INTERNATIONAL STANDARD

ISO 14520-9

Second edition
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Gaseous fire-extinguishing systems — Physical properties and system design —

Part 9: **HFC 227ea extinguishant**

Systèmes d'extinction d'incendie utilisant des agents gazeux — Propriétés physiques et conception des systèmes —

Partie 9: Agent extincteur HFC 227ea

Reference number
ISO 14520-9:2006(E)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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ISO 14520-9 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 8, *Gaseous media and firefighting systems using gas*.

This second edition cancels and replaces the first edition (ISO 14520-9:2000), which has been technically revised.

ISO 14520 consists of the following parts, under the general title *Gaseous fire-extinguishing systems — Physical properties and system design*:

— *Part 1: General requirements*

— *Part 2:* CF_3I *extinguishant*

— *Part 5: FK-5-1-12 extinguishant*

— *Part 6: HCFC Blend A extinguishant*

— *Part 8: HFC 125 extinguishant*

— *Part 9: HFC 227ea extinguishant*

— *Part 10: HFC 23 extinguishant*

— *Part 11: HFC 236fa extinguishant*

— *Part 12: IG-01 extinguishant*

— *Part 13: IG-100 extinguishant*

— *Part 14: IG-55 extinguishant*

— *Part 15: IG-541 extinguishant*

Parts 3, 4 and 7, which dealt with FC-2-1-8, FC-3-1-10 and HCFC 124 extinguishants, respectively, have been withdrawn, as these types are no longer manufactured.

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Gaseous fire-extinguishing systems — Physical properties and system design —

Part 9: HFC 227ea extinguishant

1 Scope

This part of ISO 14520 gives specific requirements for gaseous fire-extinguishing systems, with respect to the HFC 227ea extinguishant. It includes details of physical properties, specification, usage and safety aspects and is applicable to systems operating at nominal pressures of 25 bar and 42 bar superpressurized with nitrogen. This does not preclude the use of other systems.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14520-1:2006, *Gaseous fire-extinguishing systems — Physical properties and system design — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14520-1 apply.

4 Characteristics and uses

4.1 General

Extinguishant HFC 227ea shall comply with the specification according to Table 1.

HFC 227ea is a colourless, almost odourless, electrically non-conductive gas with a density approximately six times that of air.

The physical properties are given in Table 2.

HFC 227ea extinguishes fires mainly by physical means, but also by some chemical means.

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Table 1 — Specification for HFC 227ea

Property	Requirement
Purity	99,6 % by mass, min.
Acidity	3×10^{-6} by mass, max.
Water content	10×10^{-6} by mass, max.
Non-volatile residue	0,01 % by mass, max.
Suspended matter or sediment	None visible

Table 2 — Physical properties of HFC 227ea

Property	Unit	Value
Molecular mass	—	170
Boiling point at 1,013 bar (absolute) [a]	°C	−16,4
Freezing point	°C	−127
Critical temperature	°C	101,7
Critical pressure	bar abs [a]	29,26
Critical volume	cm^3/mol	274
Critical density	kg/m^3	573
Vapour pressure 20 °C	bar abs [a]	3,90
Liquid density 20 °C	kg/m^3	1 410
Saturated vapour density 20 °C	kg/m^3	31,035
Specific volume of superheated vapour at 1,013 bar and 20 °C	m^3/kg	0,1374
Chemical formula	CF_3CHFCF_3	
Chemical name	Heptafluoropropane	
[a] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.		

4.2 Use of HFC 227ea systems

HFC 227ea total flooding systems may be used for extinguishing fires of all classes within the limits specified in ISO 14520-1:2006, Clause 4.

The extinguishant requirements per volume of protected space are given in Table 3 for various levels of concentration. These are based on methods given in ISO 14520-1:2006, 7.6.

The extinguishing concentrations and design concentrations for *n*-heptane and Surface class A hazards are given in Table 4, those for other fuels in Table 5 and inerting concentrations in Table 6.

