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Fixed firefighting systems — Gas extinguishing systems —

Part 9: Physical properties and system design of gas extinguishing systems for IG-55 extinguishant

ICS 13.220.20

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 15004-9:2008. It supersedes BS ISO 14520-14:2005 which is withdrawn.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.

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Foreword

This document (EN 15004-9:2008) 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of an identical text or by endorsement, at the latest by December 2008, and conflicting national standards shall be withdrawn at the latest by December 2008.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 14520-14:2005 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 14520-14:2005

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.

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

ISO 14520-14 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 14520-14:2000), 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 IG-55 extinguishant. It includes details of physical properties, specification, usage and safety aspects and is applicable to systems operating at nominal pressure of 150 bar, 200 bar and 300 bar at 15 °C. This does not preclude the use of other systems; however, design data for other pressures were not available at time of publication.

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 IG-55 shall comply with the specification according to Table 1.

IG-55 is a colourless, odourless, electrically non-conductive gas with a density approximately the same as that of air. It is an inert gas mixture consisting nominally of 50 % argon and 50 % nitrogen with the following mixture specification:

a) Argon: range of (50 ± 5) %;

b) Nitrogen: range of (50 ± 5) %.

The physical properties are given in Table 2.

IG-55 extinguishes fires by a reduction of the oxygen concentration in the atmosphere of the hazard enclosure.

Table 1 — Specification for IG-55

Property	Requirement	
	Argon	Nitrogen
Purity	> 99,9 %	> 99,9 %
Water content	$< 15 \times 10^{-6}$	$< 10 \times 10^{-6}$
Only principal contaminants are shown. Other measurements may include hydrocarbons, CO, NO, NO^2, CO^2, etc. Most are $< 20 \times 10^{-6}$.		

Table 2 — Physical properties of IG-55

Property	Unit	Value
Molecular mass	—	33,98
Boiling point at 1,013 bar (absolute) [a]	°C	—
Freezing point	°C	—
Critical temperature	°C	—
Critical pressure	bar abs [a]	—
Critical volume	cm^3/mol	—
Critical density	kg/m^3	—
Vapour pressure 20 °C	bar abs [a]	—
Liquid density 20 °C	kg/m^3	—
Saturated vapour density 20 °C	kg/m^3	—
Specific volume of superheated vapour at 1,013 bar and 20 °C	m^3/kg	0,708
Chemical formulas	N_2 50 % by volume Ar 50 % by volume	
Chemical names	Nitrogen Argon	

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

4.2 Use of IG-55 systems

IG-55 total flooding systems may be used for extinguishing fires of all classes within the limits specified in EN 15004-1:2008, Clause 4.

The specific vapour volumes are shown in Table 3. The quantity, Q, of agent required per volume of protected space is determined using the equation in Table 3.

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

Table 3 — IG-55 total flooding quantity

Temperature T °C	Specific vapour volume S m³/kg	Temperature T °C	Specific vapour volume S m³/kg
– 40	0,5632	30	0,7323
– 35	0,5752	35	0,7444
– 30	0,5873	40	0,7564
– 25	0,5994	45	0,7685
– 20	0,6115	50	0,7806
– 15	0,6236	55	0,7927
– 10	0,6356	60	0,8048
– 5	0,6477	65	0,8168
0	0,6598	70	0,8289
5	0,6719	75	0,8410
10	0,6840	80	0,8531
15	0,6960	85	0,8652
20	0,7081	90	0,8772
25	0,7202	95	0,8893
30	0,7323	100	0,9014

This information refers only to IG-55, and may not represent any other products containing nitrogen and argon as components.

The quantity Q (in cubic metres) of agent required at a reference temperature of 20 °C and a pressure of 1,013 bar per cubic metre of protected volume to produce the indicated concentration at the temperature specified is calculated from:

$$Q_R = m \cdot S_R$$

where S_R is the specific reference volume (in cubic metres per kilogram); i.e. the specific vapour volume at the filling reference temperature for superheated IG-55 vapour at a pressure of 1,013 bar which may be approximated by the formula:

$$S_R = k_1 + k_2 \cdot T_R$$

where k_1 = 0,6598; k_2 = 0,002416; T_R is the reference temperature (in degrees Celsius), i.e. filling temperature (20 °C in the table).

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

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

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 IG-55 vapour at a pressure of 1,013 bar may be approximated by

$$S = k_1 + k_2 \cdot T \ .$$

c is the concentration (in percent); i.e. the volumetric concentration of IG-55 in air at the temperature indicated, and a pressure of 1,013 bar absolute.

