LPG FM200 SYSTEMS

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1 FM200: The agent

1.1 Properties

FM200, which chemical formula is HFC-227ea is a colourless, odourless, and electrically non conductive compound of carbon, fluorine and hydrogen, with a density approximately 6 times that of air. Its chemical formula is CF_3CHFCF_3 (1,1,1,2,3,3,3 heptafluoropropane).

1.2 Use and limitations

FM200 suppresses fire mainly by physical means. It has a refrigerant effect due to the vaporization of liquid agent being discharge through the nozzles and increases the specific heat of air entering the fire.

FM200 is used in total flooding applications. When released to the atmosphere FM200 vaporizes into gas creating an air/agent mix throughout the enclosure.

FM200 systems are suitable for class A surface fires, class B fires and electrical fires when it is important to use a clean extinguishing agent, inert and non conductive.
The following are typical hazards, but not the only ones, that can be protected with an FM200 system:

- Data processing and electronic facilities.
- Telecommunications facilities.
- Process control facilities.
- High value medical facilities.
- High value industrial equipment areas and engine areas.
- Libraries, museums, art galleries.
- Anechoic chambers.
- Flammable liquid storage areas.
- Transformers.
- Laboratories.

FM200 is not applicable when the fire is a class A deep seated one or from torch fires caused by flammable gas escapes.

Class A deep-seated fires: FM200 can decompose at high temperature giving hydrogen fluoride (HF). The longer the exposition time in this conditions the larger the decomposition and formation of this product. Attention must be paid when exposing the agent to hot surfaces or to deep seated class A fires where the agent is in contact with these high temperatures even after the fire is extinguished. So it is not suitable the use of FM200 when a deep seated class A fire is to be produced.

Flammable gas escapes: In case of flammable gas leakage or escape, the right procedure is firts to stop the escape. Under these conditions, the fire turns out to be a static fire. In that case the FM200 can be used for the supression of the fire using the inerting concentration.

FM200 is NOT specified for fires where the following material may be present:

- Chemicals or mixtures containing their own oxygen supply and, hence are able of a quick oxidation in absence of air, e.g., powder or cellulose nitrate.
- Reactive metals like sodium, potassium, magnesium, titanium, zirconium, uranium and plutonium.
- Metal hydrides, amides, organometallic compounds.

- Chemicals able to autodecompose thermically, like certain organic peroxides and hydrazines.
- Pyroforic material like white phosphor.
- Oxidizing agents.

FM200 is not suitable either because it is ineffective (cellulose nitrate) or it can react itself with them (reactive metals).

1.3 Applicable design standards

The applicable standards for the design of FM200 systems are the following:

1. **ISO 14520 Part 1 and Part 9**: *Gaseous fire-extinguishing systems. Physical properties and system design. Part 1: General Requirements. Part 9: FM200 extinguishant.* Latest edition: 2006.
2. **NFPA 2001**: *Standard on Clean Agent Extinguishing Systems*. Latest edition: 2004.
3. **CEA 4045**: *Fire extinguishing systems using liquefied "halocarbon" gases. Planning and Installation*. Latest edition: 2005. (Not included in this document).

1.4 Effects of FM200ea on people

The cardiotoxic effect is due not only to the concentration of exposure but also to the time of exposition. This approach has been studied under a physiologically based pharmacokinetic model (PBPK) which has been adopted by NFPA2001 and it has also been included in ISO 14520:2006. As a result of this study time for safe human exposure have been derived as expressed in the table below:

FM200 Concentration % vol	Safe human exposure time (minutes)
9.0	5.00
9.5	5.00
10.0	5.00
10.5	5.00
11.0	1.13
11.5	0.60
12.0	0.49

Only design concentrations that allow a safe exposure time of 5 minutes are recommended for use in normally occupied areas.
Note that oxygen depletion due to a FM200 design concentration discharge is not enough to produce difficulties in respiration when used at its normal design concentrations.

1.5 FM200 environmental effects

FM200 agent has no effect on the ozone layer. Its atmospheric lifetime and global warming potential are low.

Environmental factor	**Value**
Ozone Depletion Power (ODP) [ODP $_{CCl3F}$ = 1]	0
Global Warming Potential (GWP) [GWP $_{CO2}$ = 1]	2900

1.6 Effects of FM200 on materials

FM200 is a thermally and chemically stable compound and, in absence of moisture, is not expected to react with common materials of construction such as steel, aluminium or brass. Laboratory tests indicate that FM200 is compatible with most commonly used materials of construction and is electrically non-conductive enough to allow its use when delicate electronics are present.

