BRITISH STANDARD

BS EN
15004-4:2008

Fixed firefighting systems — Gas extinguishing systems —

Part 4: Physical properties and system design of gas extinguishing systems for HFC 125 extinguishant

ICS 13.220.20

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 15004-4:2008. It supersedes BS ISO 14520-8:2006 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee FSH/18, Fixed firefighting systems, to Subcommittee FSH/18/6, Gaseous extinguishing media and systems.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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This European Standard was approved by CEN on 26 April 2008.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document (EN 15004-4:2008) has been prepared by Technical Committee CEN/TC 191 “Fixed firefighting systems”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by December 2008, and conflicting national standards shall be withdrawn at the latest by December 2008.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

The text of the International Standard ISO 14520-8:2006 from Technical Committee ISO/TC 21 "Equipment for fire protection and fire fighting" of the International Organization for Standardization (ISO) has been taken over as a European Standard by Technical Committee CEN/TC 191 "Fixed firefighting systems", the secretariat of which is held by BSI, with common modifications which are indicated by a straight line in the margin of the text.

This European Standard will consist of the following parts, under the general title *Fixed firefighting systems – Gas extinguishing systems:*

— *Part 1: Design, installation and maintenance (ISO 14520-1, modified)*

— *Part 2: Physical properties and system design of gas extinguishing systems for FK-5-1-12 extinguishant (ISO 14520-5, modified)*

— *Part 3: Physical properties and system design of gas extinguishing systems for HCFC Blend A extinguishant (ISO 14520-6, modified)*

— *Part 4: Physical properties and system design of gas extinguishing systems for HFC 125 extinguishant (ISO 14520-8, modified)*

— *Part 5: Physical properties and system design of gas extinguishing systems for HFC 227ea extinguishant (ISO 14520-9, modified)*

— *Part 6: Physical properties and system design of gas extinguishing systems for HFC 23 extinguishant (ISO 14520-10, modified)*

— *Part 7: Physical properties and system design of gas extinguishing systems for IG-01 extinguishant (ISO 14520-12, modified)*

— *Part 8: Physical properties and system design of gas extinguishing systems for IG-100 extinguishant (ISO 14520-13, modified)*

— *Part 9: Physical properties and system design of gas extinguishing systems for IG-55 extinguishant (ISO 14520-14, modified)*

— *Part 10: Physical properties and system design of gas extinguishing systems for IG-541 extinguishant (ISO 14520-15, modified)*

The International Standards ISO 14520-2 and ISO 14520-11, which dealt with CF_3I and HFC 236fa extinguishants, respectively, have not been implemented by CEN, as CF_3I extinguishant is only valid for local

application and HFC 236fa extinguishant is only applicable for portable fire extinguishers and local application, respectively, which is not covered by the scope.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Foreword of ISO 14520-8:2006

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 14520-8 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 14520-8:2000), which has been technically revised.

ISO 14520 consists of the following parts, under the general title *Gaseous media 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.

1 Scope

This document gives specific requirements for gaseous fire-extinguishing systems, with respect to the HFC 125 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.

EN 15004-1:2008, *Fixed firefighting systems – Gas extinguishing systems - Design, installation and maintenance (ISO 14520-1, modified)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 15004-1:2008 apply.

4 Characteristics and uses

4.1 General

Extinguishant HFC 125 shall comply with the specification according to Table 1.

HFC 125 is a colourless, almost odourless, electrically non-conductive gas with a density approximately four times that of air.

The physical properties are given in Table 2.

HFC 125 extinguishes fires mainly by physical means, but also by some chemical means.

Table 1 — Specification for HFC 125

Property	Requirement
Purity	99,6 % by mass, min.
Acidity	3×10^{-4} by mass, max.
Water content	10×10^{-4} % by mass, max.
Non-volatile residue	0,01 % by mass, max.
Suspended matter or sediment	None visible

Table 2 — Physical properties of HFC 125

Property	Unit	Value
Molecular mass	—	120,02
Boiling point at 1,013 bar (absolute)	°C	– 48,09
Freezing point	°C	– 101
Critical temperature	°C	66,02
Critical pressure	bar abs [a]	36,18
Critical volume	cm^3/mol	210
Critical density	kg/m^3	573,6
Vapour pressure 20 °C	bar abs [a]	12,05
Liquid density 20 °C	kg/m^3	1 218,0
Saturated vapour density 20 °C	kg/m^3	77,97
Specific volume of superheated vapour at 1,013 bar and 20 °C	m^3/kg	0,1972
Chemical formula	CF_3CHF_2	
Chemical name	Pentafluoroethane	
[a] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.		

