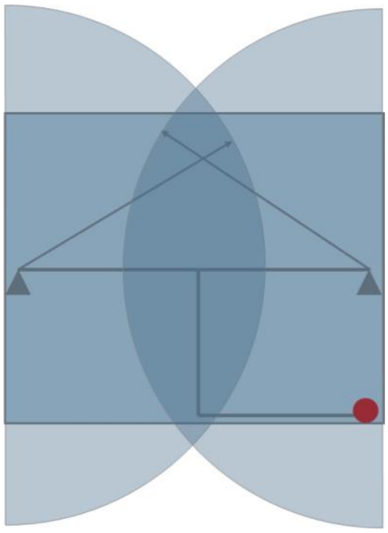


Fig. 11: Design with two 180° nozzles, "face to face"

2.11 Operating temperature

⚠ WARNING

– **Ensure that the specified temperature values are maintained.**

For UL/FM-approved systems the temperatures for the pipe system and the protected enclosure due to the previously executed tests of the calculation program (DesignManager) are limited to values from 15.6 °C (60 °F) to 26.7 °C (80 °F). If the temperatures are outside of this value range, there is a risk that the calculation will be too imprecise and the mandatory limits will not be observed. There is then a danger of injury because fires may not be extinguished.

The fire suppression system can always be set up for operation in a temperature range from -18 °C to +50 °C (0 °F to 122 °F).

However, for use of the extended maximum effective nozzle height of 5.45 m (17.9 ft) a limited temperature range of -5 °C to 50 °C (23 °F to 122 °F) applies for set up of the extinguishing agent containers.

However to ensure evaporation of the liquid extinguishing agent at activation, the temperature should be at least 0 °C (32 °F)* in the protected enclosure. The maximum temperature for the protected enclosure is 50 °C (122 °F).**

* UL/FM: 15.6 °C (60 °F)

** UL/FM: 26.7 °C (80 °F)

The additional extinguishing agent quantity is determined by design concentration and design temperature. The design temperature is the lowest temperature that can be expected in the protected enclosure.

Due to system characteristics the electrical contact of the contact pressure gauge switches at a temperature of approx. 5°C (41°F) due to the temperature-occasioned pressure drop in the extinguishing agent container.

2.12 Design concentration

Maximum effective nozzle height, standard

The design concentration is determined by the required extinguishing concentration as well as additional safety quantities. The following applies for the maximum standard effective nozzle height to 4.27 m (14 ft):

- Extinguishing concentration class A MEC (NFPA 2001): 3.34% by volume
- Extinguishing concentration class B MEC (n-heptane) (NFPA 2001): 4.5% by volume

The design concentrations for class B listed here are based on n-heptane. For other liquid and gaseous combustibles, higher values may be required. To determine the required design concentration, the design concentrations listed in the regulations and the cup-burner values for the respective combustible liquids/gases of the extinguishing agent manufacturer should be subjected to a safety margin of at least 30%.

Design concentration in accordance with NFPA 2001:

- class A fires: 4.2% by volume [1)]
- class A fires: 4.5% by volume [2)]
- class B fires (n-heptane): 5.9% by volume [2)]
- class C fires (energized electrical hazards): 4.5% by volume [2)]

[1)]NFPA 2001 (edition 2008)

[2)]NFPA 2001 (edition 2012 and later)

Design concentrations in accordance with ISO 14520-5:

- class A fires (surface): 5.3% by volume
- class A fires (higher hazard): 5.6% by volume
- class B fires (n-heptane): 5.9% by volume

Please note that in the standard guidelines the minimum concentrations are specified for standard conditions. Deviating conditions can require an increase in the minimum concentration.

Maximum effective nozzle height, extended

The design concentration is determined by the required extinguishing concentration as well as additional safety quantities. The following applies for the maximum extended effective nozzle height to 5.45 m (17.9 ft):

Design concentration in accordance with NFPA 2001:

- class A fires: 4.5% by volume [1)]
- class A fires: 4.8% by volume [2)]

- class B fires (n-heptane): 6.3% by volume [2)]
- class C fires (energized electrical hazards): 4.8% by volume [2)]

[1)]NFPA 2001 (edition 2008)

[2)]NFPA 2001 (edition 2012)

Design concentrations in accordance with ISO 14520-5:

- class A fires (surface): 5.7% by volume
- class A fires (higher hazard): 5.9% by volume
- class B fires (n-heptane): 6.2% by volume

For use of an extended maximum effective nozzle height of more than 4.27 m (14 ft) a limited temperature range of -5 °C to 50 °C (23 °F to 122 °F) applies for set up of the extinguishing agent containers.

2.13 Requirements for fire detection elements and the fire suppression detection system

Fires must be reliably detected, if possible at an extremely early stage of fire emergence. Early fire detection is the basis for the early release of the fire suppression system and thus ensures minimum fire damage.

The components of the fire detection and extinguishing control panel must satisfy local regulations and standards.

For FM-approved systems, FM-approved fire-detection elements and release devices must be used. In addition fire detection and extinguishing control panels must be used that are compatible with the fire-detection elements and release devices.

For UL-approved systems, UL-approved fire-detection elements and release devices must be used. In addition fire detection and extinguishing control panels must be used that are compatible with the fire-detection elements and release devices.

For information on compatibility see the separate operating manual of the fire detection and extinguishing control panel.

2.14 Special requirements imposed on high air movement rooms

Air conditioners generate a high air speed in operation. In the event of fire, this dilutes the fire smoke. This influences the detection characteristics of optical smoke detectors; under certain conditions this can delay activation of the smoke detector. Therefore in high air movement rooms early fire detection systems (e.g. Helios aspiration smoke detectors) should be used.

In high air movement rooms with fresh air admixture there is danger that the fire smoke from outside will be suctioned in with the fresh air and the fire detection devices will respond incorrectly. The fresh-air supply should therefore be monitored with smoke detectors and automatically closed if fire smoke occurs.

Volumes of air-conditioning or ventilation ducts that are in constant connection with the air volume of the flooding area must be taken into account as a supplemental volume in the quantity calculation of the extinguishing agent.

2.15 Pressure relief device

In the extinguishing zone negative pressure occurs briefly when flooding begins. During the flooding process the pressure increases – excess pressure occurs. For the proper function of the fire suppression system and to avoid structural damage in the protected enclosure, negative pressure and excess pressure must be dissipated from the extinguishing zone via a pressure relief device.

In DesignManager the required pressure compensation opening is calculated on the basis of the VdS model. In addition, the cross section of an existing pressure compensation opening can be entered; as the result you will get an estimate of the negative pressure/excess pressure that can be expected.

For determination of the necessary pressure relief area we recommend the procedure that is described in the FSSA Guide "Estimating Enclosure Pressure and Pressure Relief Vent Area for Applications Using Clean Agent Fire Extinguishing Systems".

