INTERNATIONAL STANDARD

**ISO 14520-10**

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

## Part 10: HFC 23 extinguishant

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

*Partie 10: Agent extincteur HFC 23*



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## Foreword

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 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 14520-10 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 10:
## HFC 23 extinguishant

## 1 Scope

**1.1** This part of ISO 14520 contains specific requirements for gaseous fire-extinguishing systems, with respect to the HFC 23 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 41 bar without nitrogen superpressurization. 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 HFC 23 shall comply with the specification shown in Table 1.

HFC 23 is a colourless, almost odourless, electrically non-conductive gas with a density approximately 2,4 times that of air.

The physical properties are shown in Table 2.

HFC 23 extinguishes fires mainly by physical means.

**Table 1 — Specification for HFC 23**

| Property | Requirement |
|---|---|
| Purity | 99,5 % (mol/mol), min. |
| Acidity | $3 \times 10^{-4}$ % by mass, max. |
| Water content | $2 \times 10^{-5}$ % by mass, max. |
| Non-volatile residue | 0,10 % by mass, max. |
| Suspended matter or sediment | None visible |

**Table 2 — Physical properties of HFC 23**

| Property | Units | Value |
|---|---|---|
| Molecular mass | — | 70 |
| Boiling point at 1,013 bar (absolute) | °C | –82,0 |
| Freezing point | °C | –155,2 |
| Critical temperature | °C | 25,9 |
| Critical pressure | bar abs | 48,36 |
| Critical volume | $cm^3/mol$ | 133 |
| Critical density | $kg/m^3$ | 525 |
| Vapour pressure 20 °C | bar abs | 41,80 |
| Liquid density 20 °C | $kg/m^3$ | 806,6 |
| Saturated vapour density 20 °C | $kg/m^3$ | 263,0 |
| Specific volume of superheated vapour at 1,013 bar and 20 °C | $m^3/kg$ | 0,3409 |
| Chemical formula | $CHF_3$ | |
| Chemical name | Trifluoromethane | |



## 4.2 Use of HFC 23 systems

HFC 23 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 acetone heptane, methanol and toluene are shown in Table 5, and inerting concentrations are shown in Table 6.

**Table 3 — HFC 23 total flooding quantity**

| Temperature | Specific vapour volume | HCFC 23 mass requirements per unit volume of protected space, $m/V$ (kg/m$^3$) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Design concentration (by volume) | | | | | | | | | |
| $T$ | $S$ | | | | | | | | | | |
| °C | m$^3$/kg | 10 % | 12 % | 14 % | 15 % | 16 % | 17 % | 18 % | 20 % | 22 % | 24 % |
| –60 | 0,2428 | 0,4576 | 0,5616 | 0,6705 | 0,7268 | 0,7845 | 0,8436 | 0,9041 | 1,0297 | 1,1617 | 1,3006 |
| –55 | 0,2492 | 0,4459 | 0,5472 | 0,6533 | 0,7081 | 0,7644 | 0,8219 | 0,8809 | 1,0032 | 1,1318 | 1,2672 |
| –50 | 0,2555 | 0,4349 | 0,5337 | 0,6371 | 0,6907 | 0,7455 | 0,8016 | 0,8591 | 0,9785 | 1,1039 | 1,2360 |
| –45 | 0,2617 | 0,4246 | 0,5211 | 0,6221 | 0,6743 | 0,7278 | 0,7826 | 0,8388 | 0,9553 | 1,0778 | 1,2067 |
| –40 | 0,2680 | 0,4146 | 0,5088 | 0,6074 | 0,6585 | 0,7107 | 0,7643 | 0,8191 | 0,9328 | 1,0524 | 1,1783 |
| –35 | 0,2742 | 0,4052 | 0,4973 | 0,5937 | 0,6436 | 0,6947 | 0,7470 | 0,8006 | 0,9117 | 1,0286 | 1,1517 |
| –30 | 0,2803 | 0,3964 | 0,4865 | 0,5808 | 0,6296 | 0,6795 | 0,7307 | 0,7831 | 0,8919 | 1,0062 | 1,1266 |
| –25 | 0,2865 | 0,3878 | 0,4760 | 0,5682 | 0,6160 | 0,6648 | 0,7149 | 0,7662 | 0,8726 | 0,9845 | 1,1022 |
| –20 | 0,2926 | 0,3797 | 0,4660 | 0,5564 | 0,6031 | 0,6510 | 0,7000 | 0,7502 | 0,8544 | 0,9639 | 1,0793 |
| –15 | 0,2987 | 0,3720 | 0,4565 | 0,5450 | 0,5908 | 0,6377 | 0,6857 | 0,7349 | 0,8370 | 0,9443 | 1,0572 |
| –10 | 0,3047 | 0,3647 | 0,4475 | 0,5343 | 0,5792 | 0,6251 | 0,6722 | 0,7204 | 0,8205 | 0,9257 | 1,0364 |
| –5 | 0,3108 | 0,3575 | 0,4388 | 0,5238 | 0,5678 | 0,6129 | 0,6590 | 0,7063 | 0,8044 | 0,9075 | 1,0161 |
| 0 | 0,3168 | 0,3507 | 0,4304 | 0,5139 | 0,5570 | 0,6013 | 0,6465 | 0,6929 | 0,7891 | 0,8903 | 0,9968 |
| 5 | 0,3229 | 0,3441 | 0,4223 | 0,5042 | 0,5465 | 0,5899 | 0,6343 | 0,6798 | 0,7742 | 0,8735 | 0,9780 |
| 10 | 0,3289 | 0,3378 | 0,4146 | 0,4950 | 0,5365 | 0,5791 | 0,6227 | 0,6674 | 0,7601 | 0,8576 | 0,9601 |
| 15 | 0,3349 | 0,3318 | 0,4072 | 0,4861 | 0,5269 | 0,5688 | 0,6116 | 0,6555 | 0,7465 | 0,8422 | 0,9429 |
| 20 | 0,3409 | 0,3259 | 0,4000 | 0,4775 | 0,5177 | 0,5587 | 0,6008 | 0,6439 | 0,7334 | 0,8274 | 0,9263 |
| 25 | 0,3468 | 0,3204 | 0,3932 | 0,4694 | 0,5089 | 0,5492 | 0,5906 | 0,6330 | 0,7209 | 0,8133 | 0,9106 |
| 30 | 0,3528 | 0,3149 | 0,3865 | 0,4614 | 0,5002 | 0,5399 | 0,5806 | 0,6222 | 0,7086 | 0,7995 | 0,8951 |
| 35 | 0,3588 | 0,3097 | 0,3801 | 0,4537 | 0,4918 | 0,5309 | 0,5708 | 0,6118 | 0,6968 | 0,7861 | 0,8801 |
| 40 | 0,3647 | 0,3047 | 0,3739 | 0,4464 | 0,4839 | 0,5223 | 0,5616 | 0,6019 | 0,6855 | 0,7734 | 0,8659 |
| 45 | 0,3707 | 0,2997 | 0,3679 | 0,4391 | 0,4760 | 0,5138 | 0,5525 | 0,5922 | 0,6744 | 0,7609 | 0,8519 |
| 50 | 0,3766 | 0,2950 | 0,3621 | 0,4323 | 0,4686 | 0,5058 | 0,5439 | 0,5829 | 0,6638 | 0,7489 | 0,8385 |
| 55 | 0,3826 | 0,2904 | 0,3564 | 0,4255 | 0,4612 | 0,4978 | 0,5353 | 0,5737 | 0,6534 | 0,7372 | 0,8254 |
| 60 | 0,3885 | 0,2860 | 0,3510 | 0,4190 | 0,4542 | 0,4903 | 0,5272 | 0,5650 | 0,6435 | 0,7260 | 0,8128 |
| 65 | 0,3944 | 0,2817 | 0,3457 | 0,4128 | 0,4474 | 0,4830 | 0,5193 | 0,5566 | 0,6339 | 0,7151 | 0,8007 |
| 70 | 0,4004 | 0,2775 | 0,3406 | 0,4066 | 0,4407 | 0,4757 | 0,5115 | 0,5482 | 0,6244 | 0,7044 | 0,7887 |