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Table 3 — HFC 227ea total flooding quantity

Temperature T	Specific vapour volume S	HFC 125 mass requirements per unit volume of protected space, m/V (kg/m^3) This information refers only to HFC 227ea, and may not represent any other products containing 1,1,1,2,3,3,3-heptafluoropropane as a component.									
		Design concentration (by volume)									
°C	m3/kg	6 %	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %
−10	0,1215	0,5254	0,6196	0,7158	0,8142	0,9147	1,0174	1,1225	1,2301	1,3401	1,4527
−5	0,1241	0,5142	0,6064	0,7005	0,7967	0,8951	0,9957	1,0985	1,2038	1,3114	1,4216
0	0,1268	0,5034	0,5936	0,6858	0,7800	0,8763	0,9748	1,0755	1,1785	1,2839	1,3918
5	0,1294	0,4932	0,5816	0,6719	0,7642	0,8586	0,9550	1,0537	1,1546	1,2579	1,3636
10	0,1320	0,4834	0,5700	0,6585	0,7490	0,8414	0,9360	1,0327	1,1316	1,2328	1,3364
15	0,1347	0,4740	0,5589	0,6457	0,7344	0,8251	0,9178	1,0126	1,1096	1,2089	1,3105
20	0,1373	0,4650	0,5483	0,6335	0,7205	0,8094	0,9004	0,9934	1,0886	1,1859	1,2856
25	0,1399	0,4564	0,5382	0,6217	0,7071	0,7944	0,8837	0,9750	1,0684	1,1640	1,2618
30	0,1425	0,4481	0,5284	0,6104	0,6943	0,7800	0,8676	0,9573	1,0490	1,1428	1,2388
35	0,1450	0,4401	0,5190	0,5996	0,6819	0,7661	0,8522	0,9402	1,0303	1,1224	1,2168
40	0,1476	0,4324	0,5099	0,5891	0,6701	0,7528	0,8374	0,9239	1,0124	1,1029	1,1956
45	0,1502	0,4250	0,5012	0,5790	0,6586	0,7399	0,8230	0,9080	0,9950	1,0840	1,1751
50	0,1527	0,4180	0,4929	0,5694	0,6476	0,7276	0,8093	0,8929	0,9784	1,0660	1,1555
55	0,1553	0,4111	0,4847	0,5600	0,6369	0,7156	0,7960	0,8782	0,9623	1,0484	1,1365
60	0,1578	0,4045	0,4770	0,5510	0,6267	0,7041	0,7832	0,8641	0,9469	1,0316	1,1183
65	0,1604	0,3980	0,4694	0,5423	0,6167	0,6929	0,7707	0,8504	0,9318	1,0152	1,1005
70	0,1629	0,3919	0,4621	0,5338	0,6072	0,6821	0,7588	0,8371	0,9173	0,9994	1,0834
75	0,1654	0,3859	0,4550	0,5257	0,5979	0,6717	0,7471	0,8243	0,9033	0,9841	1,0668
80	0,1679	0,3801	0,4482	0,5178	0,5890	0,6617	0,7360	0,8120	0,8898	0,9694	1,0509
85	0,1704	0,3745	0,4416	0,5102	0,5803	0,6519	0,7251	0,8000	0,8767	0,9551	1,0354
90	0,1730	0,3690	0,4351	0,5027	0,5717	0,6423	0,7145	0,7883	0,8638	0,9411	1,0202
95	0,1755	0,3638	0,4290	0,4956	0,5636	0,6332	0,7044	0,7771	0,8516	0,9277	1,0057
100	0,1780	0,3587	0,4229	0,4886	0,5557	0,6243	0,6945	0,7662	0,8396	0,9147	0,9916

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

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

$$m = \left(\frac{c}{100 - c}\right)\frac{V}{S}$$

T is the temperature (in degrees Celsius); i.e. the design temperature in the hazard area;

S is the specific volume (in cubic metres per kilogram); the specific volume of superheated HFC 227ea vapour at a pressure of 1,013 bar may be approximated by

$$S = k_1 + k_2 T$$

where $k_1 = 0{,}126\,9$; $k_2 = 0{,}000\,513$

c is the concentration (in percent); i.e. the volumetric concentration of HFC 227ea in air at the temperature indicated, and a pressure of 1,013 bar absolute.