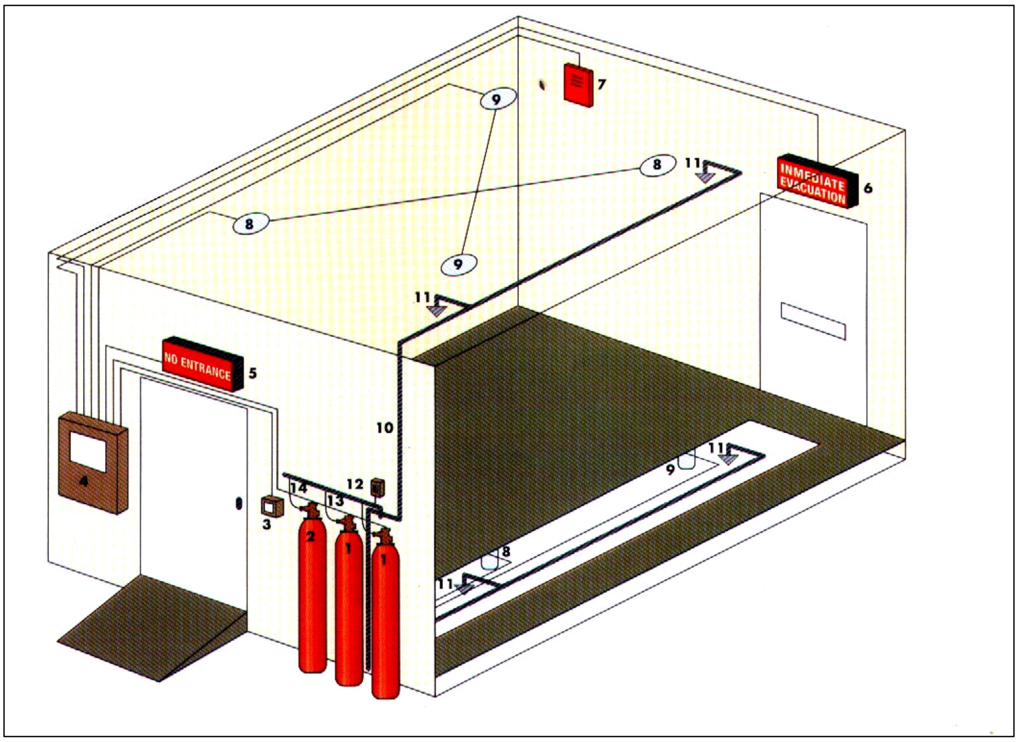
Associated effects due to the performance are the following:

a) Due to vaporization of the agent there is a cooling effect. Care shall be taken of agent being discharged directly on delicate equipment causing a cold shock that can break this equipment.

b) For temperatures exceeding the agent decomposition temperature HF is formed. This is likely to happen in the presence of a fire or heat surfaces. This effect can break or damage different equipment or surfaces.

2 LPG FM200 Systems Configuration

The following diagram shows a typical LPG FM200 system installation:



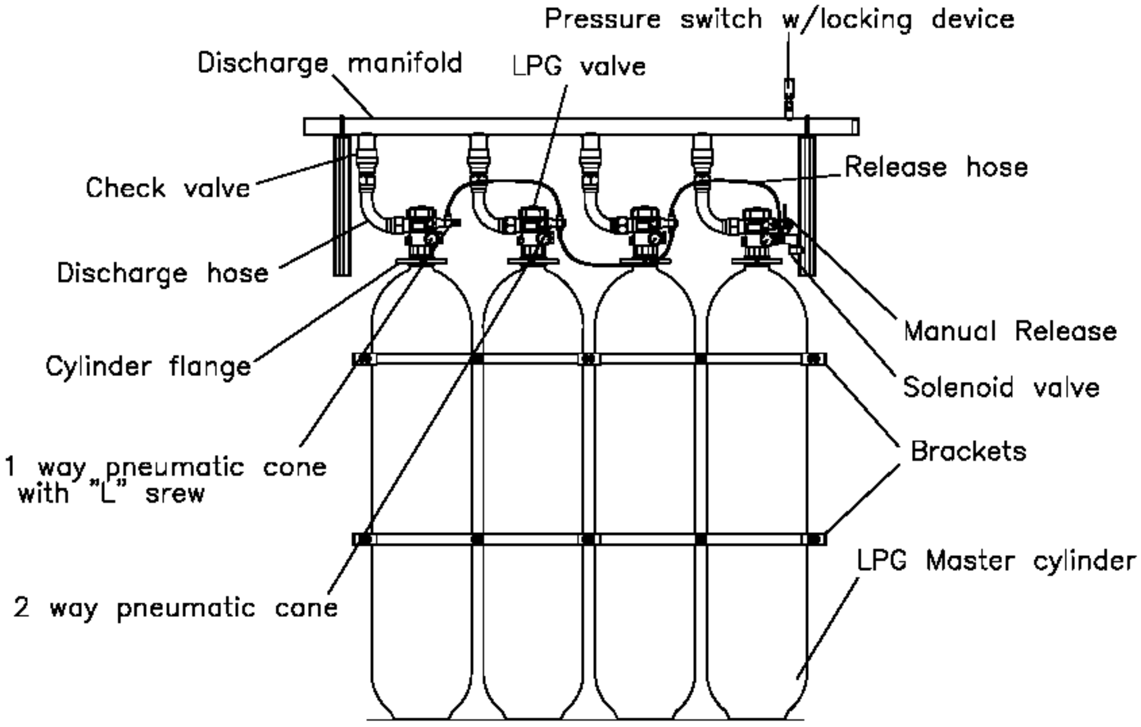
1. Auxiliary cylinders	**8 & 9.** Smoke / heat detectors
2. Master cylinder	**10.** Piping
3. Alarm push button	**11.** Discharge nozzles
4. Control panel	**12.** Manifold
5 & 6. Visual alarm	**13.** Release hose
7. Audible alarm	**14.** Discharge hose

BANK	KIND OF CYLINDERS	DISCHARGE SYSTEM
< 9 cylinders (*)	1 MASTER cylinder The rest are auxiliary cylinders	No pilot cylinder

