INTERNATIONAL STANDARD

ISO 14520-4

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

Part 4: FC-3-1-10 extinguishant

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

Partie 4: Agent extincteur FC-3-1-10

Reference number
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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

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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 3.

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.

Attention is drawn to the possibility that some of the elements of this part of ISO 14520 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 14520-4 was prepared by Technical Committee ISO/TC 21, *Equipment for fire protection and fire fighting*, Subcommittee SC 8, *Gaseous media fire extinguishing systems*.

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 3: FC-2-1-8 extinguishant*

— *Part 4: FC-3-1-10 extinguishant*

— *Part 6: HCFC Blend A extinguishant*

— *Part 7: HCFC 124 extinguishant*

— *Part 8: HCFC 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*

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

Part 4:
FC-3-1-10 extinguishant

1 Scope

1.1 This part of ISO 14520 contains specific requirements for gaseous fire-extinguishing systems, with respect to the FC-3-1-10 extinguishant. It includes details of physical properties, specification, usage and safety aspects.

1.2 This part of ISO 14520 covers systems operating at a nominal pressure of 25 bar, superpressurized with nitrogen. This does not preclude the use of other systems.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this part of ISO 14520. For dated references, subsequent amendments to, or revisions of, this publication do not apply. However, parties to agreements based on this part of ISO 14520 are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 14520-1:2000, *Gaseous fire-extinguishing systems — Physical properties and system design — Part 1: General requirements*.

3 Terms and definitions

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

4 Characteristics and uses

4.1 General

Extinguishant FC-3-1-10 shall comply with the specification shown in Table 1.

FC-3-1-10 is a colourless, odourless, electrically non-conductive gas with a density approximately eight times that of air.

The physical properties are shown in Table 2.

FC-3-1-10 extinguishes fires mainly by physical means but by some chemical means.

Table 1 — Specification for FC-3-1-10

Property	Requirement
Purity	99,0 % by mass, min.
Acidity	3×10^{-6} by mass, max.
Water content	10×10^{-6} by mass, max.
Non-volatile residue	100×10^{-6} by mass, max.
Suspended matter or sediment	None visible

Table 2 — Physical properties of FC-3-1-10

Property	Units	Value
Molecular mass	—	238
Boiling point at 1,013 bar (absolute)	°C	–2,0
Freezing point	°C	–128,2
Critical temperature	°C	113,2
Critical pressure	bar abs	23,23
Critical volume	cm^3/mol	376
Critical density	kg/m^3	633
Vapour pressure 20 °C	bar abs	2,84
Liquid density 20 °C	kg/m^3	1 517
Saturated vapour density 20 °C	kg/m^3	24,5
Specific volume of superheated vapour at 1,013 bar and 20 °C	m^3/kg	0,186
Chemical formula	C_4F_{10}	
Chemical name	Perfluorobutane	

4.2 Use of FC-3-1-10 systems

FC-3-1-10 total flooding systems may be used for extinguishing fires of all classes within the limits specified in clause 4 of ISO 14520-1:2000.

The extinguishant requirements per volume of protected space are shown in Table 3 for various levels of concentration. These are based on methods shown in 7.6 of ISO 14520-1:2000.

The extinguishing concentrations and design concentrations for *n*-heptane and surface class A hazards are shown in Table 4. Concentrations for other fuels are shown in Table 5 and inerting concentrations are shown in Table 6.