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Table 4 — HFC 227ea reference extinguishing and design concentrations

Fuel	Extinguishment % by volume	Minimum design % by volume
Class B		
Heptane (cup burner)	6,7	9,0
Heptane (room test)	6,9	
Surface Class A		
Wood crib	4,9	
PMMA	6,1	7,9
PP	6,1	
ABS	6,1	
Higher Hazard Class A	[a]	8,5

The extinguishment values for the Class B and the Surface Class A fuels are determined by testing in accordance with ISO 14520-1:2006, Annexes B and C.

The minimum design concentration for the Class B fuel is the higher value of the heptane cup burner or room test heptane extinguishment concentration multiplied by 1,3.

The minimum design concentration for Surface Class A fuel is the highest value of the wood crib, PMMA, PP or ABS extinguishment concentrations multiplied by 1,3. In the absence of any of the 4 extinguishment values, the minimum design concentration for Surface Class A shall be that of Higher Hazard Class A.

See ISO 14520-1:2006, 7.5.1.3, for guidance on Class A fuels.

The extinguishing and design concentrations for room-scale test fires are for informational purposes only. Lower and higher extinguishing concentrations than those shown for room-scale test fires may be achieved and allowed when validated by test reports from internationally recognized laboratories.

[a] The minimum design concentration for Higher Hazard Class A fuels shall be the higher of the Surface Class A or 95 % of the Class B minimum design concentration.

Table 5 — HFC 227ea extinquishing and design concentrations for other fuels

Fuel	Inertion % by volume	Minimum design % by volume
Acetone	6,7	8,7
Ethanol	8,4	10,9
Ethyl acetate	6,7	8,7
Ethylene glycol	7,8	10,1
Kerosene	6,1	7,9
Methanol	9,5	12,4
Propane	7,4	9,6
Toluene	4,9	6,4

Extinguishing concentrations for Class B fuels derived in accordance with ISO 14520-1:2006, Annex B. Minimum design values have been increased to the minimum design concentration established for heptane in accordance with ISO 14520-1:2006, 7.5.1.

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Table 6 — HFC 227ea inerting and design concentrations

Fuel	Inertion % by volume	Minimum design % by volume
Isobutane	11,3	12,4
1-Chloro-1,1-difluoroethane (HCFC 1416)	6,7	8,7
1,1-Difluoroethane (HCFC 152a)	8,6	9,5
Difluoromethane (HCFC 32)	6,7	8,7
Ethylene oxide	13,6	15,0
Methane	8,0	8,8
Pentane	11,6	12,8
Propane		
Inerting concentrations derived in accordance with ISO 14520-1:2006, 7.5.2 and Annex D.		

5 Safety of personnel

Any hazard to personnel created by the discharge of HFC 227ea shall be considered in the design of the system.

Potential hazards can arise from the following:

a) the extinguishant itself;

b) the combustion products of the fire;

c) breakdown products of the extinguishant resulting from exposure to fire.

For minimum safety requirements, see ISO 14520-1:2006, Clause 5.

Toxicological information for HFC 227ea is given in Table 7.

Table 7 — Toxicological information for HFC 227ea

Property	Value % by volume
ALC	$>$ 80 at 20 % 0_2
No observed adverse effect level (NOAEL)	9,0
Lowest observed adverse effect level (LOAEL)	10,5
ALC is the approximate lethal concentration for a rat population during a 4 h exposure.	

6 System design

6.1 Fill density

The fill density of the container shall not exceed the values given in Tables 8 and 9 for 25 bar and 42 bar systems, respectively.

