VdS Guidelines for Fire Extinguishing Systems

Fire Extinguishing Systems using Halocarbon Gases

Amendment S1: Amendment to VdS 2381 : 2009-06 (04)

The Guidelines for Fire Extinguishing Systems using Halocarbon Gases, Planning and Installation, VdS 2381 : 2009-06 (04) apply subject to the following amendments, until cancelled, for all systems applied for as of 01.01.2012. For each amendment the appropriate clause of VdS Guidelines 2381 is specified.

1.3 Definitions

Evaporation distance: Distance [L_V] within which liquid extinguishant is still available in the jet.

Core jet: Volume of diameter 0,1 × L_V and length L_V , in which there shall be no installations, obstacles, room enclosure or objects.

3.4.1 Nozzles shall be arranged so that a homogenous mixture of the required extinguishing gas concentration is achieved. The maximum protected area per nozzle shall not exceed $30m^2$.

Nozzles shall be sited so as not to affect the quick and even distribution in the enclosure by deposition of liquid extinguishant.

3.4.1.1 With HFC227ea extinguishing systems a minimum distance of 1m to the nozzle shall be kept because of the strong cooling effect of the obstacles, room enclosure, installations and objects etc. located in the jet.

3.4.1.2 With FK-5-1-12 extinguishing systems the following requirements in terms of obstacles, room enclosure, installations and objects etc. shall be adhered to (see Fig. 3.1):

- an area of 0,2 m radius around the nozzle shall be kept free entirely;
- in direction of the jet of each orifice a cylinder with a diameter of 10 % of the evaporation distance shall be kept free over the entire evaporation distance. Permitted are only individual objects of minor cross section which can be easily passed by the jet.

  Note: This includes e.g. false floor supports, supports for false ceilings, cables of minor cross section.

To ensure sufficient air admixture into the jet (feeding of evaporation heat), a minimum distance shall be kept with installations or room enclosure going parallel to the jet via the entire evaporation distance. Examples: air ducts, ceilings, beams.

This minimum distance (distance jet axis to obstacle) is also defined by the evaporation distance L_V and is 0,1 x L_V.

Publishing house: VdS Schadenverhütung GmbH
Amsterdamer Str. 172-174
50735 Köln, Germany
Phone: +49 221 77 66 0; Fax: +49 221 77 66 341

Example for calculation of minimum distances:

– evaporation distance as calculated (L_V):	3 m
– radius around the nozzle to be kept free entirely:	0,2 m
– diameter of core jet to be kept free ($0{,}1 \times L_V$):	0,3 m
– lateral minimum distance of core jet ($0{,}1 \times L_V$):	0,3 m