- Source: www.fssa.net

3 Project procedure for fire extinguishing systems

An optimal project procedure for fire extinguishing systems is presented below:

1 - Check whether all required information that is required from the design phase until transfer to the owner is present

2 - Calculate the protection volumes and estimate the quantity of extinguishing agent

3 - Determine the location of the extinguishing agent containers and container size, and preselect the system pressure stage

4 - Determine the pipeline routing and prepare isometric drawings

5 - Calculate the system with the DesignManager

6 - Optimize the system with the aid of the calculation results

7 - Have the extinguishing agent container set-up approved by the owner

8 - Order components with the DesignManager parts list

9 - Install the system

10 - Check the system calculation against the actual pipeline routing, which may deviate from the planning

11 - Prepare documentation and transfer it to the owner

4 Pipelines and pipe routing

⚠ WARNING

– **Only use tested pipelines and fittings (ISO and NPT).**

If non-tested pipelines and fittings are used there is a risk that not enough extinguishing agent will flow out of the fire suppression system. This can cause injuries.

Pipelines, fittings, and installation of pipelines and fittings must satisfy the local guidelines, directives, and standards.

With reference to the NFPA 2001 requirements the following operating pressures are specified. Pipelines must be configured for at least these operating pressures.

Fill factor 1200 kg/m³ (74.9 lb/ft³)			
Container pressure at 21 °C (70 °F)	**Container pressure (compensated) at 50 °C (122 °F)**	**Minimum design pressure for the nozzle pipe system at 21 °C (70 °F)**	**Minimum configuration pressure for manifolds upstream of selector valves at 21 °C (70 °F)**
25 bar (360psi)	29 bar (421 psi)	25 bar (360psi)	66 bar (958 psi)
42 bar (610 psi)	48 bar (696 psi)	42 bar (610 psi)	66 bar (958 psi)
50 bar (725 psi)	57,5 bar (833 psi)	50 bar (725 psi)	66 bar (958 psi)

* The prerequisite is use of the safety valve (part number 888007) in the manifold

⚠ CAUTION

– **Check manifolds for compressive strength and leaks before use.**

Distribution pipes of selector valves are prefabricated and tested components. Manifolds for the extinguishing agent containers of multiple container systems are manufactured at the construction site or in the plant.

The most important rules for designing pipe systems

- Distribute nozzle arrangement and feed line as balanced as possible
- Comply with the branching rules

- Keep the number of elbows to a minimum, these cause the highest pressure losses of all pipeline components
- Strictly note and comply with the quantity distribution to T pieces, possibly an overfilling of enclosure parts in the extinguishing zone may be necessary

NOTICE

– **Comply with specifications due to system characteristics, such as minimum nozzle pressure, flow speed of the extinguishing agent, minimum and maximum outflow times, etc.**

The pipelines are calculated on the basis of a hydraulic calculation with the DesignManager. Retroactive changes to the line routing and the pipe cross sections without a new calculation can cause the fire suppression system to fail.

Retroactive changes to the pipe system must be specified in writing and presented to the project manager for evaluation and possibly for a new calculation.

⚠ CAUTION

– **Ensure cleanliness when installing the pipe system.**

Residues and fouling (cutting oil, greases, sealing compound) can get into the extinguishing zone through the nozzles during the extinguishing process and cause damage.

Acceptable quantity distribution to T pieces

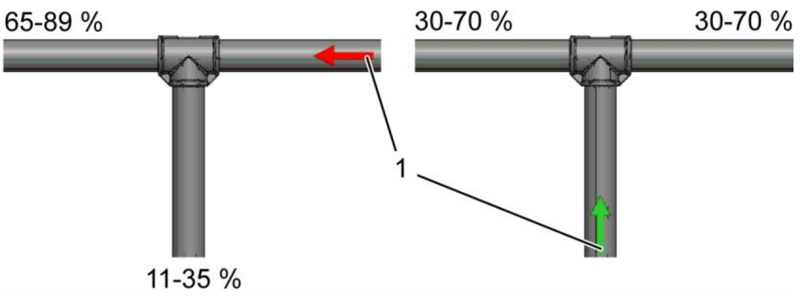


Fig. 12: Quantity distribution

1 Inlet

Due to the T piece split quantity rule (Fig. 12) it may be necessary to flood enclosure parts of the extinguishing zone (e.g. raised floor or intermediate ceiling), for which the extinguishing agent is tapped laterally from the main line (more extinguishing agent than would be mathematically required for extinguishing).

Acceptable position of T pieces

Due to the Novec™ 1230 2-phase flow in the pipeline (liquid and gaseous simultaneously) outlets to nozzles or distributions to T pieces are only permitted via lateral branches (settling section)! Direct connection of T pieces without lateral branches are permitted for stand pipes and down pipes (Fig. 13).

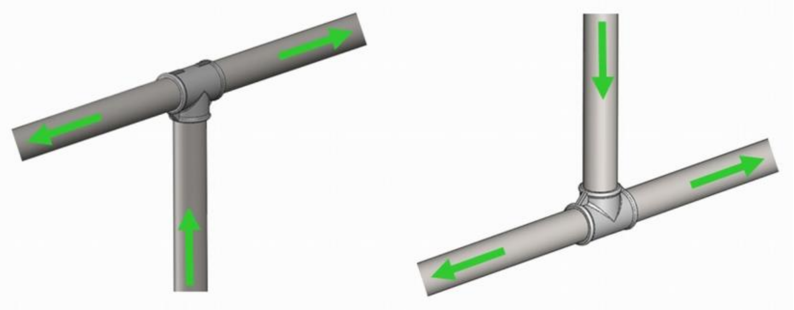


Fig. 13: Acceptable position

Unacceptable position of T pieces

The following branches are not permitted, as in these cases the proportion of gas and the proportion of liquid cannot be distributed uniformly (Fig. 14).