Table 4 — IG-55 reference extinguishing and design concentrations

Fuel	Extinguishment % by volume	Minimum design % by volume
Class B		
Heptane (cup burner) Heptane (room test)	36,5 36,6	47,6
Surface Class A		
Wood crib PMMA PP ABS	28,7 30,7 29,3 31,0	40,3
Higher Hazard Class A	[a]	45,2

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 IG-55 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.

For minimum safety requirements, see EN 15004-1:2008, Clause 5.

Physiological information for IG-55 is given in Table 5.

Table 5 — Physiological information for IG-55

Property	Value % by volume
No observed adverse effect level (NOAEL)	43
Lowest observed adverse effect level (LOAEL)	52
These values are based on physiological effects in human subjects of hypoxic atmospheres. These values are the functional equivalents of NOAEL and LOAEL values, and correspond to 12 % minimum oxygen for the no-effect level and 10 % minimum oxygen for the low-effect level.	

6 System design

6.1 Fill pressure

The fill pressure of the container shall not exceed the values given in Tables 6, 7 and 8, for systems operating at 150 bar at 15 °C, 200 bar at 15 °C and 300 bar at 15 °C, respectively.

Other pressures may be used and the minimum design pressure specified accordingly.

The relationships between pressure and temperature are shown in Figure 1.

Table 6 — Storage container characteristics for IG-55 — 150 bar

Property	Unit	Value
Filling pressure at 15 °C	bar [a]	150
Maximum container working pressure at 50 °C	bar [a]	178
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 IG-55 — 200 bar

Property	Unit	Value
Filling pressure at 15 °C	bar [a]	200
Maximum container working pressure at 50 °C	bar [a]	240
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 8 — Storage container characteristics for IG-55 — 300 bar

Property	Unit	Value
Filling pressure at 15 °C	bar [a]	300
Maximum container working pressure at 50 °C	bar [a]	366
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.		

6.2 Superpressurization

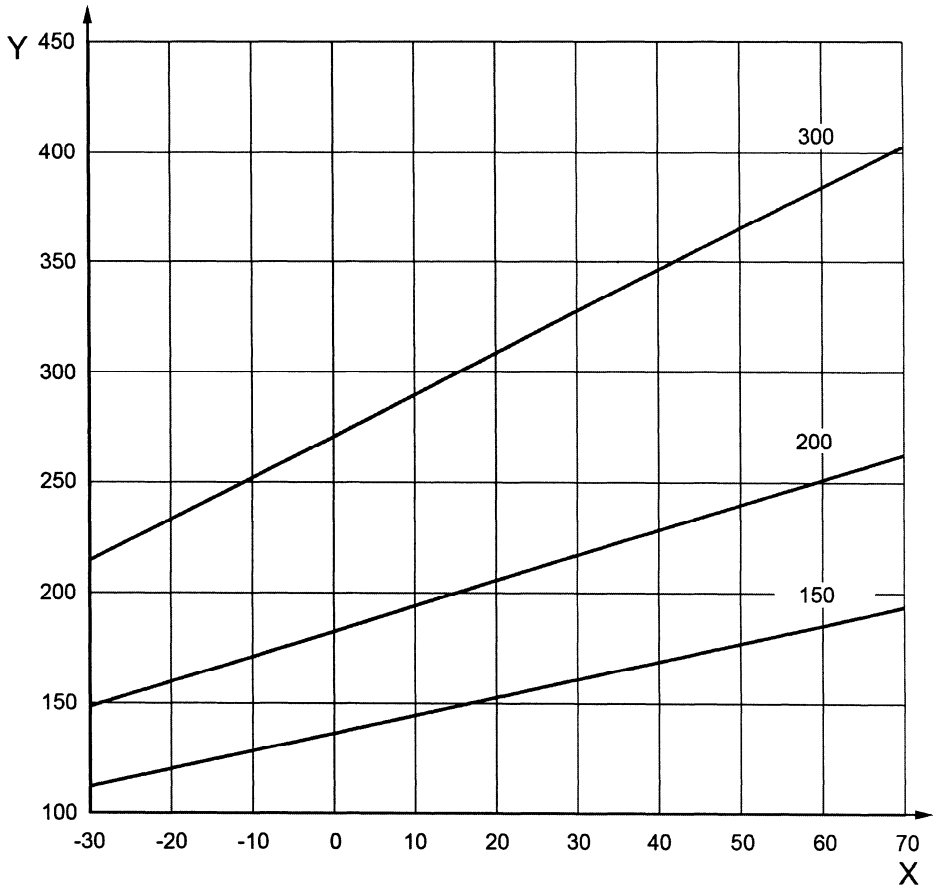
Containers for IG-55 are not superpressurized.

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 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.



Key

X temperature, °C

Y pressure, bar

Figure 1 — Temperature/pressure graph for IG-55 pressurized to 150 bar, 200 bar and 300 bar at 15 °C

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