NOTE This information was supplied by the manufacturer, DuPont Fluoroproducts, USA. It refers only to the product, FE-13, and may not represent any other products containing $CHF_3$.

Symbols:

$m/V$ is the agent mass requirements (kg/m$^3$); 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 (m$^3$); 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 (m$^3$/kg); the specific volume of superheated HFC 23 vapour at a pressure of 1,013 bar may be approximated by the formula:

$$S = k_1 + k_2 T$$

where

$k_1$ = 0,316 4

$k_2$ = 0,001 2

$c$ is the concentration (%); i.e. the volumetric concentration of HFC 23 in air at the temperature indicated, and a pressure of 1,013 bar absolute.

**Table 4 — HFC 23 reference extinguishing and design concentrations**

| Fuel | Extinguishment<br>% | Minimum design<br>% |
|---|---|---|
| Heptane | 12 | 15,6 [a] |
| Surface class A hazards [b] | 15 [c] | 19,5 |

[a] See 6.3 (extinguishant quantity) for additional guidance.

[b] See 7.5.1.3 of ISO 14520-1:2000.

[c] Wood crib used; values verified by full-scale testing by ULI and FMRC.

**Table 5 — HFC 23 extinguishing and design concentrations for other fuels**

| Fuel | Extinguishment<br>% | Minimum design<br>% |
|---|---|---|
| Acetone | 12,0 | 15,6 |
| Heptane | 12,0 | 15,6 |
| Methanol | 16,3 | 21,2 |
| Toluene | 9,2 | 12,0 |

NOTE Values were derived in accordance with the requirements of ISO 14520-1:2000, annex B.



**Table 6 — HFC 23 inerting and design concentrations**



| Fuel | Inertion<br>% | Minimum design<br>% |
|---|---|---|
| Methane | 20,2 | 22,2 |
| Propane | 20,2 | 22,2 |

NOTE Inerting concentrations were derived in accordance with the requirements of ISO 14520-1:2000, annex D and 7.5.2.

## 5 Safety of personnel

Any hazard to personnel created by the discharge of HFC 23 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 14250-1:2000, clause 5.

Toxicological information for HFC 23 is shown in Table 7.

**Table 7 — Toxicological information for HFC 23**

| Property | Value<br>% |
|---|---|
| ALC | >65 |
| No observed adverse effect level (NOAEL) | 50 |
| Lowest observed adverse effect level (LOAEL) | >50 |
| NOTE 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 result in pressures exceeding the container specifications at the maximum design temperature. For an example, see 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 HFC 23**



| Property | Unit | Value |
|---|---|---|
| Maximum fill density | kg/m$^3$ | 860 |
| Maximum container working pressure at 50 °C | bar | 137 |
| Pressure at 20 °C | bar | Not required |
| NOTE Reference should be made to Figure 1 for further data on pressure/temperature relationships. | | |

## 6.2 Superpressurization

Containers for HFC 23 are not superpressurized.

## 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. In addition a factor shall be included in agent quantity calculations to compensate for any residual agent in the storage containers at the end of 10 s. The minimum factor shall be 11 % more than that derived from Table 3.

The design concentrations shall be that specified for relevant hazards shown in Table 4. This includes a 1,3 safety factor on the extinguishing concentration.

Consideration should be given to increasing this for particular hazards, and seeking advice from the relevant authority.