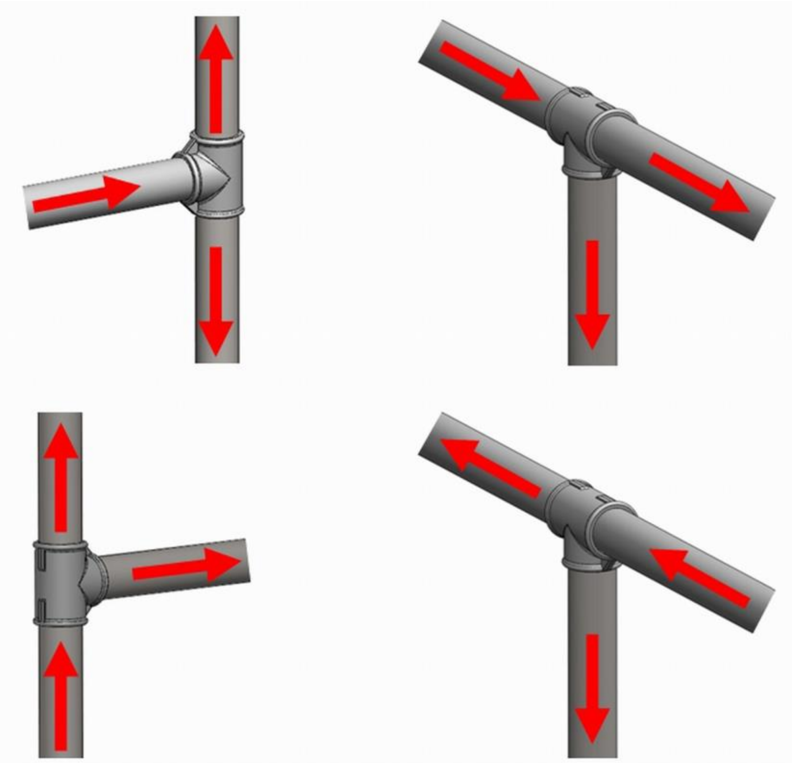


Fig. 14: Unacceptable position

Settling sections between T pieces

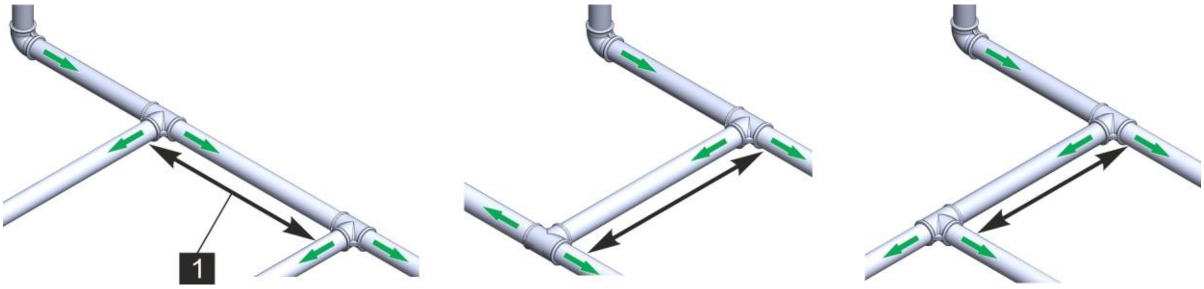


Fig. 15: Settling sections

Settling sections (Fig. 151) are required to obtain a homogenous flow behavior downstream from a distribution.

Pipeline sections must be at least as long as 10x the nominal pipe cross-section.

After a T piece, no settling segments are required directly before the individual nozzles.

Modular pipe system

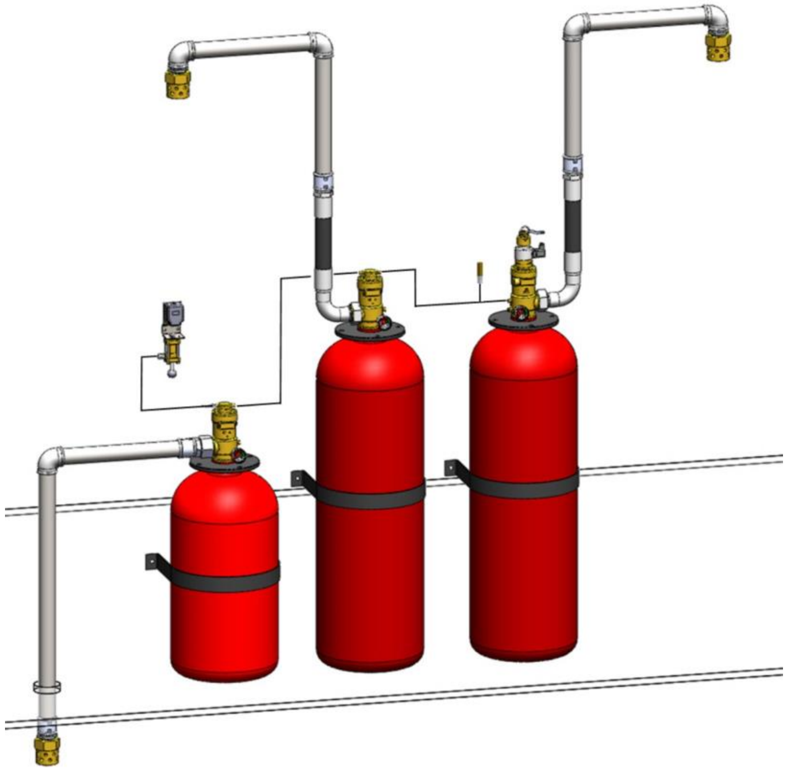


Fig. 16: Modular pipe system

For a modular pipe system (Fig. 16) every extinguishing agent container (or multiple extinguishing agent containers connected via a manifold) within a extinguishing zone, has a separate nozzle pipe system with one or more nozzles. For every extinguishing agent container the pipe system is calculated separately hydraulically. The entire volume of the extinguishing zone is subdivided into separate calculations. If a manifold is not used then the check valves can be dispensed with.

Balanced pipe system (with 2 or more nozzles on one pipe system)

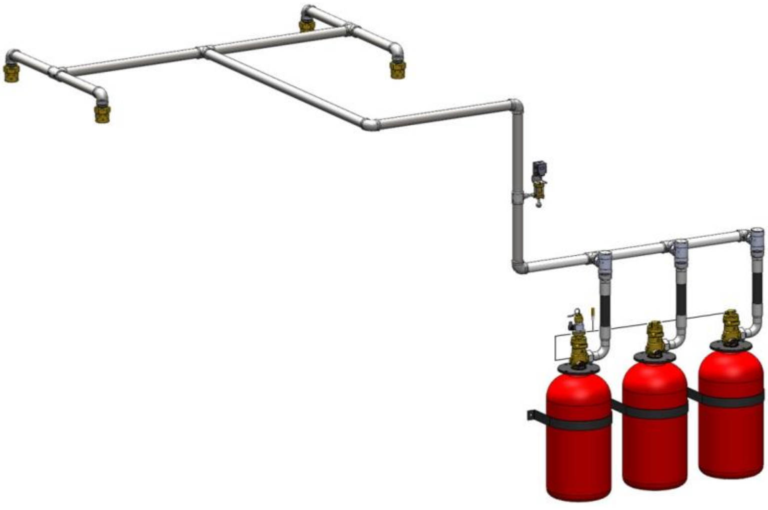


Fig. 17: Balanced pipe system

For a balanced pipe system (Fig. 17) the lengths and nominal diameters of the feed lines to the nozzles are identical. This means that all nozzles have the same nominal diameter and the same orifice diameter. Because the flow time of the extinguishing agent, the mass discharge, and the pressures are identical for all nozzles, the hydraulic calculation for balanced systems is less complex than it is for unbalanced systems.

