Room protection nozzles

Requirements and test methods

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

VdS Guidelines for Gas Extinguishing Systems

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CONTENT

Declaration of non-binding status

These VdS Guidelines for Gas Extinguishing Systems, Room protection nozzles, Requirements and test methods, VdS 3179en, are binding only if their application has been agreed on an individual basis.

Foreword

These guidelines replace the VdS guidelines VdS CEA 4010 : 1997-07 and VdS CEA 4016 : 1997-07.

1 Scope

These guidelines specify requirements and test methods for room protection nozzles for gas extinguishing systems (i.e. CO_2 fire extinguishing systems, Inert gas fire extinguishing systems and halocarbon gas fire extinguishing systems).

These guidelines are only applicable for open nozzles.

These guidelines are not applicable for local application nozzles

2 Normative References

These guidelines incorporate, by dated or undated references, provisions from other publications (e.g. European Standards EN or International Standards IEC), which are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to these guidelines only when incorporated in them by amendment or revision. For undated references the latest edition of the publication referred to applies.

VdS 2093	Guidelines for CO_2 fire extinguishing systems – planning and installation
VdS 2380	Guidelines for fire extinguishing systems; fire extinguishing systems with non-liquefied Inert gases – planning and installation
VdS 2381	Guidelines for fire extinguishing systems; fire extinguishing systems using halocarbon gases – planning and installation
EN 12094-7:2000 + A1:2005	Fixed fire fighting systems, components for gas extinguishing systems, part 7: Requirements and test methods for nozzles for CO_2-systems

3 Definitions

For the use of these guidelines the following definitions apply:

CO_2-high pressure system: Fire extinguishing system, in which CO_2 is stored at ambient temperature, e.g. the pressure of the stored CO_2 is CO_2 p_{abs} = 58,6 bar at 21 °C.

CO_2-low pressure system: Fire extinguishing system, in which CO_2 is stored at a low temperature, usually at a temperature between –19 °C and –21 °C.

Halocarbon gas: Extinguishing agents which contain as primary components one or more organic compounds containing one or more of the elements fluorine, chlorine, bromine or iodine.

Halocarbon gas fire extinguishing system: Fire extinguishing system in which the halocarbon gas is stored at ambient temperature.

Inert gas: Non liquefied gas or mixture of gases which extinguishes the fire mainly by reducing the oxygen-concentration in the protected zone, e.g. Argon, Nitrogen or CO_2 or mixtures of these gases.

Inert gas fire extinguishing system: Fire extinguishing system in which the inert gas is stored at ambient temperature.

Nozzle: Component to achieve a predetermined flow rate and a uniform distribution characteristic of the extinguishant into or onto a protected hazard.

Room protection nozzle: Nozzle from which the extinguishant is discharged for uniform distribution throughout an enclosure.

Cross section: Total area of all smallest geometrical single areas.

Distribution characteristics: Volume in which the extinguishant is distributed uniformly from a nozzle.

Filter: Component to prevent blockage of nozzles.

Flow rate: Mass flow of extinguishant against time.

Functional reliability: Ability of function under different working conditions.

Nozzle protection: Component to protect nozzles against exterior dirt.

Resistance coefficient: Value for the calculation of the pressure drop in a component under flow condition.

Working pressure: Maximum pressure at which the component is used in the system.

4 Nozzles for CO_2 Fire extinguishing systems

4.1 Requirements

4.1.1 Requirements from EN 12094-7

Nozzles for CO_2 fire extinguishing systems shall fulfil the requirements from EN 12094-7:2000 + A1:2005.

4.1.2 Impact

Nozzles for CO_2 fire extinguishing systems shall show no signs of damage which could impair the proper function after the test according section 4.2.2.

4.2 Test methods

4.2.1 Test methods from EN 12094-7

Nozzles for CO_2 fire extinguishing systems shall be tested according to EN 12094-7:2000 + A1:2005.