Table 3 — FC-3-1-10 total flooding quantity

Temperature T °C	Specific volume S m³/kg	FC-3-1-10 mass requirements per unit volume of protected space, m/V (kg/m³)							
		Design concentration (by volume)							
		5 %	6 %	7 %	8 %	9 %	10 %	11 %	12 %
0	0,0941	0,5593	0,6783	0,7998	0,9240	1,0510	1,1807	1,3134	1,4491
5	0,0958	0,5492	0,6661	0,7854	0,9074	1,0320	1,1594	1,2897	1,4230
10	0,0976	0,5395	0,6543	0,7715	0,8913	1,0138	1,1389	1,2669	1,3978
15	0,0993	0,5301	0,6429	0,7581	0,8758	0,9961	1,1191	1,2448	1,3734
20	0,1010	0,5210	0,6319	0,7451	0,8608	0,9791	1,1000	1,2235	1,3499
25	0,1027	0,5123	0,6213	0,7326	0,8464	0,9626	1,0815	1,2030	1,3272
30	0,1045	0,5038	0,6110	0,7205	0,8324	0,9467	1,0636	1,1831	1,3053
35	0,1062	0,4956	0,6011	0,7088	0,8188	0,9313	1,0463	1,1638	1,2841
40	0,1079	0,4877	0,5914	0,6974	0,8057	0,9164	1,0295	1,1452	1,2635
45	0,1097	0,4800	0,5821	0,6864	0,7930	0,9020	1,0133	1,1272	1,2436
50	0,1114	0,4725	0,5731	0,6758	0,7807	0,8880	0,9976	1,1097	1,2243
55	0,1131	0,4653	0,5643	0,6655	0,7688	0,8744	0,9824	1,0927	1,2056
60	0,1148	0,4583	0,5558	0,6555	0,7572	0,8613	0,9676	1,0763	1,1875
65	0,1166	0,4515	0,5476	0,6457	0,7460	0,8485	0,9532	1,0603	1,1699
70	0,1183	0,4449	0,5396	0,6363	0,7351	0,8361	0,9393	1,0449	1,1528
75	0,1200	0,4385	0,5318	0,6272	0,7245	0,8241	0,9258	1,0298	1,1362
80	0,1217	0,4323	0,5243	0,6183	0,7143	0,8124	0,9127	1,0152	1,1201
85	0,1235	0,4263	0,5170	0,6096	0,7043	0,8010	0,8999	1,0010	1,1044
90	0,1252	0,4204	0,5098	0,6012	0,6945	0,7900	0,8875	0,9872	1,0892
95	0,1269	0,4147	0,5029	0,5930	0,6851	0,7792	0,8754	0,9738	1,0744
100	0,1287	0,4091	0,4961	0,5850	0,6759	0,7687	0,8636	0,9607	1,0599

NOTE This information was supplied by the manufacturer, 3M Company, USA. It refers only to the product CEA-410, and may not represent any other products containing perfluorobutane.

Symbols:

m/V is the agent mass requirements (kg/m³); 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 (m³); 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 (°C); i.e. the design temperature in the hazard area;

S is the specific volume (m³/kg); the specific volume of superheated FC-3-1-10 vapour at a pressure of 1,013 bar may be approximated by the formula:

$$S = k_1 + k_2 T$$

where

k_1 = 0,094 104

k_2 = 0,000 344 55

c is the concentration (%); i.e. the volumetric concentration of FC-3-1-10 in air at the temperature indicated, and a pressure of 1,013 bar absolute.

Table 4 — FC-3-1-10 reference extinguishing and design concentrations

Fuel	Extinguishment %	Minimum design %
Heptane	5,9	7,7
Surface class A hazards [a]	5,0	6,5
NOTE Extinguishing values were derived by the manufacturer using the ICI cup burner method.		
[a] See 7.5.1.3 of ISO 14520-1:2000.		

Table 5 — FC-3-1-10 extinguishing and design concentrations for other fuels

Fuel	Extinguishment %	Minimum design %
Acetone	5,5	7,2
Benzyl alcohol	5,5	7,2
n-Butanol	6,7	8,7
Cyclohexane	5,5	7,2
Ethanol	6,8	8,8
Hexane	5,6	7,3
Isoctane	5,5	7,2
Isopropanol	6,2	8,1
JP-4	5,0	6,5
Methanol	9,4	12,2
Methyl ethyl ketone	5,9	7,7
Methyl isobutyl ketone	5,5	7,2
Toluene	4,2	5,5
NOTE Extinguishing values were derived by the manufacturer using the ICI cup burner method.		

Table 6 — FC-3-1-10 inerting and design concentrations

Fuel	Inertion %	Minimum design %
Methane	7,8	8,6
Propane	9,9	10,94
NOTE Inerting concentrations were determined in accordance with the requirements of ISO 14520-1:2000, 7.5.2 and annex D.		

5 Safety of personnel

Any hazard to personnel created by the discharge of FC-3-1-10 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; and

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

For minimum safety requirements, see ISO 14520-1:2000, clause 5.

Toxicological information for FC-3-1-10 is shown in Table 7.

Table 7 — Toxicological information for FC-3-1-10

Property	Value %
4-h LC_{50}	> 80 in 20 % O_2
No observed adverse effect level (NOAEL)	40
Lowest observed adverse effect level (LOAEL)	> 40
NOTE 4-h LC_{50} is the approximate concentration lethal to 50 % of 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 Table 8.

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 Figure 1 for various levels of fill density.

Table 8 — Storage container characteristics for FC-3-1-10

Property	Unit	Value
Maximum fill density	kg/m^3	1 280
Maximum container working pressure at 50 °C	bar	30
Superpressurization at 20 °C	bar	25
NOTE Reference should be made to Figure 1 for further data on pressure/temperature relationships.		