Unbalanced pipe system (with 2 or more nozzles on one pipe system)

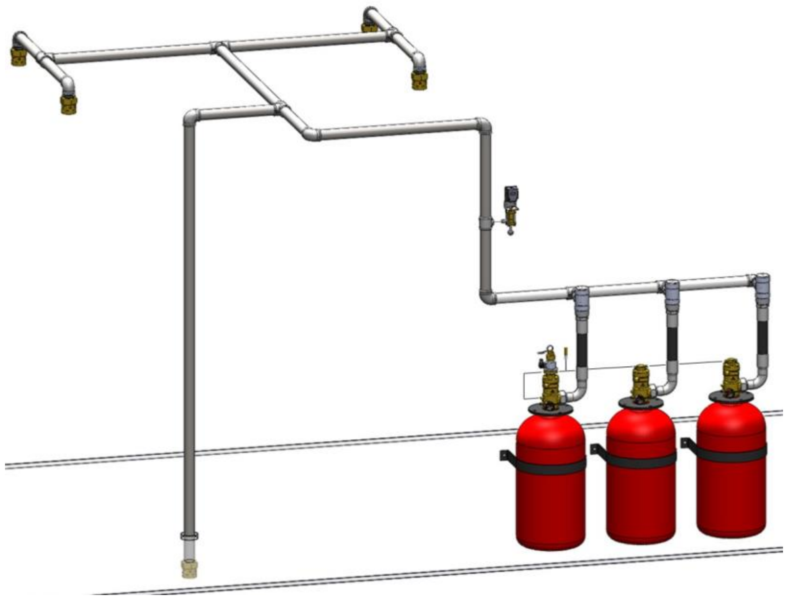


Fig. 18: Unbalanced pipe system

For unbalanced pipe systems, the lengths and nominal diameters of the feed lines to the nozzles are not identical. Nozzle pressures and mass discharges are different. Special care is required if there is retroactive change to a calculated unbalanced pipe system.

5 Information required for the design

Part numbers of the components and additional information, such as control diagrams, electrical connection data, etc. are provided in the installation and maintenance manual.

5.1 Required extinguishing agent quantity

Source: NFPA 2001, Standard on Clean Agent Fire Extinguishing Systems, 2008 Edition, Table A.5.5.1 (a)

Temp (t) (°F) - c	Specific Vapor Volume (s) (ft^3/lb) - d	Weight Requirements of Hazard Volume, W/V (lb/ft^3) - b Design Concentration (% by Volume) - e							
		4.2	5.3	5.6	5.9	6.0	7.0	8.0	9.0
30	1.05883	0.0414	0.0529	0.0560	0.0592	0.0603	0.0711	0.0821	0.0934
40	1.08324	0.0405	0.0517	0.0548	0.0579	0.0589	0.0695	0.0803	0.0913
50	1.10765	0.0396	0.0505	0.0536	0.0566	0.0576	0.0680	0.0785	0.0893
60	1.13206	0.0387	0.0494	0.0524	0.0554	0.0564	0.0665	0.0768	0.0874
70	1.15647	0.0379	0.0484	0.0513	0.0542	0.0552	0.0651	0.0752	0.0855
80	1.18088	0.0371	0.0474	0.0502	0.0531	0.0541	0.0637	0.0736	0.0838
90	1.20529	0.0364	0.0464	0.0492	0.0520	0.0530	0.0624	0.0721	0.0821
100	1.22970	0.0357	0.0455	0.0482	0.0510	0.0519	0.0612	0.0707	0.0804
110	1.25411	0.0350	0.0446	0.0473	0.0500	0.0509	0.0600	0.0693	0.0789
120	1.27852	0.0343	0.0438	0.0464	0.0490	0.0499	0.0589	0.0680	0.0774
130	1.30293	0.0336	0.0430	0.0455	0.0481	0.0490	0.0578	0.0667	0.0759
140	1.32734	0.0330	0.0422	0.0447	0.0472	0.0481	0.0567	0.0655	0.0745
150	1.35175	0.0324	0.0414	0.0439	0.0464	0.0472	0.0557	0.0643	0.0732
160	1.37616	0.0319	0.0407	0.0431	0.0456	0.0464	0.0547	0.0632	0.0719
170	1.40057	0.0313	0.0400	0.0424	0.0448	0.0456	0.0537	0.0621	0.0706
180	1.42498	0.0308	0.0393	0.0416	0.0440	0.0448	0.0528	0.0610	0.0694
190	1.44939	0.0302	0.0386	0.0409	0.0433	0.0440	0.0519	0.0600	0.0682

Temp (t) (°F) - c	Specific Vapor Volume (s) (ft^3/lb) - d	Weight Requirements of Hazard Volume, W/V (lb/ft^3) - b Design Concentration (% by Volume) - e							
		4.2	5.3	5.6	5.9	6.0	7.0	8.0	9.0
200	1.47380	0.0297	0.0380	0.0403	0.0425	0.0433	0.0511	0.0590	0.0671
210	1.49821	0.0293	0.0374	0.0396	0.0418	0.0426	0.0502	0.0580	0.0660
220	1.52262	0.0288	0.0368	0.0390	0.0412	0.0419	0.0494	0.0571	0.0650

a - The manufacturer's listing specifies the temperature range for the operation.

b - W/V [agent weight requirements (lb/ft^3)] = pounds of agent required per cubic foot of protected volume to produce indicated concentration at temperature specified

```
W = V/s * (C/(100-C))
```

c - t [temperature (°F)] = the design temperature in the hazard area

d - s [specific volume (ft^3/lb)] of superheated FK-5-1-12 vapor can be approximated by the formula: `s = 0.9856 + 0.002441*t` where t is the temperature in °F

e - C [concentration (%)] = volumetric concentration of FK-5-1-12 in air at the temperature indicated

Temperature T	Specific vapor volume S	FK-5-1-12 mass requirements per unit volume of protected space, m/V (kg/m^3) This information refers only to FK-5-1-12, and may not represent any other products containing Dodecafluoromethylpentan-3-one as a component.							
		Design concentration (by volume)							
°C	m^3/kg	4.2%	5.3 %	5.6 %	5.9 %	6 %	7 %	8 %	9 %
0	0.0664	0.6603	0.8429	0.8934	0.9443	0.9613	1.1336	1.3096	1.4895
5	0.0678	0.6466	0.8255	0.8750	0.9248	0.9418	1.1106	1.2831	1.4593
10	0.0691	0.6345	0.8099	0.8585	0.9074	0.9232	1.0886	1.2576	1.4304
15	0.0705	0.6219	0.7938	0.8414	0.8894	0.9052	1.0674	1.2332	1.4026
20	0.0719	0.6098	0.7784	0.8251	0.8720	0.8879	1.0471	1.2096	1.3758
25	0.0733	0.5981	0.7635	0.8093	0.8554	0.8713	1.0275	1.1870	1.3500