4.2.2 Impact

The test is carried out according to 5.1.12 with a nozzle of medium size.

5 Nozzles for inert gas fire extinguishing systems and halocarbon gas fire extinguishing systems

5.1 Requirements

5.1.1 General design

5.1.1.1 When tested according to 5.2.3 the test sample shall comply with the technical documentation (drawings, parts lists, functional descriptions, operation and installation instructions).

Metal parts of the component shall be made of stainless steel, copper, copper alloy or corrosion-protected steel (e.g. galvanized steel).

5.1.1.2 For inert gas nozzles, the manufacturer shall specify the working pressure.

5.1.1.3 For halocarbon gas nozzles, the manufacturer shall specify as follows:

- the type of the system (the halocarbon gas and storage pressure at + 20 °C), and
- the working pressure; and
- the minimum nozzle pressure.

5.1.2 Connection threads

Connection threads shall comply with National, European or International Standards for threads.

5.1.3 Nozzle-opening cross section

The minimum dimension of any individual discharge opening of the nozzle shall not be smaller than 1 mm.

Nozzles with dimensions of discharge openings ≥ 3 mm shall not be equipped with a filter. Nozzles with dimensions of discharge openings < 3 mm shall be equipped with a filter.

The filter shall be made of corrosion resistant metal. The unrestricted filter surface area shall be at least five times the nozzle cross section. The mesh of the filter shall be between 0,5 mm and 0,8 mm, measured in the plane of the hole.

To prevent blockage of the nozzle by solid-phase particles the cross sectional area of the nozzle should decrease in the direction of flow. Orifice plates are not allowed to be used in nozzles for extinguishants which can partly change to solid phase, except where blockage of downstream flow paths/orifices by solid phase particles is prevented by the design of the nozzle.

5.1.4 Nozzle protection

If the nozzle opening is protected against exterior dirt with a cap or similar cover, this protection device shall eject clear of the nozzle's full opening cross section at a test pressure between 0,1 bar and 3 bar, when tested in accordance with 5.8. The protection device shall not affect the distribution characteristics.

5.1.5 Flow rate

5.1.5.1 For inert gas nozzles, the manufacturer shall specify the information which describes the flow rate of the nozzle in kilograms extinguishing medium per second in the temperature range between – 50 °C and + 30 °C in the range from 2 bar up to the working pressure.

The flow characteristics values given by the manufacturer shall be within ± 10 % of the value(s) determined in accordance with 5.2.5.1.

Where filters are used, these shall be taken into account when determining the flow rate.

5.1.5.2 For halocarbon gas nozzles the manufacturer shall specify the information which describes the flow rate of the nozzle in kilograms extinguishing medium per second in the pressure range from the minimum nozzle pressure to 1 bar below the storage pressure depending on storage pressure at + 20 °C.

The flow characteristics values given by the manufacturer shall be within ± 10 % of the value(s) determined in accordance with 5.2.5.2.

Where filters are used, these shall be taken into account when determining the flow rate.

5.1.6 Distribution characteristics

5.1.6.1 For inert gas nozzles, the distribution of extinguishant shall be tested in accordance with 5.2.4.1.

5.1.6.2 For halocarbon gas nozzles, the distribution of extinguishant shall be tested in accordance with 5.2.4.2.

5.1.7 Resistance to pressure and heat

The nozzles shall be able to withstand the test pressures and the temperatures specified in table 1.

System type	Test pressure bar	Test temperature °C
Inert gas	Working pressure	600
halocarbon gas	Working pressure	600

Table 1 — Test presure and -temperature

Following testing for pressure and heat resistance in accordance with 5.2.6, the nozzles shall show no signs of deterioration which could impair proper function.

5.1.8 Resistance to heat and cold shock for halocarbon gas nozzles for halocarbon gases with cold shock potential

Note 1: Applies only to nozzles for such halocarbon gases, which in case of pressure drop in container and pipework as well as during nozzle discharge undergo phase change similar to CO_2 and thus cool down similar to CO_2.