4.2 Use of HFC 125 systems

HFC 125 total flooding systems may be used for extinguishing fires of all classes within the limits specified in EN 15004-1:2008, 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 EN 15004-1:2008, 7.6.

The extinguishing concentrations and design concentrations for n-heptane and Surface Class A hazards are given in Table 4.

Table 3 — HFC 125 total flooding quantity

Temperature T	**Specific vapour volume** S	**HCFC 125 mass requirements per unit volume of protected space**, m/V (kg/m^3) This information refers only to the product HFC-125, and does not represent any other products containing pentafluoroethane as a component.									
		Design concentration (by volume)									
°C	m^3/kg	7 %	8 %	9 %	10 %	11 %	12 %	13 %	14 %	15 %	16 %
– 45	0,1497	0,5028	0,5809	0,6607	0,7422	0,8256	0,9109	0,9982	1,0874	1,1788	1,2724
– 40	0,1534	0,4907	0,5669	0,6447	0,7243	0,8057	0,8889	0,9741	1,0612	1,1504	1,2417
– 35	0,1572	0,4788	0,5532	0,6291	0,7068	0,7862	0,8675	0,9505	1,0356	1,1226	1,2117
– 30	0,1608	0,4681	0,5408	0,6151	0,6910	0,7686	0,8480	0,9293	1,0124	1,0975	1,1846
– 25	0,1645	0,4576	0,5286	0,6012	0,6754	0,7513	0,8290	0,9084	0,9896	1,0728	1,1579
– 20	0,1682	0,4475	0,5170	0,5880	0,6606	0,7348	0,8107	0,8884	0,9678	1,0492	1,1324
– 15	0,1719	0,4379	0,5059	0,5753	0,6464	0,7190	0,7933	0,8693	0,9470	1,0266	1,1081
– 10	0,1755	0,4289	0,4955	0,5635	0,6331	0,7042	0,7770	0,8514	0,9276	1,0055	1,0853
–5	0,1791	0,4203	0,4855	0,5522	0,6204	0,6901	0,7614	0,8343	0,9089	0,9853	1,0635
0	0,1828	0,4118	0,4757	0,5410	0,6078	0,6761	0,7460	0,8174	0,8905	0,9654	1,0420
5	0,1864	0,4038	0,4665	0,5306	0,5961	0,6631	0,7316	0,8016	0,8733	0,9467	1,0219
10	0,1900	0,3962	0,4577	0,5205	0,5848	0,6505	0,7177	0,7864	0,8568	0,9288	1,0025
15	0,1935	0,3890	0,4494	0,5111	0,5742	0,6387	0,7047	0,7722	0,8413	0,9120	0,9844
20	0,1971	0,3819	0,4412	0,5018	0,5637	0,6271	0,6919	0,7581	0,8259	0,8953	0,9664
25	0,2007	0,3750	0,4333	0,4928	0,5536	0,6158	0,6794	0,7445	0,8111	0,8793	0,9491
30	0,2042	0,3686	0,4258	0,4843	0,5441	0,6053	0,6678	0,7318	0,7972	0,8642	0,9328
35	0,2078	0,3622	0,4185	0,4759	0,5347	0,5948	0,6562	0,7191	0,7834	0,8492	0,9166
40	0,2113	0,3562	0,4115	0,4681	0,5258	0,5849	0,6454	0,7072	0,7704	0,8352	0,9014
45	0,2149	0,3503	0,4046	0,4602	0,5170	0,5751	0,6345	0,6953	0,7575	0,8212	0,8863
50	0,2184	0,3446	0,3982	0,4528	0,5088	0,5659	0,6244	0,6842	0,7454	0,8080	0,8721
55	0,2219	0,3392	0,3919	0,4457	0,5007	0,5570	0,6145	0,6734	0,7336	0,7953	0,8584
60	0,2254	0,3339	0,3858	0,4388	0,4930	0,5483	0,6050	0,6629	0,7222	0,7829	0,8451
65	0,2289	0,3288	0,3799	0,4321	0,4854	0,5400	0,5957	0,6528	0,7112	0,7710	0,8321
70	0,2324	0,3239	0,3742	0,4256	0,4781	0,5318	0,5868	0,6430	0,7005	0,7593	0,8196
75	0,2358	0,3192	0,3688	0,4194	0,4712	0,5242	0,5783	0,6337	0,6904	0,7484	0,8078
80	0,2393	0,3145	0,3634	0,4133	0,4643	0,5165	0,5698	0,6244	0,6803	0,7374	0,7960
85	0,2428	0,3100	0,3581	0,4073	0,4576	0,5090	0,5616	0,6154	0,6705	0,7268	0,7845
90	0,2463	0,3056	0,3531	0,4015	0,4511	0,5018	0,5536	0,6067	0,6609	0,7165	0,7734
95	0,2498	0,3013	0,3481	0,3959	0,4448	0,4948	0,5459	0,5982	0,6517	0,7064	0,7625

m/V is the agent mass requirements (in kilogram 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 metre); 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 degree Celsius); i.e. the design temperature in the hazard area.