≥ 9 cylinders	All are auxiliary cylinders	With pilot cylinder

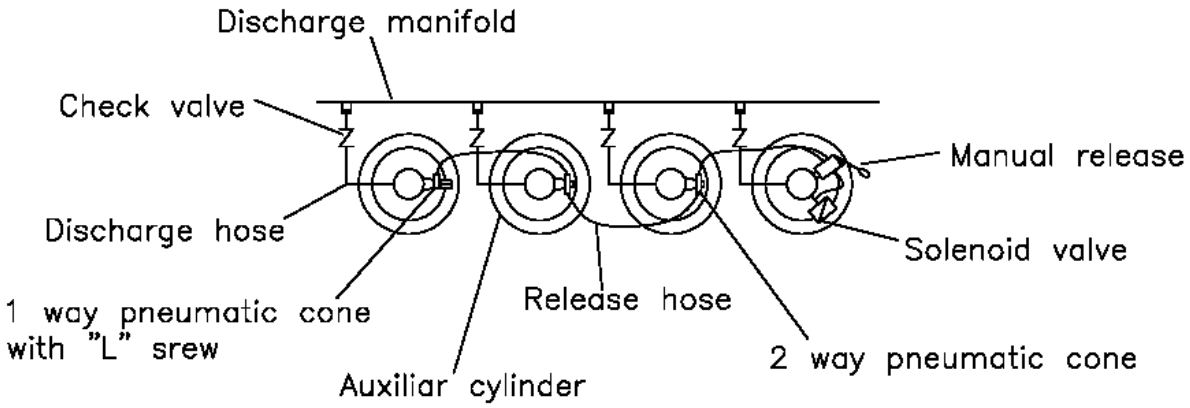
Note(*): A bank of less than 9 cylinders with N_2 pilot cylinder could be ordered upon request.

2.1 LPG FM200 Centralized Systems of less than 9 cylinders



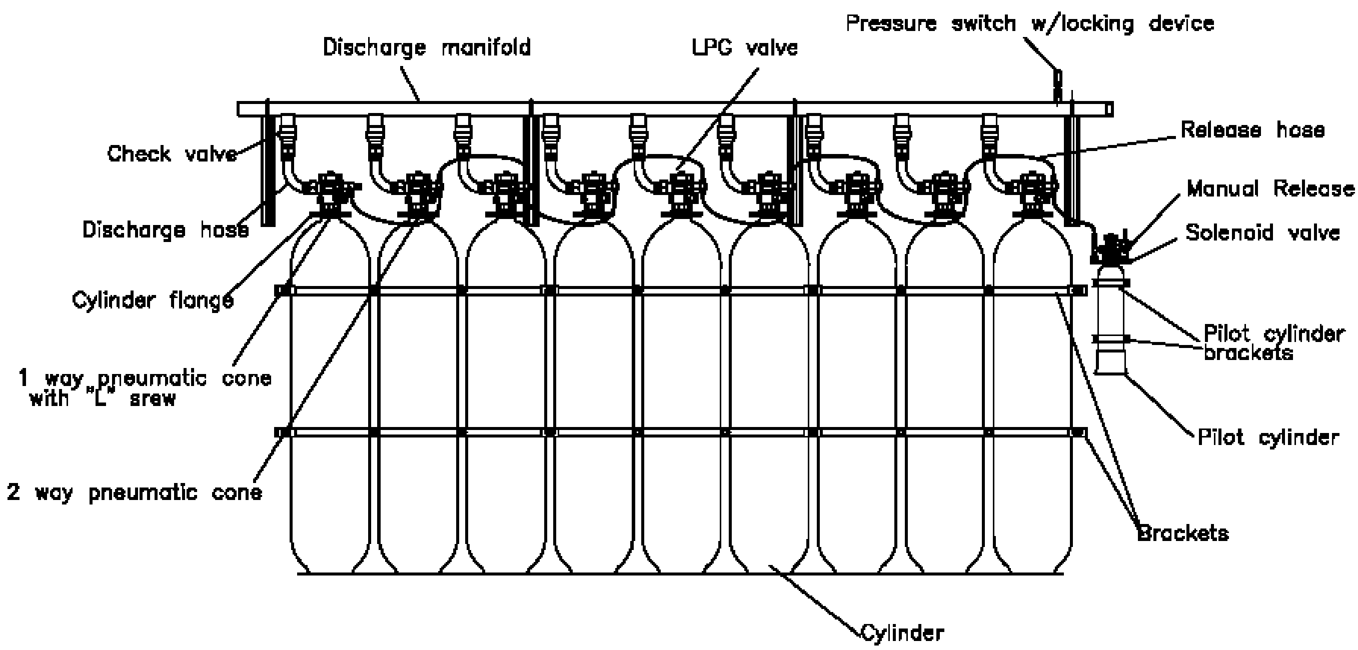
LPG FM200 single row bank system of 4 cylinders / 100 L

The LPG FM200 bank systems of less than 9 cylinders have a master cylinder that can be activated either electrically (solenoid valve) or manually (manual release). The rest of cylinders are auxiliary and are discharged pneumatically once the master has been activated.



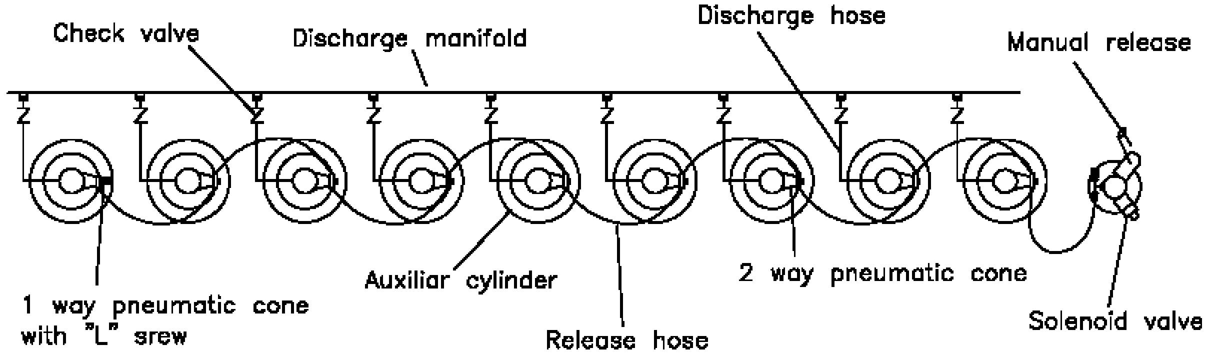
Release and discharge scheme of a single row LPG FM200 single row bank system of 4cylinders 100 L.