Note 2: Due to short experience, no examples can be given for halocarbon gases which are covered by note 1. Examples for halocarbon gases which are not covered by note 1, are HFC-227ea und FK-5-1-12.

The nozzles shall withstand both the high temperatures generated during a fire and the cold shock caused by the extinguishant as it is discharged. Following testing for heat and cold shock resistance in accordance with 5.2.7, the nozzles shall show no signs of deterioration which could impair proper function.

5.1.9 Corrosion

The performance of the nozzles shall not be adversely affected as a result of the corrosion test in accordance with 5.2.9.

5.1.10 Stress corrosion

Any copper alloy part used in nozzles shall not crack, when tested in accordance with 5.2.10.

5.1.11 Vibration

Nozzles assembled from several parts shall not be damaged, when tested as described in 5.2.11.

5.1.12 Impact

Following testing in accordance with section 5.2.12, the nozzles shall show no signs of damage which could impair proper function.

5.1.13 Marking

5.1.13.1 Nozzles shall be marked with following details:

- Name or trademark of manufacturer or supplier,
- model designation or size,
- Serial or batch number.

5.1.13.2 The markings shall be non-detachable, non-flammable, permanent and well legible.

5.1.14 Documentation

5.1.14.1 The manufacturer shall prepare and maintain a documentation.

5.1.14.2 The manufacturer shall prepare an installation and user documentation which shall be submitted to the testing authority together with the test samples. This documentation shall contain at least:

- a general description of the component with a list of all features and functions;
- a technical description including:
  - the information required in these guidelines;
  - sufficient information to permit an assessment of compatibility with other system components;
- installation instructions including mounting instructions;
- operating manuals;
- maintenance instructions;
- routine testing instructions, if appropriate.

5.1.14.3 The manufacturer shall prepare a design documentation which shall be submitted to the testing authority together with the test sample(s). This documentation shall contain drawings, parts lists, block diagrams (if applicable), diagrams (if applicable) and functional descriptions to an extent that the compliance with the requirements of this documents and a general assessment of the design is possible.

5.2 Test methods

5.2.1 Test conditions

The components shall be tested assembled according to the installation instruction of the manufacturer. The tests shall be carried out at a temperature of (20 ± 5) °C, except when stated otherwise.

The tolerance for all test parameters is 5 %, unless stated otherwise.

5.2.2 Test samples and test order

When testing a nozzle type with only one size, four test samples shall be provided. The order of tests is shown in Table 2.

Test	Order of tests for			
	Test sample A	Test sample B	Test sample C	Test sample D
5.2.3 Compliance	1	1	1	1
5.2.4 Distribution characteristics	—	—	2	—
5.2.5 Flow rate	2/4	—	—	—
5.2.6 Resistance to pressure and heat	—	2	—	—
5.2.7 Resistance to heat and cold shock (only for halocarbon gas)	—	3	—	—
5.2.8 Nozzle protection	—	—	—	2
5.2.9 Corrosion	3	—	—	—
5.2.10 Stress corrosion	—	—	—	3
5.2.11 Vibration	—	—	3	—
5.2.12 Impact	—	—	4	—

Table 2 — Order of tests for one nozzle size

When testing a nozzle series of identical design, 3 test samples A, B, C of different sizes 1, 2, 3 (lower, medium and upper end of series) as well as one (maximum 5) test sample(s) of each of the remaining sizes are required. The order of tests is shown in Table 3.