Temperature T	Specific vapor volume S	FK-5-1-12 mass requirements per unit volume of protected space, m/V (kg/m³) This information refers only to FK-5-1-12, and may not represent any other products containing Dodecafluoromethylpentan-3-one as a component.							
		Design concentration (by volume)							
°C	m³/kg	4.2%	5.3 %	5.6 %	5.9 %	6 %	7 %	8 %	9 %
30	0.0746	0.5877	0.7502	0.7952	0.8405	0.8553	1.0086	1.1652	1.3252
35	0.0760	0.5769	0.7364	0.7806	0.8250	0.8399	0.9904	1.1442	1.3013
40	0.0774	0.5664	0.7231	0.7664	0.8101	0.8250	0.9728	1.1239	1.2783
45	0.0787	0.5571	0.7111	0.7538	0.7967	0.8106	0.9559	1.1043	1.2560
50	0.0801	0.5473	0.6987	0.7406	0.7828	0.7967	0.9395	1.0854	1.2345
55	0.0815	0.5379	0.6867	0.7279	0.7693	0.7833	0.9237	1.0671	1.2137
60	0.0829	0.5288	0.6751	0.7156	0.7563	0.7704	0.9084	1.0495	1.1936
65	0.0842	0.5207	0.6647	0.7045	0.7446	0.7578	0.8936	1.0324	1.1742
70	0.0856	0.5122	0.6538	0.6930	0.7325	0.7457	0.8793	1.0158	1.1554
75	0.0870	0.5039	0.6433	0.6819	0.7207	0.7339	0.8654	0.9998	1.1372
80	0.0883	0.4965	0.6338	0.6718	0.7101	0.7225	0.8520	0.9843	1.1195
85	0.0897	0.4888	0.6239	0.6613	0.6990	0.7115	0.8390	0.9692	1.1024
90	0.0911	0.4812	0.6143	0.6512	0.6882	0.7008	0.8263	0.9547	1.0858
95	0.0925	0.4740	0.6050	0.6413	0.6778	0.6904	0.8141	0.9405	1.0697
100	0.0938	0.4674	0.5967	0.6324	0.6684	0.6803	0.8022	0.9267	1.0540

m/V - is the agent mass requirement (in kg/m³); i.e. mass, m, in kilograms of agent required per m³ of protected volume V to produce the indicated concentration at the temperature specified

V - is the net volume of hazard (in m³); i.e. the enclosed volume minus the fixed structures impervious to extinguishant;

```
m = V/S * (c/(100-c))
```

T - is the temperature (in °C); i.e. the design temperature in the hazard area

S - is the specific volume (in m³/kg); the specific volume of superheated FK-5-1-12 vapor at a pressure of 1.013 bar may be approximated by `S = k1 + k2*T` where `k1 = 0.0664` and `k2 = 0.000274`

c - is the concentration (in %); i.e. the volumetric concentration of FK-5-1-12 in air at the temperature indicated, and a pressure of 1.013 bar absolute

5.2 Extinguishing agent container

Detailed information on the extinguishing agent containers is provided in the Appendix (separate document, part number 924680).

Extinguishing agent container size (nominal filling)	Valve type [1]	Siphon tube nominal diameter	Connection to the pipe system [2]
< 80 l (220 lbs)	B0482 DN33	32 mm (1.26 inches)	DN 40 (1 1/2 inch)
< 80 l (220 lbs)	B0481 DN49	42 mm (1.65 inches)	DN 50 (2 inch)

[1] - Type A = standard valve

Type B = valve with integrated electrical release device (special applications)

[2] - Nominal diameter of the hoses and adapters for the connection on the valve

Fill factor for all system pressure stages and container sizes

- Minimum fill factor: 400 kg/m³ (25.0 lb/ft³)
- Maximum fill factor UL/FM/CE: 1200 kg/m³ (74.9 lb/ft³)
- Maximum fill factor VdS: 1050 kg/m³ (65.5 lb/ft³)

Maximum container size: 180 l (500 lbs) empty volume

The extinguishing agent containers connected together on a manifold must have the same size and the same fill factor.

5.3 Use of different system pressure stages

Only connect extinguishing agent containers with the same system pressure on a distribution pipework.

Recommended use of the 25 bar (360 psi) system pressure stage:

- Systems with one extinguishing agent container, if for the calculation of a system with a system pressure of 42 bar (610 psi) the lowest nozzle pressure is greater than 25 bar (360 psi)
- Conversion from existing 25 bar (360 psi) systems, if these systems cannot be replaced by 42 bar (610 psi)
- Small protected enclosures in which the extinguishing agent container can be set up in the room
- Short pipelines from the extinguishing agent container to the nozzle

Recommended use of the 42 bar (610 psi) system pressure stage:

- Cost-optimized and use-optimized system for standard designs

Recommended use of the 50 bar (725 psi) system pressure stage:

- Systems with long pipelines for which the hydraulic calculation is not possible with a system pressure of 42 bar (610 psi)
- Multi zone systems for which the hydraulic calculation is not possible with a system pressure of 42 bar (610 psi)
  ↳ *Chapter 5.4 “Release of extinguishing agent containers through a “control cylinder” extinguishing agent container or CO_2 pilot cylinder” on page 39*

5.4 Release of extinguishing agent containers through a “control cylinder” extinguishing agent container or CO_2 pilot cylinder

Operating pressure “control cylinder" extinguishing agent container at 21 °C (70 °F)	Maximum length of the control line (pipe or hose with nominal diameter 4 mm ($^5/_{32}$ inches))	Maximum number of the pneumatic release devices for the slave extinguishing agent containers
25 bar (360 psi)	4 m (13.12 ft)	1 control cylinder + 4 slaves
42 bar (610psi)	6 m (19.69 ft)	1 control cylinder + 6 slaves
50 bar (725 psi)	8 m (23.25 ft)	1 control cylinder + 8 slaves

	Maximum length of the control line (pipe or hose with nominal diameter 4 mm ($^5/_{32}$ inches))	Maximum number of the pneumatic release devices for the slave extinguishing agent containers
CO_2 pilot cylinder	30 m (98.4 ft)	30

5.5 Use of test connections

For implementation of pneumatically-activated components the use of a test connection is recommended. Depending on the regulations and standards and local directives these test connections may also be prescribed.

- Extinguishing agent containers with pneumatic release devices
- Pneumatically-activated pressure relief devices

- If necessary pneumatically-activated limit switches or pressure switches that can no longer be activated manually for function verification
- Pneumatically activated door closing devices

Via the test connection the function of the pneumatically-activated components is tested with pressure from an external test agent container. If a test connection is not available a connection to the test agent container must be established. Each test connection must have an automatic non-return valve to ensure the impermeability of the pilot line in normal operation.

5.6 Quantity regulation for multi zone systems

The number of extinguishing agent containers that must be released can be controlled with shuttle non-return valves in the pilot lines of the pneumatic release devices of the extinguishing agent containers *Appendix A "Control diagram of a multi zone system" on page 55*.

5.7 Maximum extinguishing agent concentration at high temperatures

At a high temperature in the extinguishing zone, in the event of flooding the extinguishing agent concentration would be correspondingly higher. The maximum possible extinguishing concentration must be determined based on the maximum temperature that can be expected in the extinguishing zone. Personnel protection measures must be designed in accordance with the local requirements relative to this extinguishing agent concentration.

```
C = (W * S * 100)/(V + (W * S))
```

C - Concentration [%]

W - Extinguishing agent quantity used [kg (lb)]

V - Volume, extinguishing zone [m^3 (ft^3)]

T - Maximum temperature in the extinguishing zone [°C (°F)]

S - Specific vapor volume [m^3/kg (ft^3/lb)]

for this temperature *Chapter 5.1 "Required extinguishing agent quantity" on page 34*

5.8 Flooding time

Within the flooding time, the quantity of extinguishing agent specified for achieving the design concentration will be flooded into the extinguishing zone.

- Minimum flooding time: 7 s
- Maximum flooding time: 10 s

The size of the pressure relief device is also determined by the flooding time. At a shorter flooding time, a higher mass flow or volume flow is required, and thus a greater pressure compensating area is required than is required for a longer flooding time.