2.2 LPG FM200 Centralized Systems of 9 or more cylinders



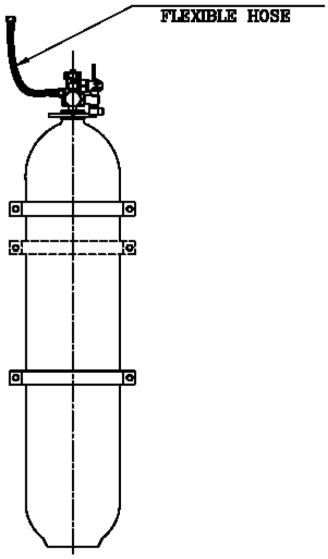
LPG FM200 single row bank system of 9 cylinders / 100 L

For LPG FM200 bank systems of more than 8 cylinders, all the cylinders are auxiliary. The bank is activated by means of a pilot cylinder filled with N_2 at 100 bar which can be activated either electrically (solenoid valve) or manually (manual release).



Release and discharge scheme of a single row LPG FM200 single row bank system of 9 cylinders 100 L.

2.3 LPG FM200 Modular System



Modular cylinders include:

- Cylinder with valve
- Solenoid valve
- Manual release
- Brackets
- Discharge hose

2.4 LPG Cylinder charge capacities:

LPG has two types of FM200 systems: high pressure and low-pressure systems. High-pressure FM200 systems are pressurized with N_2 at 42 bar and 21ºC. Low-pressure FM200 systems are pressurized with N_2 at 24 bar and 21ºC.

Low-pressure LPG systems use 240, 175 l cylinders.

High-pressure LPG systems use 120, 100, 75, 67, 42, 26.8, 13.4 and 5 l cylinders.

A key parameter for the cylinder selection is the maximum filling density. For FM200 systems the filling density is limited to a maximum value of 1.15 kg/l .

It must be pointed out that although the only restriction of filling of containers is that of the maximum filling density, it may be good design practice for particular systems to use more cylinders than strictly necessary or more capacity cylinders with the same amount of agent in order to ensure the discharge is completed in 10 seconds, since high fill densities give low pressure in containers in mid discharge conditions. Care shall be taken for:

- Long piping lengths
- Bank systems involving a big number of cylinders
- Low-pressure systems

For the above-mentioned reason, low-pressure FM200 bank systems are limited to three cylinders maximum.

The cylinder valve depends on the cylinder capacity.

The maximum charges in kg, the cylinder valve and its outlet size as a function of the cylinder capacity are presented in the table below:

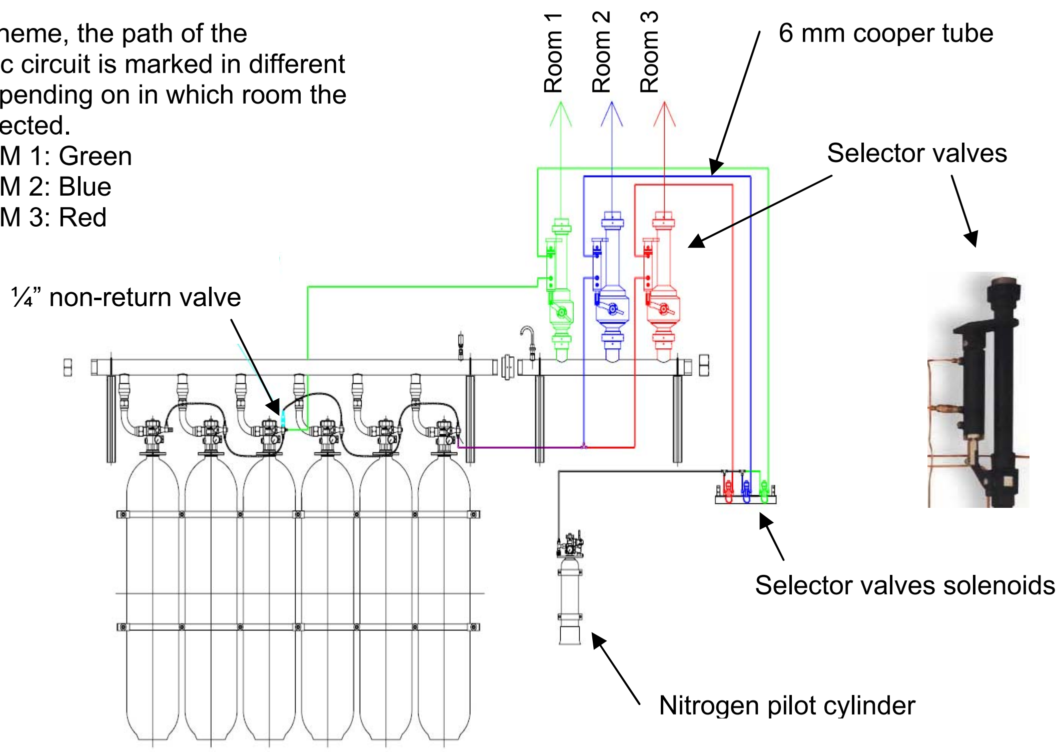
Capacity [L]	Type	LPG valve	Outlet size	Maximum charge [kg]
240	Low-pressure	LPG BP 230	2 ½”	276.0
175	Low-pressure	LPG BP 230	2 ½”	201.0
120	High-pressure	LPG 190	1 ½”	138.0
100	High-pressure	LPG 190	1 ½”	115.0
75	High-pressure	LPG 190	1 ½”	86.0
67	High-pressure	LPG 145	1”	77.0
40.2	High-pressure	LPG 145	1”	46.0
26.8	High-pressure	LPG 128	¾”	30.5
13.4	High-pressure	LPG 128	¾”	15.0
5	High-pressure	LPG 128	¾”	5.5

2.5 Selector valves systems

The FM200 systems with selector valves allow the protection of various risks using the same bank of cylinders. In the following example, a selector valves system is used to protect 3 rooms. Room 1 needs 309 Kg of FM200 and Room 1 and 2 are identical and need 630 Kg of FM200 each one. The proposed system is a bank of 6 cylinders of 120 L with 105 kg each. In case there were alarm in Room1, 3 cylinders would be released in this room, if there were alarm in Room 2 or 3, 6 cylinders would be released. Obviously, the selector valves system can only protect one room at the same time.