S is the specific volume (in cubic metre per kilogram); the specific volume of superheated HFC 125 vapour at a pressure of 1,013 bar may be approximated by the formula:

$S = k_1 + k_2 T$

where $k_1 = 0{,}1825$; $k_2 = 0{,}0007$.

c is the concentration (in percent); i.e. the volumetric concentration of HFC 125 in air at the temperature indicated, and a pressure of 1,013 bar.

Table 4 — HFC 125 reference extinguishing and design concentrations

Fuel	Extinguishment % by volume	Minimum design % by volume
Class B		
Heptane (cup burner) Heptane (room test)	9,3 9,3	12,1
Surface Class A		
Wood crib PMMA PP ABS	6,7 8,6 8,6 8,6	11,2
Higher Hazard Class A	[a]	11,5

The extinguishment values for the Class B and the Surface Class A fuels are determined by testing in accordance with EN 15004-1:2008, 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 EN 15004-1:2008, 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.

5 Safety of personnel

Any hazard to personnel created by the discharge of HFC 125 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 EN 15004-1:2008, Clause 5.

Toxicological information for HFC 125 is given in Table 5.

Table 5 — Toxicological information for HFC 125

Property	Value % by volume
ALC[a]	> 70
No observed adverse effect level (NOAEL)	7,5
Lowest observed adverse effect level (LOAEL)	10
[a] ALC is the concentration lethal 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 6 and 7 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 maximum fill density.

Table 6 — Storage container characteristics for HFC 125 – 25 bar

Property	Unit	Value
Maximum fill density	kg/m^3	929
Maximum container working pressure at 50 °C	bar [a]	40
Superpressurization at 20 °C	bar [a]	25
Reference should be made to Figure 1 for further data on pressure/temperature relationships.		
[a] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.		

Table 7 — Storage container characteristics for HFC 125 – 42 bar

Property	Unit	Value
Maximum fill density	kg/m^3	929
Maximum container working pressure at 50 °C	bar [a]	63
Superpressurization at 20 °C	bar [a]	42
Reference should be made to Figure 2 for further data on pressure/temperature relationships.		
[a] 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.		

6.2 Superpressurization

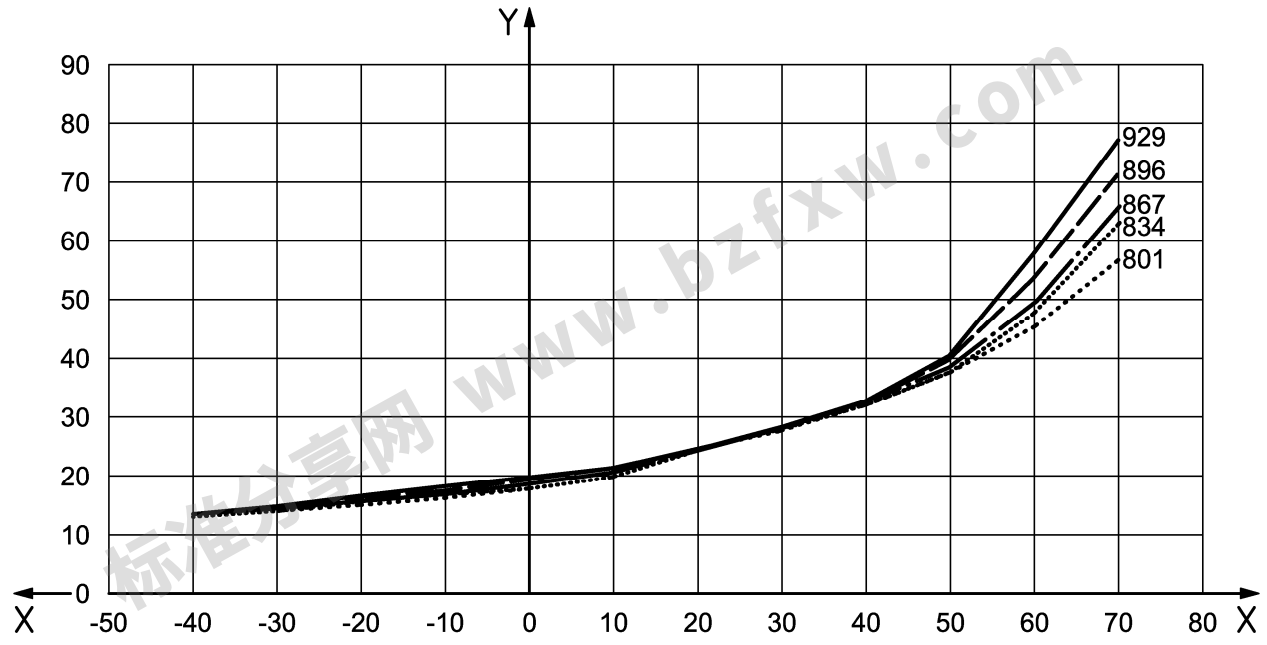
Containers shall be superpressurized with nitrogen with a moisture content of not more than 60×10^{-4} % by mass to an equilibrium pressure of $(25\ ^{+1,25}_{0})$ bar and $(42\ ^{+2,1}_{0})$ bar at a temperature of 22 °C (see Clause 1 for exception).