Test	Order of tests for				
	Test sample A1	Test sample B1	Test sample A2	Test sample A3	other
5.2.3 Compliance	1	1	1	1	1
5.2.4 Distribution characteristics	2 †	—	3 †	3 †	—
5.2.5 Flow rate	—	3/5	2	2	—
5.2.6 Resistance to pressure and heat	—	—	—	4	—
5.2.7 Resistance to pressure and heat (only for halocarbon gas)	—	—	—	5	—
5.2.8 Nozzle protection	—	2	—	—	—
5.2.9 Corrosion	—	4	—	—	—
5.2.10 Stress corrosion	3	—	—	—	—
5.2.11 Vibration	—	—	4	—	—
5.2.12 Impact	—	—	5	—	—

† Only one nozzle size is chosen according to the volume of the test room (see section 5.2.4)

Note 1: The order of tests is not binding except for the flow rate test after corrosion.

Note 2: The tests indicated for one test sample can also be distributed to several test samples of the same size.

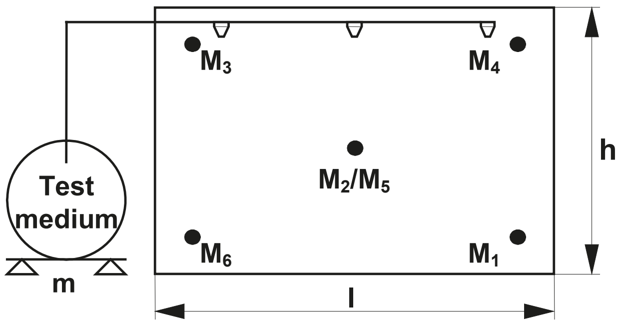
Table 3 — Order of tests for nozzle series

5.2.3 Compliance

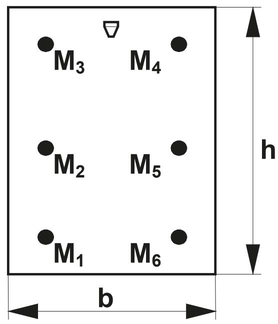
A visual and measurement check shall be made to determine whether the test samples correspond to the technical documentation (drawings, parts lists, description of functions and installation instructions), and whether the samples comply with the verifiable requirements of these guidelines.

5.2.4 Distribution characteristics

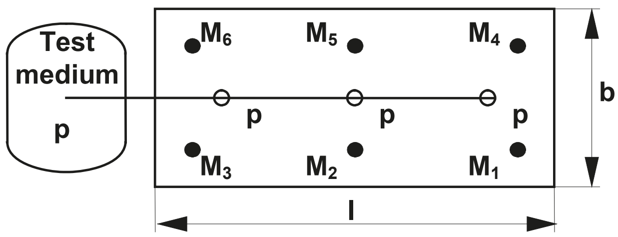
Note: This test relates to the requirements of 5.1.6.



a) Front view of test room



b) Side view of test room



c) Top view of test room

1 Pressure relief

p Pressure measuring point

m Mass measuring point

h Room height in meters

b Width of room according to the flow rate of nozzle, in metres

l Length of room according to the flow rate of nozzle, in metres

M_1... M_6 Concentration measuring points 1 to 6

Arrangement of the concentration measuring points:

- Height above floor:
  - M_1 ; M_6 0,1 *h*
  - M_2 ; M_5 0,5 *h*
  - M_3 ; M_4 0,9 *h*.
- Distance from the wall:
  - M1, M2, M3 and M4: 0,1 l from the wall of length b and 0,1 b from the wall of length l
  - M2 and M5: 0,5 l from the wall of length b and 0,1 b from the wall of length l.

Figure 1: Test set up for distribution characteristics of room protection nozzles

5.2.4.1 Inert gas nozzles

The tests may be carried out with inert gas or with gaseous CO_2.