In this scheme, the path of the pneumatic circuit is marked in different colors depending on in which room the fire is detected.

- ROOM 1: Green
- ROOM 2: Blue
- ROOM 3: Red



When the control panel is informed of an alarm in Room 1, it gives a signal to the corresponding selector valve solenoid (green one) and to the solenoid of the nitrogen pilot cylinder. Then the nitrogen follows the green path (it is the only one that it is open), arrives to the room 1 selector valve and opens it (please note that the selector valves can only be pneumatically opened, not electrically). Finally the nitrogen continues to the third cylinder of the bank and opens it. The next two cylinders are released pneumatically and the preceding 3 cylinders cannot be activated because of the ¼" non-return valve. The gas of the 3 cylinders would be discharged through the bank manifold and through the green selector valve (the only one which would be opened) and would finally arrive to room 1.

It is highly recommended to use a main and reserve system, especially when we are protecting many rooms with the selector valves system. By installing another bank of cylinders permanently connected to the installation, the protection is guaranteed while the main cylinders are being refilled (in case a discharge has occurred).

It is important to bear in mind that because all the cylinders in the bank have to be charged at the same level (e.g. same amount of Kg), it can happen that the discharged amount of gas in a room can be higher than the necessary. Therefore, special attention shall be given to the maximum concentration that can be developed.

3 FM200 System Design. Quantity of agent required.

3.1 Preliminary information

For a correct design of the extinguishing system the designer shall determine the following characteristics of the hazard:

a) Dimensions of the enclosure (including false ceiling or floor void if applicable).
b) Hazard and fuel type (in order to know the design concentration).
c) Minimum and maximum temperature expected in the enclosure.
d) Altitude of the enclosure above sea level.
e) Level of occupation.
f) Suitability of enclosure to contain the agent after discharge, including data to determine minimum hold time, size of non closable openings in order to determine whether extended discharge is required. The protected enclosure shall have not only the sufficient structural strength to withstand the overpressure due to agent discharge but also the sufficient integrity to maintain the required concentration during the hold time.
g) Pipe distribution and location of the bank cylinders.

3.2 Quantity of agent required

ISO 14520 and NFPA 2001 propose the same method of calculation for the quantity of extinguishing agent:

$$W = \frac{V}{S}\left(\frac{C}{100 - C}\right)$$

where:
W [kg]: Required quantity of FM200
C [% vol.]: Design concentration of FM200
V [m^3]: Protected volume

S [m^3/kg]: Specific volume at the minimum design temperature. It can be approximated by the formula:

$$S = K_1 + K_2 \cdot T$$

where $K_1 = 0.1269$ and $K_2 = 0.000513$ (according to ISO)

3.3 Design concentrations

Extinguishing and design concentrations depend on which standard is used: ISO 14520 or NFPA 2001. Each Standard specifies its procedure to determine the extinguishing and design concentrations.

ISO 14520

Class of fire	Design Concentration [%]	Flooding Factor at 20ºC [kg/m^3]
Class A surface	7.9 %	0.625
Higher Hazard Class A (*)	8.5%	0.677
Class B (Heptane)	9.0 %	0.721
Class B (Acetone)	8.7 %	0.695
Class B (Ethanol)	10.9 %	0.892
Class B (Ethyl acetate)	8.7 %	0.695
Class B (Ethylene glycol)	10.1 %	0.819
Class B (Kerosene)	7.9 %	0.625
Class B (Methanol)	12.4 %	1.032
Class B (Propane)	9.6 %	0.774
Class B (Toluene)	6.4 %	0.499

(*) A new type of fire for class A has been defined in the 2006 edition of ISO14520. According to the standard, the reason is that *it is recognized that wood crib and polymeric sheet class A fire tests may not adequately indicate extinguishing concentrations suitable for the protection of certain plastic fuel hazards (e.g. electrical and electronic type hazards involving grouped power or data cables such as computer and control room under-floor voids, telecommunications facilities, etc.).*
The class A Higher concentration shall be used under certain conditions. These conditions may include:

- Cable bundles greater than 100 mm in diameter;
- Cable trays with a fill density greater than 20% of the tray cross-section;
- Horizontal or vertical stacks of cable trays (closer than 250 mm);
- Equipment energized during the extinguishment period where the collective power consumption exceeds 5 kW.

NFPA 2001

Class of fire	Design Concentration [%]	Flooding Factor at 20ºC [kg/m^3]
Class A surface (UL hardware)	6,25 %	0.485
Class A surface (LPCB hardware)	7.3 %	0.574
Class B (heptane)	8.6 %	0.686

3.4 Altitude correction factor

The design quantity of extinguishing agent shall be adjusted to compensate for ambient pressures that vary more than 11% (equivalent to approximately 1000 m. of elevation change) from standard sea level pressures (760 mm Hg at 20ºC). The ambient pressure is affected by changes in altitude, pressurization or depressurisation of the protected enclosure, and weather related barometric pressure changes.

The extinguishing agent quantity is determined by multiplying the determined quantity by the ratio of ambient enclosure pressure to standard sea level pressure.