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 EN 15004-1:2008, 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 for particular hazards, while seeking advice from the relevant authority.

Values of density in kilograms per cubic metre

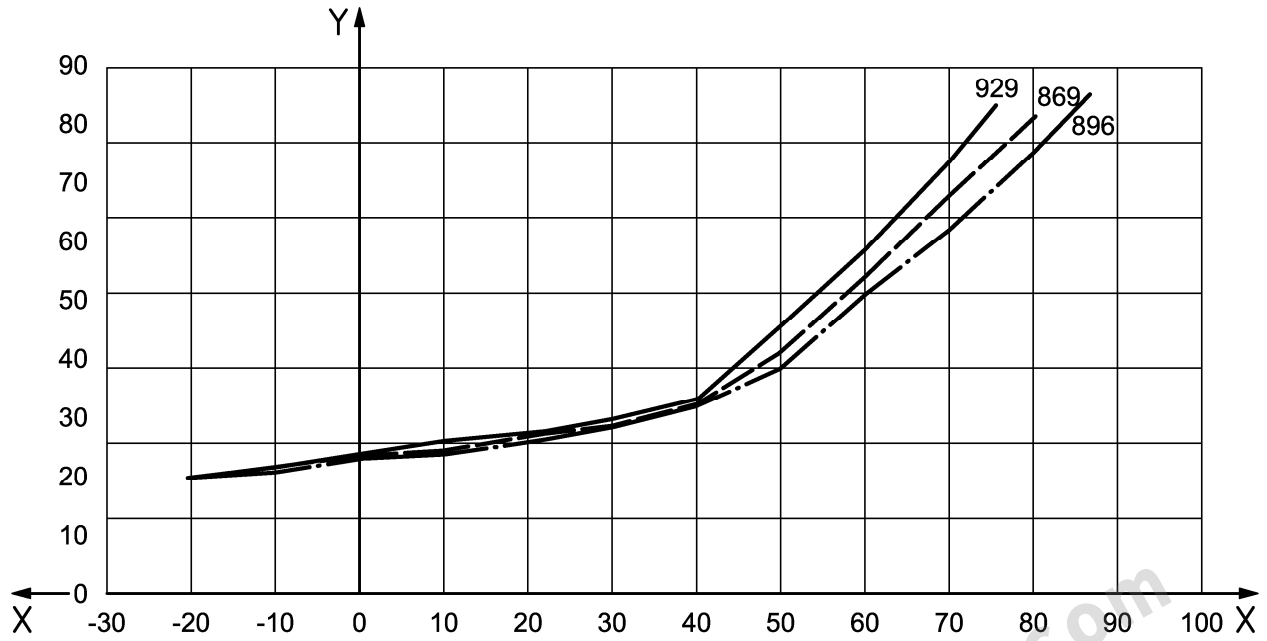


Key

X temperature, °C Y pressure, bar

Figure 1 — Temperature/pressure graph for HFC 125 – Superpressurized with nitrogen to 25 bar at 22 °C

Values of density in kilograms per cubic metre



Key

X temperature, °C

Y pressure, bar

Figure 2 — Temperature/pressure graph for HFC 125 – Superpressurized with nitrogen to 42 bar at 22 °C

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BSI Group Headquarters
389 Chiswick High Road,
London W4 4AL, UK
Tel +44 (0)20 8996 9001
Fax +44 (0)20 8996 7001
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