Exceeding the maximum fill density may result in the container becoming “liquid full”, with the effect that an extremely high rise in pressure occurs with small increases in temperature, which could adversely affect the integrity of the container assembly.

The relationships between pressure and temperature are shown in Figures 1 and 2 for various levels of fill density.

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Table 8 — Storage container characteristics for HFC 227ea — 25 bar

Property	Unit	Value
Maximum fill density	kg/m^3	1 150
Maximum container working pressure at 50 °C	bar [a] [b]	34
Superpressurization at 21 °C	bar [a] [b]	25
Reference should be made to Figure 1 for further data on pressure/temperature relationships.		

[a] Gauge.

[b] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

Table 9 — Storage container characteristics for HFC 227ea — 42 bar

Property	Unit	Value
Maximum fill density	kg/m^3	1 150
Maximum container working pressure at 50 °C	bar [a] [b]	53
Superpressurization at 21 °C	bar [a] [b]	42
Reference should be made to Figure 2 for further data on pressure/temperature relationships.		

[a] Absolute.

[b] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

6.2 Superpressurization

Containers shall be superpressurized with nitrogen with a moisture content of not more than 60×10^{-6} by mass to an equilibrium pressure of $\left(25^{+1,25}_{0}\right)$ bar or $\left(42^{+2,1}_{0}\right)$ bar at a temperature of 21 °C (see Clause 1 for exception).

6.3 Extinguishant quantity

The quantity of extinguishant shall be the minimum required to achieve the design concentration within the hazard volume at the minimum expected temperature, determined using Table 3 and the method according to ISO 14520-1:2006, 7.6.

The design concentrations shall be those specified for relevant hazards in Table 4, including a 1,3 safety factor on the extinguishing concentration. Consideration should be given to increasing this factor for particular hazards, while seeking advice from the relevant authority.

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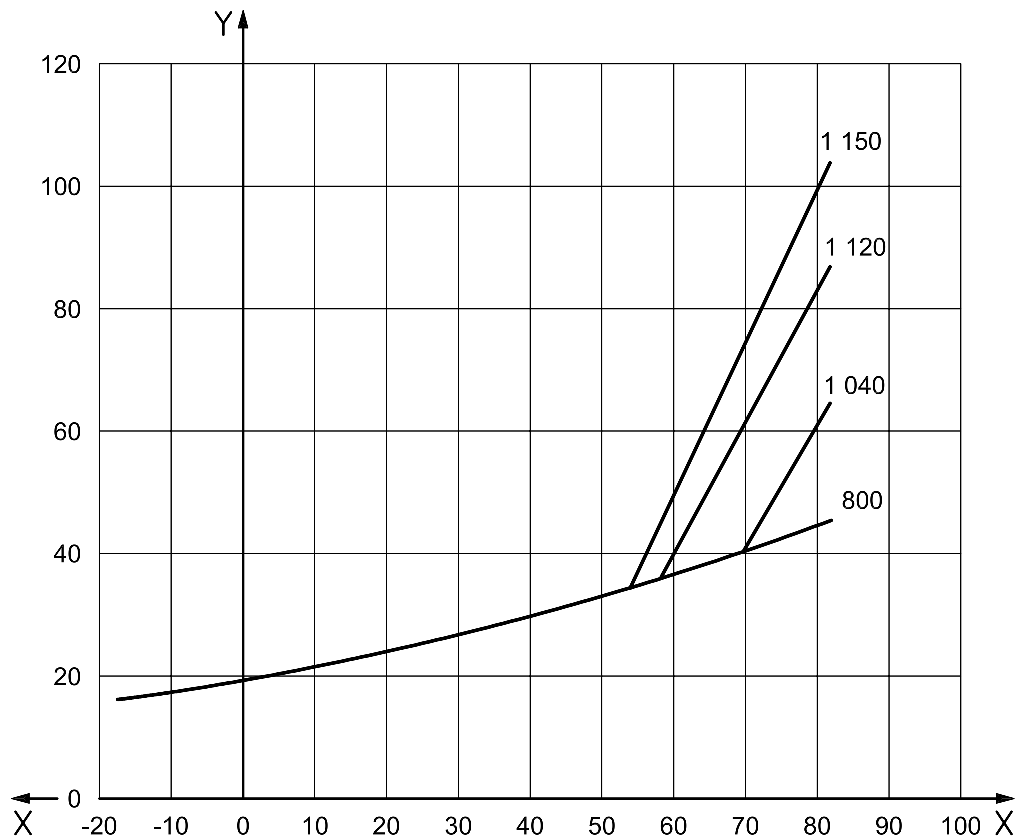
Values of density in kilograms per cubic metre