The correction factors are shown in the table below:

According to ISO

Equivalent Altitude [m]	Correction Factor
- 1000	1.130
0	1.000
1000	0.885
1500	0.830
2000	0.785
2500	0.735
3000	0.690
3500	0.650
4000	0.610
4500	0.565

According to NFPA

Equivalent Altitude [m]	Correction Factor
- 920	1.11
-610	1.07
-300	1.04
0	1.00
300	0.96
610	0.93
910	0.89
1220	0.86
1520	0.82
1830	0.78
2130	0.75
2450	0.72
2740	0.69
3050	0.66

3.5 Climatic/Environmental conditions

FM200 systems are applicable within enclosure temperatures varying in the range from minus 10 to 90ºC and atmospheric pressures. If the application is expected to exceed these ranges it should be noted in order to adapt the design to the special conditions.

3.6 Discharge time

In accordance with both ISO 14520 and NFPA 2001, the discharge shall be completed as quickly as possible to suppress the fire and limit the formation of decomposition products.

The discharge time period is defined as the time required to discharge from the nozzles 95 % of the extinguishant mass required to achieve the design concentration at 20 °C.

In no case shall the discharge time required to achieve 95 % of the design concentration exceed 10 s at 20°C.

3.7 Duration of protection

It is important not only to achieve an effective concentration in a hazard but also that it is maintained for a sufficient period of time to allow effective performance. This is equally important in all classes of fires since a persistent ignition source (e.g., an arc, heat source, oxyacetylene torch or “deep-seated” fire) may be present once the extinguishing agent has dissipated.
The hold time is an enclosure property and is defined as the period during which the extinguishing concentration will be maintained about the hazard. The predicted hold time shall be determined by the door fan test or a full discharge test. It shall accomplish the following, unless specified by the authority having jurisdiction:

a) At the start of the hold time the concentration throughout the enclosure is the design concentration.
b) At the end of the hold time the extinguishing agent concentration at the height of the tallest hazard in the enclosure is not less than the extinguishing concentration.
c) The hold time shall not be less than 10 minutes.

If necessary an extended discharge must be made at sufficient rate to maintain the desired concentration for the required hold time. It should be considered in cases of fires with a persistent ignition source, or hazards where forced ventilation cannot be shut down before extinguishing systems activation, or hazards with large openings.

3.8 Enclosure integrity testing

All flooding systems shall have the enclosure checked to locate and then properly seal any significant air leaks that could result in a failure of the enclosure to hold the specified extinguishing agent concentration level for the specified holding period. The recommended test is a fan door test.

Adequate information and formulas to enable calculation of minimum hold time is available in the Annex E of ISO14520-1.

A full discharge test for extinguishing agents is generally not recommended in order to reduce unnecessary discharges into the environment but may be conducted if acceptable to the authority. However, if a discharge test is to be conducted, the filling of the containers for the extinguishing agent shall be by weighing or other approved methods. Concentration measurements should be made at a minimum of three points, one at the highest hazard level.

4 Design of installation

4.1 Conditions and design of storage

- Cylinders shall be located as near as possible to the protected enclosure, preferably outside the protected hazard. Cylinders may be stored inside the enclosure only when exposure to a fire or explosion is minimized.

- Adverse climatic conditions, exposure to corrosive substances or possible mechanical damage should be avoided. Containers shall be arranged in manner that they are not exposed to any damage or fire. Proper ventilation shall be provided in the area where the containers are located.

- Arrangements shall be made for container and valve assemblies and accessories to be accessible for inspection, testing and other maintenance when required. Containers shall be accessible for use of manual release.

- It shall be taken into account the loading to be installed and the adequateness of the floor to withstand the extra load.

- It is important to make sure there will be enough space in the storage room to place and install the bank of cylinders.

4.2 Piping design. Supports.

Pipework should be designed in such a way that the pipe distance between each nozzle and the bank of cylinders should be the same. It is very difficult to design a pipework with these properties (it is not always possible), but the designer should take it into account.

Pipe and valve supports shall be suitable for the expected temperature and be able to withstand the dynamic and static forces involved. Due allowance shall be made for the stresses induced in the pipework by temperature variations. Adequate environmental protection shall be given to supports and associated steelwork. The distance between pipe supports shall be as in the following table:

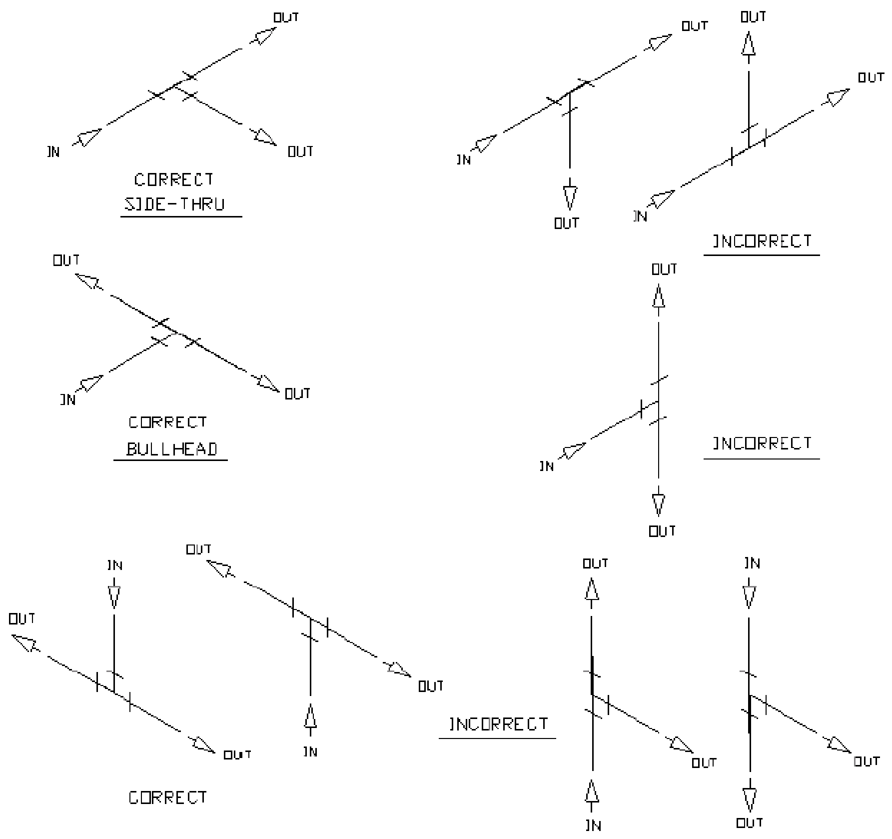
Nominal size of pipe		Maximum pipework distance (m)
10 mm	3/8”	1’0
15 mm	½”	1’5
20 mm	¾”	1’8
25 mm	1”	2’1
32 mm	1 ¼”	2’4
40 mm	1 ½”	2’7
50 mm	2”	3’4
65 mm	2 ½”	3’5
80 mm	3”	3’7
100 mm	4”	4’3