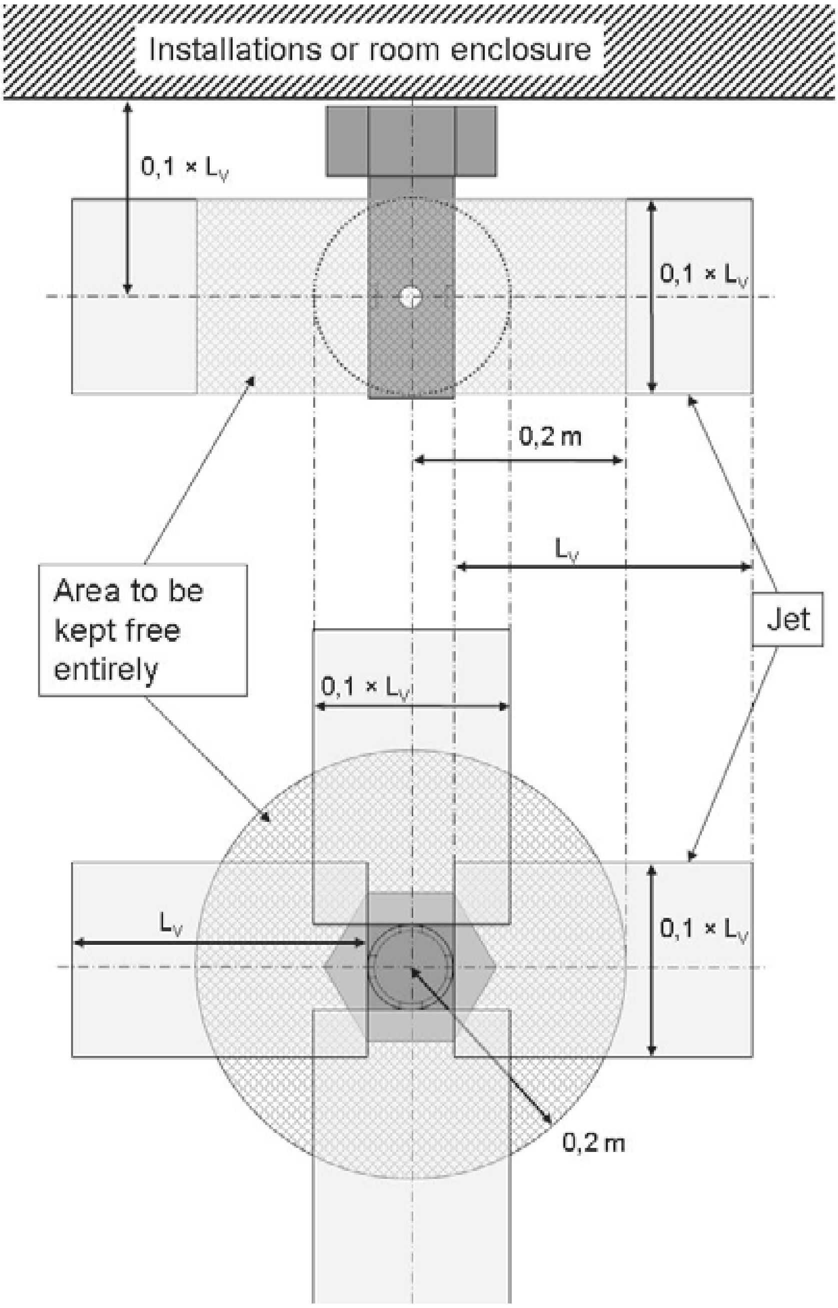

Fig. 3.1: Minimum distances (side view and top view)

Annex A13
Model for calculation of evaporation distance

The model for jet evaporation is based on the balance of the conserved quantities: number of particles, energy and jet momentum. The exact interaction of liquid droplets and gas phase was deliberately disregarded, as the required data (size spectrums of droplets) are not available, and as this examination would only marginally affect the evaporation distance as long as the systems have been installed in accordance with the guidelines.

Further simplification is achieved by not calculating turbulent currents generated during discharge. Instead, a fixed free jet angle of 7° (half of opening angle) is applied which determines the air admixture. This angle (for free jets an angle of 5°…10° is customary) has been determined in discharge tests. The stronger expansion of the jet directly after discharge from the nozzle is taken into account by assuming a close-up range in front of the nozzle in which no air admixture takes place. The admixed air is assumed to consist of 100 % nitrogen.

For calculating the evaporation distance, the free jet is divided into zones in the direction of the jet; these zones are passed through successively. If in one zone more than 95 % of FK-5-1-12 has evaporated, the distance of the current zone to the nozzle orifice will be declared as the evaporation distance. A maximum evaporation distance is also determined by the nozzle orifice. This value is based on experience and additionally limits this model.

In each zone the following steps are taken:

1. The **local jet velocity** is calculated from the overall mass flow and the jet momentum (conserved quantity).

2. **Iteration of air (-nitrogen) admixture:**
   The local nitrogen admixture is calculated from the local jet velocity, jet expansion (free jet angle, difference to prior zone) and density of jet-gas phase.

3. **Iteration of jet temperature:**
   The quantity of evaporated FK-5-1-12 is calculated from the saturation vapour pressure of FK-5-1-12 at the local jet temperature. The admixed nitrogen supplies part of the required evaporation heat, the rest is generated by reducing the jet temperature.

4. Thus, the following modified values apply to the next zone: temperature, relation FK-5-1-12 liquid/gaseous (termination condition), mass flow nitrogen and overall mass flow.

The results of this model can be described analytically in good approximation. Required parameters are

w … exit speed

$\dot{m}$ … mass flow through nozzle orifice

d … diameter of nozzle orifice

The evaporation distance L_V is the lesser of the two values, respectively:

– 50-bar storage: $$L_V = \begin{cases} 0{,}10\,\text{m} + \sqrt{156\,\frac{\text{m}^3}{\text{kg}}\,\frac{\dot{m}}{w}} \\ 0{,}38\,\frac{\text{m}}{\text{mm}} \times d \end{cases}$$

– 42-bar storage: $$L_V = \begin{cases} 0{,}09\,\text{m} + \sqrt{132\,\frac{\text{m}^3}{\text{kg}}\,\frac{\dot{m}}{w}} \\ 0{,}38\,\frac{\text{m}}{\text{mm}} \times d \end{cases}$$

– 25-bar storage: $$L_V = \begin{cases} 0{,}26\,\text{m} + \sqrt{77{,}8\,\frac{\text{m}^3}{\text{kg}}\,\frac{\dot{m}}{w}} \\ 0{,}38\,\frac{\text{m}}{\text{mm}} \times d \end{cases}$$