In order to test the distribution characteristics with one or several nozzles in a test room, the following test conditions have to be set up:

a) Test room: area 30 m2 ± 9 m2 with a relation of length to width of 1 to 2, a height of 5 m ± 1,5 m, a volume of 150 m3 ± 30 m3;
b) Flooding mass: mass which gives an oxygen reduction from a volume fraction of 20,8 % to (13± 1) % in the test room; the gas supply shall be shut down immediately after flooding of the flooding mass;
c) Start-pressure in the gas supply: design pressure (system pressure) of the system -5/+0 bar, however 50 bar maximum;
d) Pressure at the nozzle during the test: in the range of 50 % to 75 % of the pressure in the supply container;
e) Flooding time: (60 ± 5) s;
f) Supply mass: maximum 120 % of flooding mass.

Oxygen concentration measurements shall be made to determine whether the test gas is distributed evenly in the volume served by the nozzle(s). The deviation of the concentration at the different measuring points shall be a maximum of 0,7 percentage points (Vol-% oxygen) (60 ± 10) s after the end of the discharge. The test set-up shall correspond to figure 1. The test room shall be equipped with a pressure relief vent opening in the ceiling or near the ceiling. The pressure relief opening shall be closed after termination of discharge.

5.2.4.2 Halocarbon gas nozzles for

The tests shall be carried out with the extinguishing medium.

In order to test the distribution characteristics with one or several nozzles in a test room, the following test conditions have to be set up:

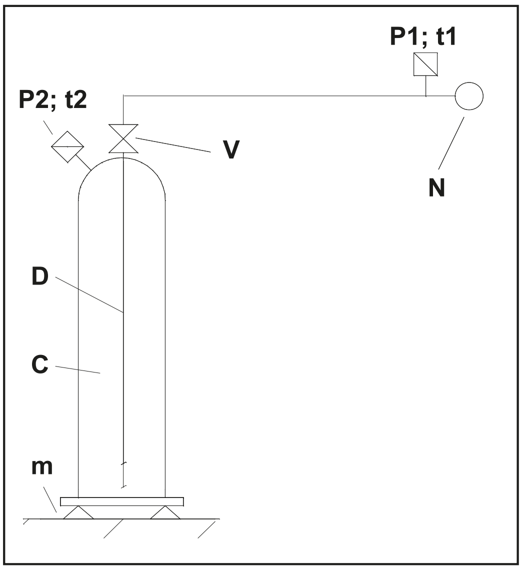
a) Test room: area 30 m^2 ± 9 m^2 with a relation of length to width of 1 to 2, a height of 5 m ± 1,5 m, a volume of 150 m^3 ± 30 m^3;
b) Supply mass: mass which gives the extinguishing concentration for heptane -5/+0 % according to the corresponding part of ISO 14520 for the extinguishing medium;
c) Superpressurization (if applicable): minimum specified supply pressure at 20 °C;
d) Pressure at the nozzle (mean pressure during liquid phase flooding): maximum 80 % of the specified mininum nozzle pressure;
e) Discharge time: (10 ± 1) s.

Concentration measurements (preferably of extinguishant concentration) shall be made to determine whether the test gas is distributed evenly in the volume served by the nozzle(s). The concentration at all measuring points shall reach a concentration of at least 95 % of the extinguishing concentration for heptane at the latest 30 s after the end of the discharge. With the established minimum concentration as above, the deviation, i.e. the maximum minus minimum concentration between the different measuring points shall not exceed 10 % of the extinguishing concentration for Heptane. The test set-up except the test gas supply shall correspond to figure 1. The test room shall be equipped with a pressure relief opening in the ceiling or near the ceiling. The pressure relief opening shall be closed after termination of discharge.

A visual check or a check by other suitable means shall be made, to ensure that no liquid extinguishant is present in the test room after the conclusion of testing.

5.2.5 Verification of flow rate

Note: This test relates to the requirements of 5.1.5.



t_1 Temperature at nozzle	P_2 Pressure in container	D Diptube
t_2 Temperature in container	C Supply container	m Mass measuring point
P_1 Pressure at nozzle	V Container valve	N Nozzle

Figure 2: Test set-up for verification of flow rate

5.2.5.1 Inert gas nozzles

Checks shall be made to determine whether the test samples comply with the flow rate indicated by the manufacturer. Deviations shall not exceed ± 10 %. The test set-up is generally shown in Figure 2. Diptube, measuring point t_2 and measuring point P_2 are not necessary.