Pipe supports distance

Adequate support shall be provided for nozzles. Distance from the last support should be as follows:

- Piping sizes ≤ 25mm. Then pipework distance ≤ 0'1 m
- Piping sizes > 25mm. Then pipework distance ≤ 0'25 m

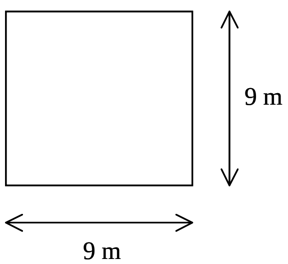
4.3 Tee orientations



4.4 Nozzles:

A minimum number of nozzles is required for an installation to discharge accurately. This minimum number depends on the maximum coverage, the quantity of agent to be released and pressure drop that may be produced from storage outlet to nozzle inlet.
A methodology to calculate the necessary number of nozzles and its diameters is given below. We have to know first the minimum number of nozzles that will be needed according to the maximum area and height coverage and then we have to choose the diameters according to the agent flow. It should be noted that the criteria given in this document to choose the diameters is approximate and that it should be confirmed by the hydraulic calculations.

<u>Nozzle area coverage</u>:



The maximum area coverage is expressed as maximum length x maximum width. For FM200 the maximum length and width are 9 m.

Nozzle height coverage:

The maximum height coverage is 4 m. Therefore, for rooms higher than 4 m, an intermediate level of nozzles should be installed.

Nozzle coverage values are the same for all FM200 nozzles, regardless of orifice, pipe size and discharge pattern.

Calculated nozzles according to above criteria shall be distributed uniformly on the plan of the enclosure to be protected.

Nozzle diameters:

Once we have determined the necessary number of nozzles, the following methodology should be used to determine its diameters:

1. Calculate the flow per each nozzle as Kg of agent / number of nozzles. The resulting value is the mass of agent that has to be discharged per each nozzle in 10 seconds.
2. Take the diameter corresponding to the Kg of agent in 10 seconds of the following table:

PIPING FLOW RATES (Kg./10s.)

Ø NOMINAL	Ø INCHES	HFC227 (H. Pressure)	HFC227 (L. Pressure)
10	3/8"	Up to 12	Up to 9
15	1/2"	13-24	10-15
20	3/4"	25-35	16-27
25	1"	36-48	28-38
32	11/4"	49-120	39-59
40	11/2"	121-203	60-88
50	2"	204-318	89-149
65	21/2"	319-517	150-263
80	3"	518-682	264-430
100	4"	Over	Over
Maximum area protected per nozzle		9 m x 9 m	

* LPG supplies nozzles of 3/8", 1/2", 3/4", 1", 1 1/4", 1 1/2" and 2" inches

Very important: As above-mentioned, these values are approximate and should be confirmed by the hydraulic calculations.

Diaphragm drillings:

Nozzles incorporate an orifice plate (diaphragm) which drilled diameter is made according to the hydraulic calculations. To ensure that the nozzle and not the pipe controls the flow, a maximum area rate between the orifice area and the pipe area has been established. This maximum rate is 0.7 which corresponds to a maximum orifice plate diameter of 83.67 % of the pipe diameter before the nozzle. In the following table, the maximum orifice drillings for a schedule 40 pipe can be found:

Nozzle size	Maximum drilling (mm)
3/8”	10,47
1/2”	13,22
3/4”	17,51
1”	22,29
1 1/4”	29,32
1 1/2”	34,22
2”	43,92

Maximum nozzle orifice diameters (drillings) for a pipe of schedule 40.

Distribution of the nozzles:

Nozzles shall be approved and shall be located with the geometry of the enclosure taken in consideration. The type, number and placement of nozzles shall be such that:

a) The design concentration is achieved in all parts of the enclosure.
b) The discharge does not unduly splash flammable liquids or create dust clouds that might extend the fire, create an explosion or otherwise adversely affect the occupants.
c) The velocity of discharge does not adversely affect the enclosure or its contents.

Discharge patterns:

The 180º and 360º type discharge nozzles are designed to provide the proper flow rate and distribution of the agent to total flood a hazard area. The 180º nozzle is designed to provide a 180º discharge pattern for sidewall applications. The 360º nozzles offer a full 360º discharge pattern for installations where nozzles are located in the centre of the hazard.

LPG nozzles

LPG diaphragms

Other considerations:

- If distribution pipe produces a very high-pressure loss (very long and narrow pipe, or pipe divided into many branches) it is possible that when carrying out hydraulic calculation the discharge time must not be too long or the nozzle diameters too large. In such an event more nozzles should be added or if the pipes produce little pressure drop, it is possible that the number of nozzles is too large.