The specifications of the maximum flooding time required in the local regulations and standards (e.g. NFPA 2001) must be complied with. Likewise the minimum quantity of extinguishing agent to be brought in during flooding time must be complied with.

5.9 Restrictions due to the calculation method

Restriction of the extinguishing agent quantity in the pipeline:

- A maximum of 87% of the total extinguishing agent quantity should be in the pipeline.

Minimum and maximum fluid speeds:

- Minimum empty pipe speed of the fluid: 1.25 m/s (4.1 ft/s)
- Maximum empty pipe speed of the fluid: 10 m/s (32.81 ft/s)

Restrictions for the minimum and maximum opening cross section of the orifice bore relative to the connected pipe cross-section:

- Minimum: 0.071
- Maximum: 0.356

In the data sheet of the nozzles (separate document, part number 924680), in some cases larger bores or smaller bores are specified for technical reasons.

The method for calculating the nozzle opening cross section and for selecting a nozzle, as well as the nozzle flow data satisfy the specifications in VdS 2381.

Restrictions of the flow time deviation of the extinguishing agent:

- The flow time deviation of the extinguishing agent depends on the maximum volume deviation per nozzle. The maximum volume deviation is the volume differential per nozzle that occurs from the calculation of the discharge differential. The maximum discharge differential of the respective value is 10%.

Restriction of the maximum height differential between container valve and nozzle (only for UL):

- The maximum height differential between container valve and nozzle is restricted to 16.4 m (53.8 ft).

In addition, for multi zone systems the following also applies:

- Maximum number of selector valves: 15 units
- Maximum ratio of the dead volume in the manifold to the total volume of the manifold: 0.545
- Maximum number of unopened selector valve branches that the extinguishing agent flows by: 14 units

5.10 Equivalent lengths

Tee splits, Side-T

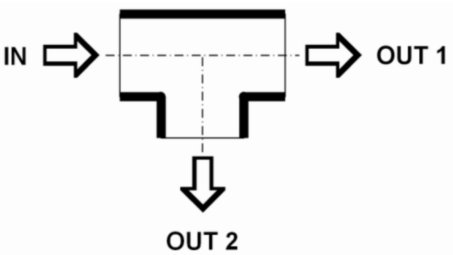


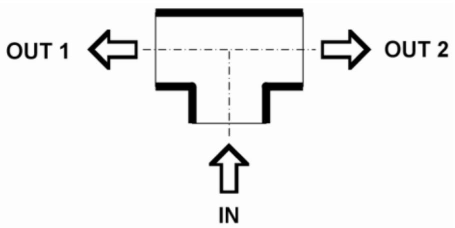
Fig. 19: Tee splits, Side-T

D_{IN} Nominal diameter of the inlet
D_{OUT1} Nominal diameter of the first outlet
D_{OUT2} Nominal diameter of the second outlet
L_{OUT1} Equivalent length of the first outlet
L_{OUT2} Equivalent length of the second outlet

D_{IN} [in.]	D_{OUT1} [in.]	D_{OUT2} [in.]	D_{IN} [mm]	D_{OUT1} [mm]	D_{OUT2} [mm]	L_{OUT1} [ft]	L_{OUT2} [ft]	L_{OUT1} [m]	L_{OUT2} [m]
1/2	1/2	1/2	15	15	15	0.98	3.41	0.30	1.04
3/4	3/4	3/4	20	20	20	1.41	4.49	0.43	1.37
1	1	1	25	25	25	1.80	5.71	0.55	1.74
1 1/4	1 1/4	1 1/4	32	32	32	2.30	7.51	0.70	2.29

D_{IN} [in.]	D_{OUT1} [in.]	D_{OUT2} [in.]	D_{IN} [mm]	D_{OUT1} [mm]	D_{OUT2} [mm]	L_{OUT1} [ft]	L_{OUT2} [ft]	L_{OUT1} [m]	L_{OUT2} [m]
1 1/2	1 1/2	1 1/2	40	40	40	2.69	8.69	0.82	2.65
2	2	2	50	50	50	3.48	11.19	1.06	3.41
2 1/2	2 1/2	2 1/2	65	65	65	4.10	13.39	1.25	4.08
3	3	3	80	80	80	5.09	16.60	1.55	5.06
3/4	3/4	1/2	20	20	15	1.41	3.41	0.43	1.04
1	1	1/2	25	25	15	1.80	3.41	0.55	1.04
1	1	3/4	25	25	20	1.80	4.49	0.55	1.37
1 1/4	1	3/4	32	25	20	1.80	4.49	0.55	1.37
1 1/4	1 1/4	1/2	32	32	15	2.30	3.41	0.70	1.04
1 1/4	1 1/4	3/4	32	32	20	2.30	4.49	0.70	1.37
1 1/4	1 1/4	1	32	32	25	2.30	5.71	0.70	1.74
1 1/2	1 1/2	1/2	40	40	15	2.69	3.41	0.82	1.04
1 1/2	1 1/2	3/4	40	40	20	2.69	4.49	0.82	1.37
2	2	1/2	50	50	15	3.48	3.41	1.06	1.04
2	2	3/4	50	50	20	3.48	4.49	1.06	1.37
2	2	1	50	50	25	3.48	5.71	1.06	1.74
2	2	1 1/4	50	50	32	3.48	7.51	1.06	2.29
2	2	1 1/2	50	50	40	3.48	8.69	1.06	2.65

Tee splits, Bull-T



D_{IN} Nominal diameter of the inlet
D_{OUT1} Nominal diameter of the first outlet
D_{OUT2} Nominal diameter of the second outlet
L_{OUT1} Equivalent length of the first outlet
L_{OUT2} Equivalent length of the second outlet

Fig. 20: Tee splits, Bull-T

Information required for the design

D_{IN} [in.]	D_{OUT1} [in.]	D_{OUT2} [in.]	D_{IN} [mm]	D_{OUT1} [mm]	D_{OUT2} [mm]	L_{OUT1} [ft]	L_{OUT2} [ft]	L_{OUT1} [m]	L_{OUT2} [m]
1/2	1/2	1/2	15	15	15	3.41	3.41	1.04	1.04
3/4	3/4	3/4	20	20	20	4.49	4.49	1.37	1.37
1	1	1	25	25	25	5.71	5.71	1.74	1.74
1 1/4	1 1/4	1 1/4	32	32	32	7.51	7.51	2.29	2.29
1 1/2	1 1/2	1 1/2	40	40	40	8.69	8.69	2.65	2.65
2	2	2	50	50	50	11.19	11.19	3.41	3.41
2 1/2	2 1/2	2 1/2	65	65	65	13.39	13.39	4.08	4.08
3	3	3	80	80	80	16.60	16.60	5.06	5.06
4	4	4	100	100	100	21.78	21.78	6.64	6.64

Table 1: Curves

Inch	DN	Equivalent length [ft]	Equivalent length [m]
3/8	10	1.31	0.40
1/2	15	1.67	0.51
3/4	20	2.20	0.67
1	25	2.79	0.85
1 1/4	32	3.61	1.10
1 1/2	40	4.27	1.30
2	50	5.58	1.70
2 1/2	65	6.56	2.00
3	80	8.20	2.50
4	100	10.70	3.26

Table 2: Valves including hoses and check valves

DN	Equivalent length [ft]	Equivalent length [m]
32	27.13	8.27
49	35.63	10.86

Table 3: Valves including hoses (excluding check valves)

DN	Equivalent length [ft]	Equivalent length [m]
32	24.41	7.44
49	32.05	9.77

Siphon tubes

Siphon tube losses are included into the cylinder assemble friction loss and therefore do not need to be calculated.