5.2.5.2 Halocarbon gas nozzles

Checks shall be made to determine whether the test samples comply with the flow rate indicated by the manufacturer. Deviations shall not exceed ± 10 %. The test set-up is shown in Figure 2.

5.2.6 Resistance to pressure and heat

Note: This test relates to the requirements of 5.1.7.

A nozzle is connected to a pressure supply and subjected to a temperature of (600 ± 30)°C for a period of 10 min. Then the gaseous test medium, e.g. gaseous CO_2, nitrogen or air is led through the heated nozzle body with the specified working pressure.

Note: The nozzle outlet(s) may be partly or fully blocked by suitable means (without affecting the strength characteristics of the component) to prevent damage of test equipment by excessive gas flow.

The pressure shall be measured at a distance of (1 ± 0,1) m upstream from the nozzle. The nominal diameter of the pipe between pressure measuring point and nozzle shall be not less than the nominal size of the connection thread of the nozzle tested.

5.2.7 Resistance to heat and cold shock for halocarbon gas nozzles for halocarbon gases with cold shock potential

Note: This test relates to the requirements of 5.1.8.

The sample shall be connected to a CO_2 vessel which incorporates a diptube and is capable of delivering liquid CO_2 at an absolute pressure of (20 ± 1) bar. A 2-position, 3-port ball valve (bypass-valve) shall be installed in the pipework between the vessel and the sample which allows the CO_2 flow from the vessel to be controlled.

The pipe between the container and the bypass valve shall be dimensioned such that a minimum pressure of 17 bar is reached at the bypass valve. The nominal diameter of the bypass valve and the connected pipeline shall be not less than the nominal size of the connection thread of the tested nozzle.

The length of the conneced pipe shall be (1 ± 0,1) m. In one position, the bypass-valve allows the CO_2 to pass through the test sample. In the other position, the bypass position, the outlet to the test sample shall be closed and the CO_2 flow shall be diverted via an appropriate pipework, which shall be dimensioned to reach a stable flow of liquid CO_2 at the bypass-valve within 35 s.

The test sample shall be subjected to a temperature of (600 ± 30)°C in a furnace for the period of 10 min. Just before completion of the heating period the CO_2 shall commence to flow through the bypass.

Upon stabilisation of liquid CO_2 flow and completion of the heating period the flow shall be diverted through the sample for a period of 10 s. The pressure at the bypass-valve shall be at least 17 bar during this period.

Subsequently, the sample shall be removed for inspection.

5.2.8 Nozzle protection

Note: This test relates to the requirements of 5.1.4.

The nozzle with protection device shall be mounted on pipe equipped with a pressure gauge. The pressure in the pipe shall be raised by (1 +0,1/-0) bar/min. The pressure required to eject the protection device clear of the nozzle's full opening cross section shall be measured.

5.2.9 Corrosion

Note: This test relates to the requirements of 5.1.9.

A sample shall be suspended freely in its normal mounting position.

The test set-up comprises a container 5 l volume, made of heat-resistant glass and with a corrosion-resistant cover which is shaped to prevent condensate dripping onto the test samples. If a container 10 l volume is used, the quantities of chemicals given below shall be doubled. The container shall be heated electrically and the side walls shall be cooled with water. A thermostat regulates the heating so as to maintain a temperature of approximately 45 °C inside the container. During testing water is passed through a cooling coil wrapped around the container; it shall flow fast enough that its temperature at the discharge point is below 30 °C.