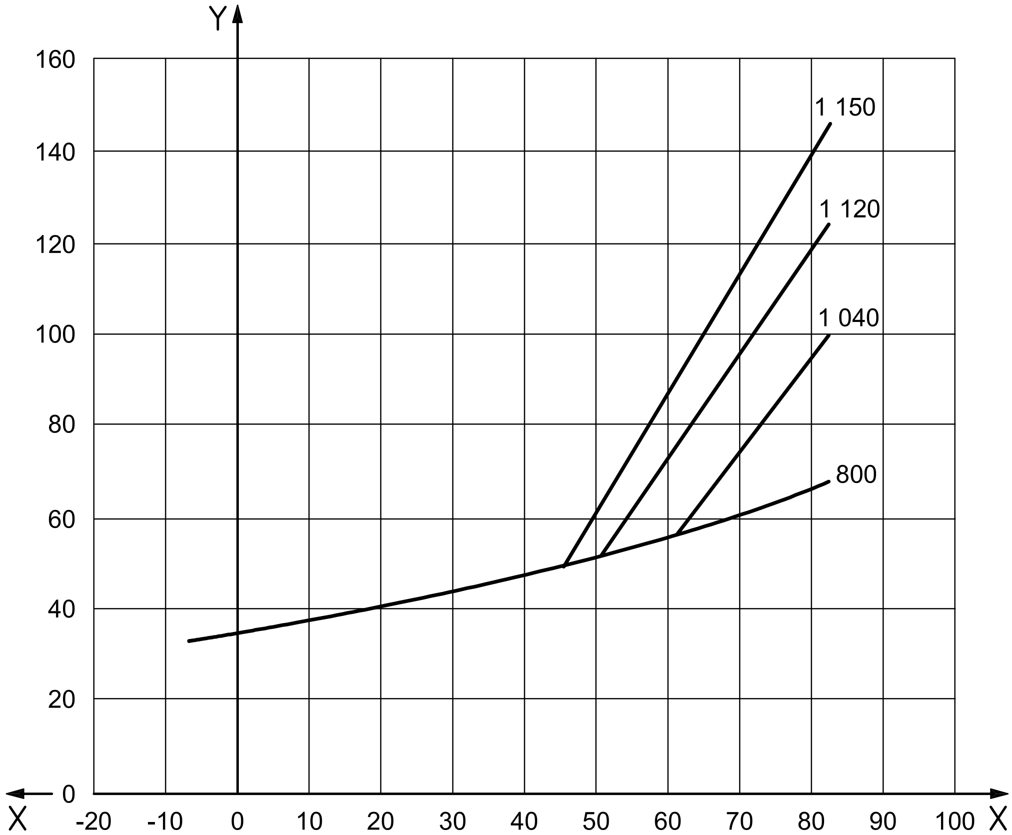
Key

X temperature, °C

Y pressure, bar

Figure 1 — Temperature/pressure graph for HFC 227ea — Superpressurized with nitrogen to 25 bar at 21 °C

Values of density in kilograms per cubic metre



Key

X temperature, °C

Y pressure, bar

Figure 2 — Temperature/pressure graph for HFC 227ea — Superpressurized with nitrogen to 42 bar at 21 °C

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