Adapters and connection pieces

Adapters and connection pieces are not relevant for the hydraulic model.

5.11 Conversion table for mass units

US unit	European SI unit
1 in.	25.4 mm
1 gal	3.785 l
1 ft^3	0.028317 m^3
1 lb	0.4536 kg
1 lb/ft^3	16.0185 kg/m^3
1 psi	6895 Pa
1 psi	0.0689 bar (1 bar = 10^5 Pa)

6 Documentation for the owner

Usually the documentation of a fire extinguishing system consists of the following documents:

- Operating manual
- Hydraulic calculation
- Isometric drawings of the pipeline (with lengths, diameters, and nozzle information)
- Blow-out certification and leak test (and possibly pressure test)
- Report book
- Documentation for extinguishing control panel
- Certificates

The required scope of documentation is specified in the regulations and standards (e.g. NFPA 2001).

7 Transfer to the owner of the system

When transferring the ready-to-operate system the owner, or the person who the owner has appointed to be responsible for the system, must be instructed in the following points:

- Mode of operation and characteristics of the system
- Possible dangers
- Function and operation the system
- Obligations of the owner (e.g. regular inspections, keeping the report book)
- Required maintenance tasks or maintenance intervals

The owner, or the person who the owner has appointed to be responsible for the system, must confirm the transfer of the ready-to-operate system on a transfer protocol and confirm the instruction.

8 Glossary

Additional quantity	Quantity of extinguishing agent that needs to be kept available in addition to the required quantity used in consideration of the allowable leakage quantities and other tolerances.
Approved	Approved by an Authority Having Jurisdiction (ADJ) / competent authority.
Blocking device	Mechanical device used to prevent the extinguishing agent from flowing into the extinguishing zone, e. g. during maintenance, inspections, and repairs inside the extinguishing zone.
Check valves	The check valve allows the extinguishing agent to flow only in the designated direction of flow (towards the extinguishing zone). It is installed in the inlets of the manifold (multi-container system) and prevents extinguishing agent originating from other extinguishing agent cylinders to exit the manifold into the open when the system is activated or extinguishing agent cylinders have been removed.
Design concentration	Concentration of the extinguishing agent that includes a safety factor and must be taken into consideration when the system is designed.
Door fan test	The door fan test (often also referred to as blower door test) is a check testing the integrity of an enclosure in connection with the installation of a gaseous fire suppression system or active fire prevention systems. For the purposes of this test, a fan installed in a door is used to generate an overpressure/underpressure in the enclosure which will then be compared to theoretical set values. This makes it possible to determine the size of the leakage area in this enclosure. A door fan test is often the more affordable alternative to test flooding.
Extinguishing concentration	Minimum concentration of the extinguishing agent necessary to put out a specific incendiary under specified test conditions (without consideration of design and safety factors).
Extinguishing zone	Total of all areas that will be flooded with extinguishing agent simultaneously in the event of fire.

Fill factor
Mass of the extinguishing agent per volume unit of the extinguishing agent cylinder.

Filling pressure
Pressure used to superpressurize the extinguishing agent container with nitrogen at the filling temperature in order to reach the system pressure.

Flooding
Outflow of the extinguishing agent into the extinguishing zone.

Flooding time
Period during which the required quantity of extinguishing agent flows out.

Hold time
Period during which a concentration of the extinguishing agent is present inside the extinguishing zone which is higher than the specified minimum concentration.

Manifold
Manifolds connect several extinguishing agent cylinders with one another and merge them into a single unit. Each manifold is fitted with a ➪ check valve.

Minimum nozzle pressure
Allowable and tested mean pressure on the discharge nozzles at which the fire suppression system still operates within the specified limits.

Nozzle pipe system
Part of the pipe system of a fire suppression system that begins at the outlet of the manifold and the outlet of the selector valves for single-zone systems and multi-zone systems, respectively.

Operating pressure
Pressure inside a container at the maximum permitted operating temperature.

Pilot cylinder
Compressed gas cylinder, the contents of which is used for control purposes.

Pressure relief device
Preventing damage to the containment components caused by excessive overpressures (required for extinguishing gases as they must be introduced at high concentrations and rates) requires a mechanical pressure relief device which will limit the increase or drop of pressure inside the extinguishing zone to a specified value.

Protected enclosure
Total of all extinguishing zones connected to a fire suppression system.

Quantity used
Mass or volume of the extinguishing agent that is required to reach the design concentration intended for the protected enclosure.

Release

Automatic or manual activation of the fire suppression system for the purpose of flooding the extinguishing zone by opening the container valves and – if present – the selector valves.

Release device

Device integrated into the container valve or screwed on to the container valve. It opens the cylinder valve to allow the extinguishing agent to flow out. There are the following different types of release devices:

Manual release device: It can/may only be fitted on top of the "Master" extinguishing agent container and, if applicable, also on top of an electrical release device already mounted on the container.

Electrical release device: It is used to electrically release the container. The electrical release device receives its triggering signal from the fire extinguishing detection system.

Pneumatic release device: It is used to pneumatically release additional containers in multi-container systems. It is screwed onto the extinguishing agent container instead of the electric release device and connected to a pneumatic pilot line that is located at the side release outlet of the electrically activated "master" extinguishing agent container.

Pneumatic/manual release device: The pneumatic/manual release device also makes it possible to release a container manually on location.

Safety device malfunction pressure

↯ Safeguard against slow gas leaks

Selector valve

A valve installed in the main supply line which will, when activated, release the extinguishing agent into the respective zone to be flooded.

Single-zone system

Single zone systems are equipped with one extinguishing agent supply that is intended for one extinguishing zone (↯ multi zone system).

Spray obstacle

An object present in the immediate spray zone of the discharge nozzle which obstructs the even distribution of the extinguishing agent.

System pressure

Pressure for which the fire suppression system has been designed and tested.

Time delay device

Automatic device used to delay the onset of the flooding by a preset time (pre-discharge timer) after the fire suppression system has been activated.

Pneumatic: A mechanically adjustable period (of usually 30 s) is counted down in a pneumatically actuated timing element before the extinguishing agent is released.

Mechanical: An adjustable period (of usually 30 s) is counted down in a mechanically actuated timing element before the extinguishing agent is released.

Electrical: A delay time is counted down in an electronic component of the fire suppression detection system before the fire suppression system is activated.