The combination of heating and cooling shall be designed to ensure that vapours will condense on the surface of the samples. The sulphur dioxide atmosphere shall be generated in the 5 l container with a solution of 20 g of sodium thiosulphate ($Na_2S_2O_3$ x $5H_2O$) in 500 cm^3 of distilled water, to which 20 cm^3 of dilute sulphuric acid shall be added daily. The dilute sulphuric acid comprises 128 cm^3 of one molar sulphuric acid (H_2SO_4) dissolved in 1 l of distilled water. The test samples shall be removed from the container after eight days; the container shall be cleaned. Then the procedure described above shall be repeated for a further period of eight days.

After a total of 16 days, the samples shall be removed from the container and shall be allowed to dry for seven days at a temperature of (20 ± 5) °C at maximum relative humidity of 70 %.

5.2.10 Stress corrosion

Note: This test relates to the requirements of 5.1.10.

A glass container of known volume fitted with a capillary tube vent shall be used. The aqueous ammonia solution shall have a specific weight of (0,94 ± 0,02) kg/l. The container shall be filled with (10 ± 0,5) ml of the solution for each litre of container volume.

The sample shall be degreased for test and shall be exposed for 10 days to the moist atmosphere of ammonia and air, at a temperature of (34 ± 2) °C. The samples shall be positioned (40 ± 5) mm above the level of the liquid.

After testing, the samples shall be cleaned and dried and shall be subjected to careful visual examination. To make cracking clearly visible, the liquid penetration method shall be used.

5.2.11 Vibration

Note: This test relates to the requirements of 5.1.11.

The sample shall be mounted to a vibration table using fixed materials provided by the manufacturer.

The sample shall then be subjected to sinusoidal vibration in all three axes, in a range of 10 Hz to 150 Hz. The frequency shall be raised uniformly at a rate of one octave every 30 min. The vibration acceleration shall be 1 *g* in the frequency range from 10 Hz to 50 Hz and 3 *g* in the 50 Hz to 150 Hz range.

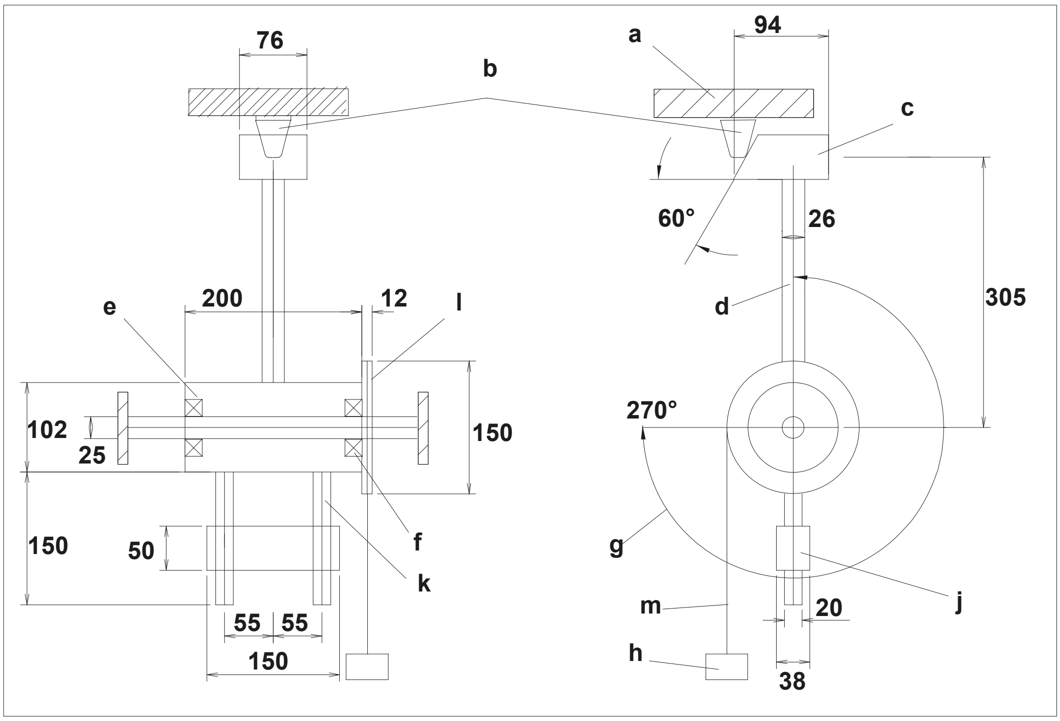
No operation of the sample shall be caused by the vibrations. No deterioration or detachment of parts shall occur. The components shall be able to function after the vibration.