- In order to minimize the possibility of lifting or displacement of lightweight ceiling tiles, precautions should be taken to securely anchor tiles for a minimum distance of 1’5 meters from each discharge nozzle. The discharge velocities created by the design of nozzles can be a factor in the displacement of such tiles.

- Nozzles shall not be located over exhaust ducts. Nozzles shall be arranged in such a way that the discharge effects will not damage protected objects.

- In the case of enclosures divided into compartments by means of high structures (libraries, exhibitors, store shelves) nozzles shall be located in each of the zones to ensure a homogeneous distribution of the agent.

Useful tables

MANIFOLD'S DIAMETERS vs. NUMBER OF CYLINDERS

HFC 227

67 liters		75 liters	
Number of cyl.	DIAMETER	Number of cyl.	DIAMETER
2 and 3	1 1/2"	from 2 to 4	2"
4	2"	5 and 6	2 1/2"
from 5 to 7	2 1/2"	from 7 to 9	3"
from 8 to 10	3"	over 9	4"

HFC 227

100 liters		120 liters	
Number of cyl.	DIAMETER	Number of cyl.	DIAMETER
2 and 3	2"	2	2"
4 and 5	2 1/2"	3 and 4	2 1/2"
6	3"	5	3"
over 6	4"	over 5	4"

* For low pressure systems (142, 175 or 240 l. cylinders with 2 or 3 cylinders) the manifold size is 4".

* It is important to take into account that these diameters must be confirmed with the results of the hydraulic calculations.

PIPING FLOW RATES (Kg./10s.)

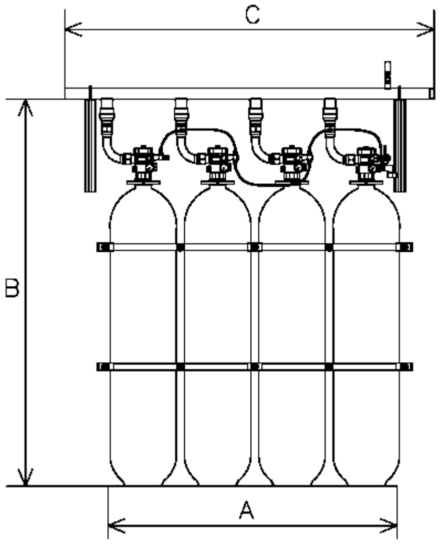
Ø NOMINAL	Ø INCHES	HFC227 (H. Pressure)	HFC227 (L. Pressure)
10	3/8"	Up to 12	Up to 9
15	1/2"	13-24	10-15
20	3/4"	25-35	16-27
25	1"	36-48	28-38
32	11/4"	49-120	39-59
40	11/2"	121-203	60-88
50	2"	204-318	89-149
65	21/2"	319-517	150-263
80	3"	518-682	264-430
100	4"	Over	Over
Maximum area protected per nozzle		9 m x 9 m	

* LPG supplies nozzles of 3/8", 1/2", 3/4", 1", 1 1/4", 1 1/2" and 2" inches

PIPING SCHEDULE

3/8"	Sch 40
1/2"	
3/4"	
1"	
1 1/4"	
1 1/2"	
2"	
2 1/2"	
3"	
4"	

* LPG manifolds are sch. 80



N° CIL.	67 HFC125-227 H. PRESSURE S. ROW A	B	Width	C	"U" FIXATION	75 HFC125-227 H. PRESSURE S. ROW A	B	Width	C	"U" FIXATION	100 HFC125-227 H. PRESSURE S. ROW A	B	Width	C	"U" FIXATION	120 HFC125-227 H. PRESSURE S. ROW A	B	Width	C	"U" FIXATION
2	770	1860	310	1035	2	770	2095	310	950	2	890	1690	440	1185	2	890	1890	440	1185	2
3	1120	1860	310	1385	2	1120	2095	310	1300	2	1290	1690	440	1585	2	1290	1890	440	1585	2
4	1470	1860	310	1735	2	1470	2095	310	1650	2	1690	1690	440	1985	2	1690	1890	440	1985	2
5	1820	1860	310	2085	2	1820	2095	310	2000	2	2090	1690	440	2385	3	2090	1890	440	2385	3
6	2170	1860	310	2435	2	2170	2095	310	2350	2	2490	1690	440	2785	3	2490	1890	440	2785	3
7	2520	1860	310	2785	2	2520	2095	310	2700	2	2890	1690	440	3185	3	2890	1890	440	3185	3
8	2870	1860	310	3135	3	2870	2095	310	3050	3	3290	1690	440	3585	3	3290	1890	440	3585	3
9	3220	1860	310	3485	3	3220	2095	310	3400	3	3690	1690	440	3985	4	3690	1890	440	3985	4
10	3570	1860	310	3835	3	3570	2095	310	3750	3	4090	1690	440	4385	4	4090	1890	440	4385	4

N° CIL.	142 HFC125-227 L. PRESSURE S. ROW A	B	Width	C	"U" FIXATION	175 HFC125-227 L. PRESSURE S. ROW A	B	Width	C	"U" FIXATION	240 HFC125-227 L. PRESSURE S. ROW A	B	Width	C	"U" FIXATION
2	1229	1742	474	1355	2	1335	1708	530	1405	2	1335	2113	530	1405	2
3	1779	1742	474	1905	2	1935	1708	530	2005	2	1935	2113	530	2005	2

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Important: It should be pointed out that this document is a basic guideline on LPG HFC-227ea systems and that it does not intend to replace the LPG *Design manual for HFC-227ea systems* (document: MD-27-01-IN) and the *Installation, Maintenance and User manual for HFC-227ea fire extinguishing systems* (document: MU-27-01-IN).