9 Index

Appendix

A Control diagram of a multi zone system

Table 4: Legend

BMZ	Fire detection control panel *(not part of this system approval)*
EST	Control device, electrical
EV	Electric time delay device
	Selector valve BV [07.1.2, 07.1.3]
	Pneumatic release device Reserve 3.6 to 30.0 kg (7.9 to 66.1 lb) CO_2 [04.7.1, 04.7.2] Shuttle non-return valve [04.4.1] Weighing device [01.2.1] High pressure container valve [01.1.2] Release device EM [03.2.1] Hose DN4 [01.4.1, 01.4.5] *(alternatively)* Hose [01.4.3] *(alternatively)*
	Manifold DN15 VT-15 High pressure container valve [03.1.1] and release device EM [03.2.1] Manifold [04.1.4]
	Extinguishing agent container VSH1230 [01.9.1] Electric release device VSH1230 [03.2.3] or integrated in the valve *optional, additional*: manual pneumatic release device VSH1230 [04.3.2] Contact pressure gauge [01.5.9] Hose DN50/40 [01.4.9] Container valve B0481/0482 [01.9.9] Hose [04.8.1, 04.8.2] EL = Electrical release M = Master

Control diagram of a multi zone system

	Extinguishing agent container VSH1230 [01.9.1] Electric release device with mechanical blocking device VSH1230 [03.2.4] *optional, additional*: manual pneumatic release device VSH1230 [04.3.2] Contact pressure gauge [01.5.9] Hose DN50/40 [01.4.9] Container valve B0481/0482 [01.9.9] Hose [04.8.1, 04.8.2] EL B = Electrical release with blocking M = Master
	Extinguishing agent container VSH1230 [01.9.1] Pneumatic release device VSH1230 [04.3.1] Contact pressure gauge [01.5.9] Hose DN50/40 [01.4.9] Container valve B0481/0482 [01.9.9] Hose [04.8.1, 04.8.2] PN = Pneumatic release S = Slave
	Electric fire detection element *(not part of this system approval)*
	Nozzle [07.2.6]
	Shuttle non-return valve [04.4.1]
	Pneumatic means of alarm [06.3.1]
	Monitored electric means of alarm, 24V-DC,
	Non monitored electric means of alarm, 230V-AC, *optional* Non monitored electric means of alarm, 24V-DC
	Safety device malfunction pressure SFD [04.6.1], SFD 300 [04.6.2]
	Manual release, electrical
	Disable device MX [04.1.3]
	Pneumatic time delay device PV-3-C [04.1.2]

	Pressure reducer [04.2.1]
	Push button selector valve [04.6.4] (air bleed device)
	Check valve MX-CR [01.3.9]
	Test connection [04.5.1]
	Safety relief valve Only for extinguishing agent manifold [07.3.1] Only for pilot pipe [07.3.2]
	Pressure gauge [04.5.2]

Fig. 21 shows a control diagram of a multi zone system with

- electro-pneumatic release
- mechanical blocking
- electrical time delay device
- secure electrical alarm
- DN15 distributor

Control diagram of a multi zone system

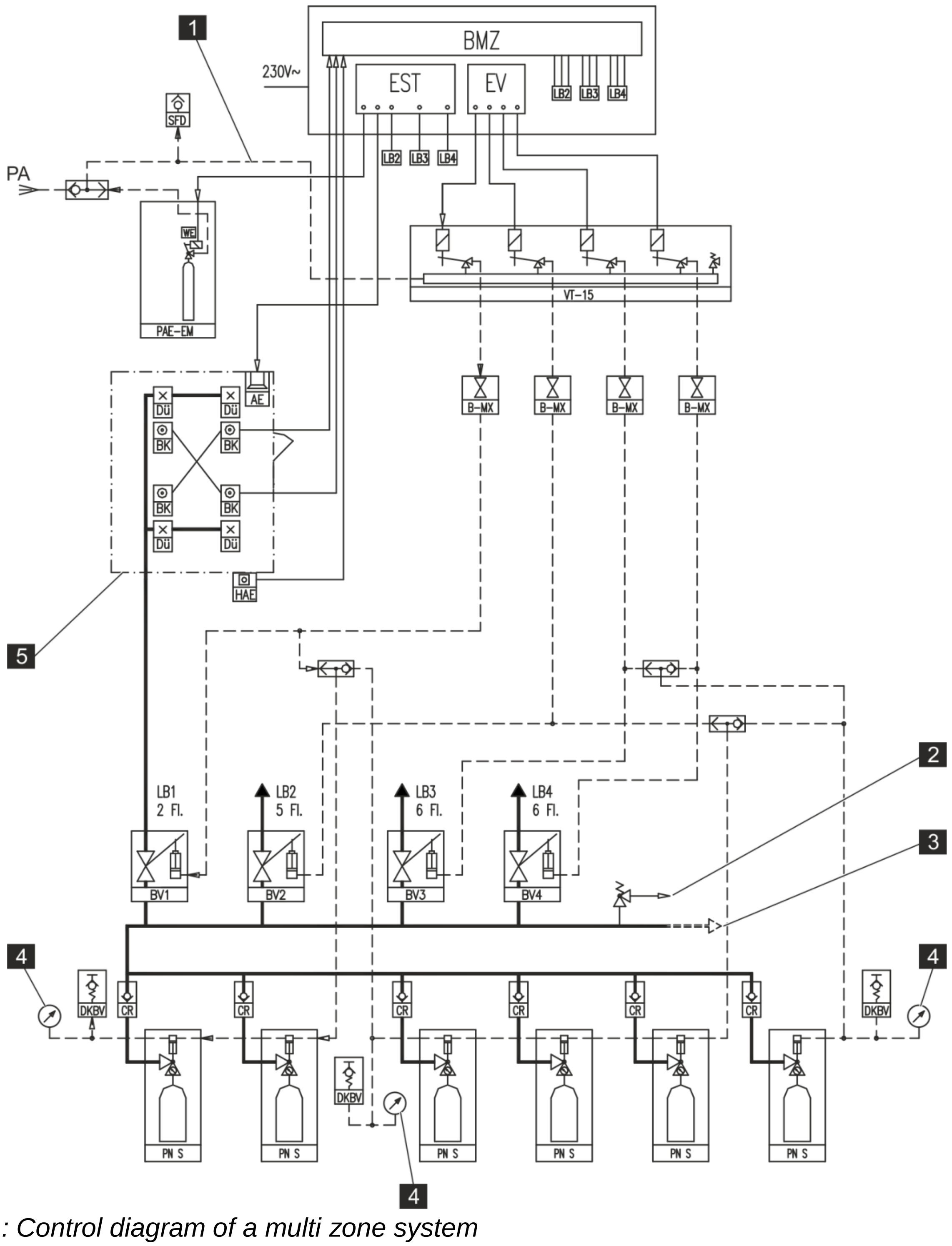


Fig. 21: Control diagram of a multi zone system

1 Total length of all pilot pipes (6x1) of each extinguishing zone: maximum 30 m (98 ft)
2 Relief into the atmosphere or into the largest extinguishing zone
3 Further extinguishing zones
4 Only in case of verification of the activation
5 Extinguishing zone 1
Fl. Extinguishing agent container
LB Extinguishing zone