5.2.12 Impact

Note: This test relates to the requirements of 5.1.12.

Impact testing is used to determine whether the nozzle is sufficiently resistant to impact loads.

The nozzle is suspended from the impact mechanism as shown in Figure 3. A horizontal blow is then delivered to the nozzle, at an energy level of 2,6 Joule, hammer head velocity of (1,8 ± 0,15) m/s. The impact surface of the hammer head shall be at a (60 ± 3)° angle to the nozzle's vertical axis at the moment of impact.



a) Mounting surface
b) Test sample
c) Hammer head
d) Hammer shaft
e) Hub
f) Ball bearing
g) 270° angle
h) Drive weight
j) Counter weight
k) Shaft of counter weight
l) Pulley

Measurement in millimeter, the details to the measurements serve only as guideline

Figure 3: Impact test set-up

The test set-up comprises essentially a rotating hammer with a head made of aluminium having a rectangular cross section and sloped impact surface; it is mounted on a round steel shaft.

The shaft of the hammer is affixed to a hub which rotates on ball bearings around the axis of a fixed steel shaft, so that the hammer can rotate freely around the axis of the fixed shaft. The rigid frame is designed so that the hammer can make a complete revolution if no nozzles are present.

The hammer head is 76 mm wide, 50 mm deep and 94 mm long (overall dimensions). It has a flat impact surface which is sloped at an angle of (60 ± 1)° to the long axis of the hand. The round steel shaft has an outside diameter of (25 ± 0,1) mm. The hammer head is mounted on the shaft in such a way that its longitudinal axis is at a distance of 300 mm from the centre line of the unit, whereby the two axes are perpendicular one to the other. The hub has an outside diameter of 100 mm, a length of 200 mm and is mounted coaxially to the fixed steel shaft, which has a diameter of 25 mm.

There is a counterweight opposite the hammer, attached to the hub with two steel arms. These arms are bolted to the hub in such a way that 150 mm of their length is exposed. The counterweight is attached in such a way that it can be shifted to balance out the weight of the hammer. At the end of the hub there is a pulley 12 mm wide, 150 mm in diameter, made of aluminium. Around it is wrapped a non-stretchable cable, one end of which is attached to the pulley. The other end is attached to a weight.

The rigid frame is also equipped with a mounting plate. This mounting plate can be adjusted along the vertical axis so that the centre point of the hammer impact surface strikes the nozzle when the hammer is moving through the apex of its arc (i.e. quasi-horizontal motion).

To operate the test set-up the position of the nozzle and the mounting plate are adjusted at first. The hammer is then carefully balanced by adjusting the counterweight. The drive weight is detached while doing so. The shaft of the hammer is rotated back through 270° (to the horizontal) and the drive weight is attached. When released, the drive weight rotates the hammer and its shaft through a 270° arc. The mass of the drive weight for this configuration is 0,552 kg 3 r whereby the actual radius of the pulley is given in metres. This corresponds to approximately 0,78 kg when using a pulley with a radius of 0,075 m.

Since a hammer velocity of (1,8 ± 0,15) m/s is specified at the moment of impact, it may be necessary to drill out the rear face of the hammer in order to achieve the required velocity. Tests shall be made to determine that the device is working properly.

5.2.13 Other tests

Where necessary due to special designs or new manufacturing methods, additional tests will be conducted in agreement with the manufacturer.